

2019 2nd International Conference on Mathematics and Natural Sciences

IC^{ON} MNS 2019

**“Developing Mathematics, Natural Sciences,
Marine, and Educational Researches Oriented
to Sustainable Development Goals”**



Organized by



August, 30-31 2019
Harris Sunset Road, Kuta-Bali
<http://fmipa.undiksha.ac.id/iconmns2019>

The Faculty of Mathematics and Natural Sciences
Universitas Pendidikan Ganesha



PROSIDING
The 2nd International Conference on Mathematics and Natural Sciences

"Developing Mathematics, Natural Sciences, Marine, and Educational Researches Oriented to Sustainable Development Goals"
”

Disunting oleh :

Dr. I Wayan Puja Astawa, M.Stat.Sci.
Putu Kartika Dewi, M.Sc.
Putu Widiarini, M.Pd., M.Sc.
Ni Luh Putu Ananda Saraswati, M.Si.
Luh Mitha Priyanka, M.Pd.

Diselenggarakan di Singaraja pada 30-31 Agustus 2019

Diselenggarakan oleh :

Fakultas Matematika dan Ilmu Pengetahuan Alam
Universitas Pendidikan Ganesha
Singaraja

UNDIKSHA PRESS
2019

The 2nd International Conference on Mathematics and Natural Sciences

Tema : “Developing Mathematics, Natural Sciences, Marine, and Educational Researches Oriented to Sustainable Development Goals”

Advisory Board

Prof. Dr. I Nengah Suparta, M.Si. (Ganesha University of Education, Indonesia)
Prof. Dr. Ida Bagus Jelantik Swasta, M.Si (Ganesha University of Education, Indonesia)
Dr. I Gusti Lanang Wiratma, M.Si. (Ganesha University of Education, Indonesia)
Dr. Sri Handayani (Universitas Negeri Yogyakarta)
Dr. Jane Sylvia Annatje Sumarauw (Universitas Negeri Manado)
Dr. Suyatno, M.Si (Institut Teknologi Sepuluh November Surabaya)
Dr. I Gusti Made Ngurah Budiana, S.Si., M.Si. (Universitas Nusa Cendana NTT)
Prof. Dr. Sabine Fechner (Paderborn University, Germany)
Prof. Ernesto Mollo, Istituto Di Chimica Biomolecolare, Italia.
Prof. Kazuhito Kawakita, Ph.D (Nagoya University)
Prof. Sathoshi Ohkura, Ph.D (Nagoya University)
Dr. Eliani Ardi, Astrophysic (Kyoto International University)
Dr. Martina Restuati, M.Si (Universitas Negeri Medan)
Prof Nyoman Adi Asmara Giri (BBRPBL, Gondol Buleleng)

Scientific Committee :

Drs. I Wayan Muderawan, M.S.,Ph.D.
Dr. rer. nat. I Wayan Karyasa, S.Pd., M.Sc.
Prof. Dr. Phil I Gusti Putu Sudiarta, M.Si.
Prof.Dr. I Gusti Putu Suharta,M.Si
Prof.Dr. I Wayan Santiasa, M.Si
Prof. Dr. I Wayan Suastra, M.Pd.
Prof.Dr. Ketut Suma,MS
Prof. Drs. I Wayan Subagia,M.Sc, PhD
Prof.Dr . Wayan Redhana,M.Si
Prof. Dr. Made Sutajaya,M.Kes
Dr. rer. nat. I Gusti Ngurah Agung Suryaputra, S.T., M.Sc.
I Wayan Mudianta, S.Pd., M.Phil., Ph.D.
Dr. I Nyoman Sukajaya, M.T.
Dr. I Wayan Sukrawarpala, M.Sc.
Dr. I Nyoman Dodik Prasetya,S.Si, M.Si
Prof. Dr. Ni Putu Ristiati, M.Pd.
Dr. I Gede Ari Yudasmara, M.Si.
Dr. Ida Bagus Putu Mardana
Dr . Ir Ketut Sri Marheni Julyasih,M.Si

Editor:

Dr. I Wayan Puja Astawa, M.Stat.Sci.
Putu Kartika Dewi, M.Sc.
Putu Widiarini, M.Pd., M.Sc.
Ni Luh Putu Ananda Saraswati, M.Si.
Luh Mitha Priyanka, M.Pd.

Panitia Pelaksana:

Ketua Pelaksana : Dr . I Gede Aris Gunadi, S.Si, M.Kom
Sekretaris : Dr. Gede Iwan Setiabudi.,S.Pd.,M.Si
Bendahara : Kadek Swandewi,A.Md
Humas dan Acara : Ni Putu Kartika Dewi, S.Pd,M.Sc .
Internal Editor : Drs. I Wayan Muderawan, M.S.,Ph.D.
Sekretariat : Putu Pasek Suryawan.,S.Pd,M.Pd
Prosiding : Dr. I Wayan Puja Astawa, M.Stat.Sci.
IT Support : Made Suarsana, S.Pd, MSi

Diterbitkan oleh:

Undiksha Press

Jalan Udayana No. 11
Telp. +62 362 26609
Fax. +62 362 25735
Email lp3undiksha@yahoo.com
Singaraja-Bali

ISBN 978-623-7482-41-3

WELCOME ADDRESS: CHAIR OF THE COMMITTEE

Om Swastyastu, Assalamualaikum Wr. Wb., Namoh Buddhaya, Shalom,

The honourable Rector of Universitas Pendidikan Ganesha, and all Vice Rectors.

The Head of Research Institute and Community Service Universitas Pendidikan Ganesha.

The Dean of the Faculty of Mathematics and Natural Sciences and all Vice Deans,

The Speakers and Participants,

Ladies and Gentlemen,

First of all, let us praise and thank The Almighty God for His graces bestowed upon us. Allow me to heartily welcome all participants to Bali. It is my pleasure and privilege to extend our warmest welcome to all participants of the IConMNS 2019, the 2nd International Conference on Mathematics and Natural Sciences 2019 with the theme of “Developing Mathematics, Natural Sciences, Marine, and Educational Researches Oriented to Sustainable Development Goals”. The purpose of this conference is to promote and encourage the exchange of thoughts and ideas of the advanced research in the fields of mathematics, natural sciences, education, marine, and computer science.

The Faculty of Mathematics and Natural Sciences, Universitas Pendidikan Ganesha is proud to organized and host this conference. We received 217 abstract submissions, of which 194 manuscripts will be presented tomorrow on 31st of August. Moreover, the conference is also attended by 34 non-presenter participants. To all presenters and participants, thank for your enthusiastic responses to the conference. Your present in this conference is highly appreciated.

In this special occasion, let me also give a special welcome to our keynote and invite speakers who are pleased to make contributions to our conference and share their new research ideas with us. They are Prof. Dr. Susanne Bogeholz from Department of Biology Education, Faculty of Biology and Psychology Albrecht-von-Haller-Institute for Plant Sciences Waldweg, Gottingen, Germany; Prof. Dr. Ernesto Mollo from Institute of Biomolecular Chemistry, Italia; Prof. Kazuhito Kawakita, Ph.D from Nagoya University, Japan; Prof. Sathoshi Ohkura from Nagoya University, Japan; Prof. Dr. Phil IGP. Sudiarta from Universitas Pendidikan Ganesha, Indonesia; Dr. Eliani Ardi from Osaka University, Japan; Prof. I Nyoman Adi Asmara Giri from Institute for Mariculture Research and Fishes Extension (IMRAFE), Gondol Buleleng Indonesia.

On 31st August, we have 7 parallel presentation sessions including mathematics education, mathematics, computer science, environmental science, marine and fisheries science, chemistry, chemistry education, natural science education, physics, and physics educations. The platform is ready, so please seize this opportunity to show your thoughts, ideas, and innovations confidently.

Wish you will enjoy this conference, contribute effectively toward it and bring home the knowledge, experiences, relations, and happy memories. Thank you for your attention and have a nice day.

Om, Shanti, Shanti, Shanti, Om; Wassalamualaikum Wr. Wb.; Sadhu, Sadhu, Sadhu; Shalom

Denpasar, August 30th, 2019
Chair,
I Gede Aris Gunadi

DAFTAR ISI

Judul	Hal
<i>The Prediction of Inflation Rate in Denpasar City Using Artificial Neural Network by Considering Foodstuffs Prices</i>	
Restu Wiranata, Emik Sapitri, and Eka N. Kencana	1-6
<i>Predicting the gold jewellery price in Bali: an ANN Approach</i>	
Putu Adi Gunawan, Nasyaldha Indrianto, and Eka N Kencana	7-12
<i>Fuzzy Logic in The Navigation of Line Follower Robot</i>	
C Widyawati and Sugiyarto	13-19
<i>Decision Support System for Outstanding Lecturers Selection at Dhyana Pura University by the Combination of Analytical Hierarchy Process Methods and Simple Additive Weighting</i>	
P W Rahayu, I G A Gunadi, and I M Candiasa	20- 26
<i>Help With Math: A Serious Game For the 3rd Grade Elementary School Students in Plane Geometry</i>	
Kadek Arya Teguh Raharja, and Sukajaya I N	27-35
<i>Captain Math: An Educational Game For The 5th Grade of Elementary School Students In Weight-Unit Conversion</i>	
Damurrosysyi and Sukajaya I	36-45
<i>Story of Math: A Serious Game Based-Learning for Improvement of Students Achievement in Time Unit Conversion</i>	
P Rika Sahriana, and Sukajaya I N	46-60
<i>A Lower Bound For Irregularity Strength of The Complete Graph of Power Two Vertices</i>	
Kadek Riska Savitri, and I Nengah Suparta	61-64

Developing Geogebra Mathlet On Geometry Transformation Oriented Ikrar Strategy To Improve Students Mathematical Problem Solving Skills

I Dewa Gede Putra Ardinata, I Gusti Putu Sudiarta, and I Gusti Putu Suharta 65- 70

The Influence of Edmodo Assignment Method towards Students' Motivation and Achievement on Learning Matemathics

Mahayukti, Gst Ayu, Dinda Nirmala Suci, Ni Gst Ayu Made, and Sariyasa 71-78

Development of Contextual Fable Module Charged with Characters in Problem Based Learning to Improve Students Concept Understanding and Mathematical Motivation

N M W Pradnyawati, I G P Suharta, and I N Suparta 79-84

Development of Geogebra-Based Assessments to Increase Student Motivation and Literacy in Mathematics

Ida ayu Kade Suryani, I Made Ardana, and I Gusti Putu Suharta 85-88

Development Of Problem-Based Physics Learning Module To Improve Students Critical Thinking Ability

Aditya, T. P., Dewi, R. I. L., Sari, N. M. D. M. P., Suma, K., Gunadi, I. G. A 89-96

Development of STEM-Based PhET Simulation Students Woorksheet To Improve Creative Thinking Skills of Class XI in High School

I Made Astra, and Hannah Yessi Pricilia 97-102

Analysis of insulation ability on partition room compartment

Dewi oktifa Rahmawati, and I Gede Aris Gunadi 103-109

The Effect of Chitosan Immersion to Physical and Breaking Strength of Pineapple Leaves Rope for Fishing Gear

Muth Mainnah, Diniah, Budi Hascaryo, and Made Mahendra Jaya 110-118

The Implementation of 7E Learning Cycle Model in Improving the Social Attitude And Physics Learning Achievement of the XI MIPA 3 Class Students of in the Academic Year of 2018/2019

119-128

***The Effect Of Problem Based Learning Model toward Formal Reasoning Ability
And Science Process Skills Of Junior High School***

Pratiwi Ni Luh Gede Sri, Suastra I W , and Siti Maryam 129-135

***Fish Abundance in The Estuary of Cianjur, West Java Based on Temporal of
Lunar Cycles and Spatial Differences***

E Paujiah, A Mas'ud, and Wilman Taupik Ardiansyah 136-139

***Water Quality Management for Surface Water Resources: System Dynamics
(SD) Approach***

Hendra Andiananta Pradana, Elida Novita, Bambang Herry Purnomo, and Amelia
Ika Puspitasari 140-147

***The Development Of Student Worksheet On Science Subject SMK Based On
Internet Learning Resources To Improve Learning Outcomes***

Made Shita Prajnitya, I Wayan Subagia, and Desak Made Citrawathi 148-154

***Development of Chemistry Learning Book Based on Case Study to Improve
Students' Learning Outcome***

L A Widiandari, I W Redhana, and A A I A R Sudiarmika 155-160

***Development of Multiple Representations Chemistry Learning Book to Improve
Students' Learning Outcomes***

K Widiastari, I W Redhana, and N K Rapi 161-168

Analysis of Students' Learning Interest toward Chemistry

L G Suryani, I N Suardana, and I W Redhana 169-173

***Website Based Multimedia Development as Learning Media on Wave and Sound
Vibration Materials to Increase Student Motivation and Learning Outcomes***

Ni Putu Dewi Masyuni , Ketut Suma and I Dewa Ketut Sastrawidana 174-180

The Effect of Self-Efficacy, Achievement Motivation, and Study Habits to Science Literacy at Junior High School Students

I Gede Sandi Wiarsana, I Wayan Sadia, and Ida Bagus Putu Arnyana

181-191

The Academic Supervision Process by Principal in Science Learning at SMPN Satap 1 Tembuku

I W Winarsa, I W Subagia, and N L P M Widayanti

192-197

Levels of serum glutamate oxaloacetate transaminase (sgot) white rat (Rattus norvegicus) wistar strain after administration Katsuwonus pelamis L. which has been soaked using the leaf extract of Moringa oleifera L.

198-205

N L P M Widiyant , N P Ristiati , D M Citrawathi, D W Wahyuni

The implementation of flipped learning model in classroom: literature review

L P R Ukirsari, I W Subagia and N P Ristiati

206 -212

The effect of science environment technological and society learning model (SETS) on the students' critical thinking skill and learning achievement

213-217

D A P D O Lestari, K Suma and I W Suja

The Development of Local Wisdom-based Learning Material for Science Instruction in Junior High School

218-225

I Wayan Sukra Warpala

The Prediction of Inflation Rate in Denpasar City Using Artificial Neural Network by Considering Foodstuffs Prices

Restu Wiranata¹, Emik Sapitri², and Eka N. Kencana³

¹Department of Mathematics, Udayana University

E-mail: ¹restuwiranata98@gmail.com, ²emikpitri@gmail.com,

³i.putu.enk@unud.ac.id,

Abstract. Inflation is a phenomenon of price increases that are general and continuous on one item which can extend to most other item types. Foodstuffs prices can be affected by inflation. It is necessary to predict inflation rate so the people can anticipate the increases of foodstuffs prices. The significance between each of 5 types of foodstuffs that found on Indonesian National Strategic Food Price Information Center (Pusat Informasi Harga Pangan Strategis Nasional Indonesia) and inflation rate in Denpasar were checked by ANOVA. The result showed among 5 checked foodstuffs i.e. rice, red onion, beef, chicken, and cayenne pepper, only the last has significant effect on inflation in Denpasar City. Therefore, this study uses cayenne pepper prices data in Denpasar City from July 2016 until June 2019 to predict inflation rate on June 2019. The inflation data are obtained from Badan Pusat Statistik Provinsi Bali. Inflation rate in Denpasar City will be predicted using artificial neural networks that are processed by Jupyterlab 0.31.5. After testing the architecture with hidden unit size from 1 to 15, the 1-11-1 architecture chosen as best architecture for predicting inflation rate. The predicted inflation rate in June 2019 is 0.1587. So, this study has contributed to predicting the latest inflation rate in Denpasar City.

1. Introduction

Denpasar is the capital of Bali Province, one of small island in Indonesia. Commonly, before traditional ceremonies in Bali, price fluctuations usually occurs on some commodities, which one is food commodities. Food commodities are everything that can be consumed and traded comes from the soil and require the help of water as well as biological and animal sources that can be used and traded by humans as foodstuffs [1] [2]. Foodstuffs' prices can be affected by inflation. Inflation is a phenomenon of price increases that are general and continuous on one item which can extend to most other item types and become great problem for the developing countries [3]. Friedman (1956) and Lim & Papi (1997) in [3] said that inflation is always occur in monetary phenomenon and the key to inflation is an increase in money supply. Inflation can be classified into food inflation, in which the prices of food items are increased [3].

Uncontrolled inflation negatively affects the society, noting an increase in goods and services' price will automatically reduce people purchasing power. Then, it is necessary to predict inflation rate so the people may anticipate the increases of foodstuffs' prices. For that reason, this study aimed to forecast the inflation rate of Denpasar City from the best Artificial Neural Network (ANN) model.

ANN is computing model of the processing elements (called neurons) and the relationship between them with the coefficient (weight) is tied to the connection that consist training and testing algorithms [4]. ANN can be used in forecasting [5]. So, ANN can process some data to estimate something in the future.

ANN model need some inputs data [6]. To get the best input for ANN models, this study use the Multiple Regression Analysis to check the relationship amongst foodstuffs' prices and the inflation rate of Denpasar City. ANN model(s) were built refers to significant price(s).

Setiawan & Hardianto (2014) [7] examined the price of food commodities that have an impact on inflation in Banten Province. As a result, commodity prices for corn, rice, pedigree meat, purebred chicken eggs and curly red chili are expected to have an impact on increasing inflation in Banten Province. Based on that reference and on data obtained from Pusat Informasi Harga Pangan Strategis Nasional (PIHPSN) Indonesia, this study utilizes the prices of five food items: rice, onion, beef, chicken meat, and cayenne pepper to test the significance of inflation in the city Denpasar with the Multiple Regression Analysis.

Multivariate regression analysis is a regression models with one dependent variable and more than one independent variable [8]. Green & Salkind (2012) in [9] said that for examining the relationship between variables, researchers can use the Multiple Regression Analysis especially t-test or ANOVA to compare the means of two groups on the dependent variable. The main difference between t-test and ANOVA is that t-test can only be used to compare two groups while ANOVA can be used to compare two or more groups [9].

ANN used in this study is a follow up of the ANOVA test results. Food price data that significantly affect inflation in the city of Denpasar will be used as input to predict the inflation rate in the city of Denpasar in the most recent month when this research was conducted, namely June 2019. Previously, several network architectures will be tested to get the best model to predict the inflation rate. Thus, this research will produce the latest predictions of inflation rates in the city of Denpasar.

2. Method

This study utilizes two kinds of data, such as:

The prices of five food items, namely: rice, onion, beef, chicken meat, and cayenne pepper in Denpasar City. These data were obtained from Indonesian National Strategic Food Price Information Center (Pusat Informasi Harga Pangan Strategis Nasional Indonesia), for period July 2016 until June 2019.

The inflation rate data at Denpasar for period July 2016 until May 2019 were collected from Bali Statistics Office (BPS Bali).

This study aimed to forecast the inflation rate of Denpasar City from the best ANN model. To built best model, we need to know the significant variable amongst the five food items as best inputs for the ANN model. For that reason, this study use multiple regression to check the relationship amongst foodstuffs' prices and the inflation rate of Denpasar City.

To conduct regression analysis, we used SPSS for Windows. The dependent variable is the inflation rate of Denpasar City (INF), while the independent variables are the prices of rice (RIC), onion (ONI), beef (BEE), chicken meat (CHI), and cayenne pepper (CAY). The multiple regression equation will built from the significant price(s). The multiple regression equation is formulated as [8]:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n + \dots \quad (1)$$

where y refer to inflation rate, x_i refer(s) to the significant price(s), i is parameter, and ϵ is error.

On the next steps, the significant price(s) will use as input(s) data for the ANN model(s). Before built the ANN models, the data must be transform to range 0 to 1. This process called normalization. On this study, the min-max formula is used to normalize the data. The formula is [10]:

$$X_{norm} = (X_k - X_{min}) * (1 - 0) / X_{max} - X_{min} ; \text{fork} = 1, 2, 3, , n \quad (2)$$

After do the normalization process, the data should be separate as training and testing data. This study use 80% : 20% as a proportion for separate the data [11]. So, training data contains 80% of data and testing data contains 20%.

The training and testing data uses to built some ANN models. The ANN models that were built is only differ from the number of neurons on hidden layer. One hidden layer is defined between those layers with its neuron varied from 1 to 15. Every ANN model is processed by applying JupyterLab 0.31.5 with Python programming language. The total iteration was set as much as 2000 iteration [16].

To get the optimal number of neurons in hidden layer, a training process is carried out using the backpropagation algorithm. Then, the regularization process will be conducted to minimize overfitting. Regularization utilizes lambda parameters to avoid all parameters except intercepts so that the model generalizes data and will not overfit [12].

To choose the best ANN model, the average forecasting error rates (AFER) per iteration will be calculated. The best model is chosen based on its AFER, where the model with the smallest AFER is the best ANN model.

The AFER that will be calculated is the average error after the regularization process. AFER is calculated by the formula:

$$AFER = 1/n \sum J_i - TestJ_i \quad (3)$$

where n represents many iterations, J_i represents the value of the cost function in the i iteration for training data, and $testJ_i$ states the cost function value in the i iteration for the test data.

The best ANN model will be used to forecast the inflation rate of Denpasar City on the next month. This study use Jupyterlab 0.31.5 to get the forecast result. The forecast result obtained from Jupyterlab 0.31.5 is still a normalized result. For this reason, a de-normalization process must be carried out to obtain the actual results. De-normalization is carried out according to the normalization formula. The de-normalization formula is shown below:

$$X_{realresult} = X_{normresult} * (X_{max} - X_{min}) / (1 - 0) + X_{min} \quad (4)$$

3. Result

The regression analysis result is listed on table 1. From table 1, can be seen that only the P-Value of cayenne pepper (CAY) that approaching the value of $= 0:05$. This means that data cayenne pepper (CAY) is significant affects the inflation rate [13]. Refers to the regression result that shows cayenne pepper (CAY) is the only variable significantly affects the inflation rate, then we built single regression to study the causal relationship between INF and CAY. We got the regression equation between these variables as follows:

Table 1. Regressions' Results				
Predictor	Standardized	t-Value	p-Value	VIF
RIC	0.236	1.089	0.285	1.756
ONI	0.189	0.941	0.355	1.518
BEE	{ 0.079	{ 0.434	0.667	1.241
CHI	0.112	0.521	0.606	1.727
CAY	0.375	1.989	0.056	1.330

$$INF = 0.375CAY + \wedge$$

This equation is significant [14] and has a coefficient of determination (R^2) as much as 37.5 percent. This means the influence of cayenne pepper (CAY) amounted 37.5 percent to inflation rate (INF) and as much as 62.5 percent are influenced by factors outside the model.

By believing CAY is the significant determinant of the INF, we decided to build an ANN model where its input and output layers are CAY and INF, respectively. So, the normalized form of CAY and INF are calculated.

After normalized the CAY and INF data with min-max formula, the data will separate into training and testing data. This study uses normalized data of cayenne pepper (CAY) for period July 2016 until June 2019 and inflation rate data at Denpasar for period July 2016 until May 2019. So, training data contains 28 data and testing data contains 7 data.

Some ANN models were built. One hidden layer is defined between input and output layer with its neuron varied from 1 to 15 [15]. Every model is processed by applying JupyterLab 0.31.5. In addition, the average forecasting errors rates (AFER) for each architecture is recorded.

The best model is chosen based on its AFER, where the model with the smallest AFER is the best ANN model. The AFERs were listed on Table 2.

Table 2. The AFERs					
Neuron	AFER	Neuron	AFER	Neuron	AFER
1	0.00282	6	0.00189	11	0.00169
2	0.00326	7	0.00193	12	0.00176
3	0.00208	8	0.00190	13	0.00200
4	0.00189	9	0.00174	14	0.00181
5	0.00193	10	0.00170	15	0.00195

Refers to those AFERs, the best model is the ANN architecture with 1 input (CAY), 1 output (INF), and 1 hidden layer with 11 neurons with AFER = 0.00169. The iterations' error on best ANN model were displayed on Figure 1.

By using 1-11-1 model, the inflation rate on June 2019 will forecast. The forecasts' result is 0.3554 and the de-normalized form is 0.1587.

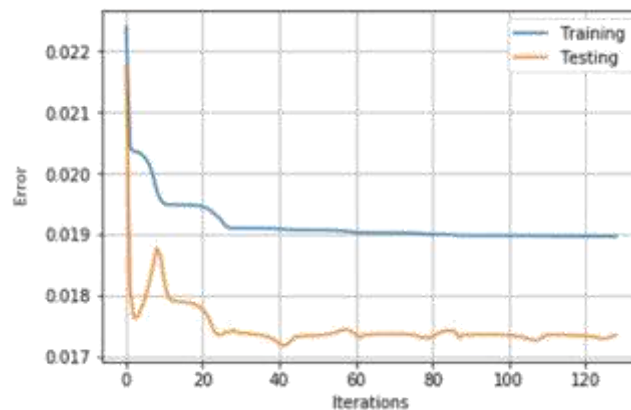


Figure 1. Iterations' error on 1-11-1 model

4. Conclusion

Based on the results on research and discussion, the researchers concluded the following:

The 1-11-1 ANN architecture was chosen as the best model in predicting the inflation rate of Denpasar City noting it has the smallest AFER;

The predicted inflation in June 2019 is 0.1587 which has an AFER as much as 0.00169

Comparing to the real data of inflation rate for June 2019 as much 0.04, the out-of sample forecast error is quite big, i.e. 74.89 percent. This finding signals the small in-sample forecasting error does not warrant small out-of-sample error.

If the coefficient of determination (R^2) value is below 50 percent, it is not good enough to model it, it is justifying through ANN apparently with ANN indicating that the error is in high out-of-sample.

References

- [1] S. K R S, A Study of Commodity Futures in India Asia Pacific J. Res., vol. 2, no. 4, pp. 19, 2013.
- [2] C. Saparinto and D. Hidayati, Bahan Tambahan Pangan 2006.
- [3] A. Qayyum and B. Sultana, Factors of Food Inflation: Evidence from Time Series of Pakistan J. Bank. Financ. Manag., vol. 1, no. 2, pp. 2330, 2018.
- [4] S. Shanmuganathan and S. Samarasinghe, Artificial Neural Network Modelling, 2016.
- [5] F. D. Syahtra, R. Syahputra, and K. T. Putra, Implementation of Backpropagation Artificial Neural Network as a Forecasting System of Power Transformer Peak Load at Bumiayu Substation, vol. 1, no. 3, pp. 118125, 2017.
- [6] Y. Singh and A. S. Chauhan, Neural Networks in Data Mining, J. Theor. Appl. Inf. Technol., 2009.
- [7] A. F. Setiawan and A. Hardianto, Fluktuasi Harga Komoditas Pangan dan Dampaknya Terhadap Inflation di Provinsi Banten, J. Agric. Resour. Environ. Econ., vol. 2, no. 2, pp. 8197, 2014.
- [8] N. G. Gulden Kaya Uyanik, A Study on Multiple Linear Regression Analysis, Procedia - Soc. Behav. Sci., vol. 106, pp. 234240, 2013.
- [9] M. T. Sow, Using ANOVA to Examine the Relationship between Safety & Security and Human Development, J. Int. Bus. Econ., vol. 2, no. 4, pp. 101106, 2014.
- [10] A. S. Eesa and W. Arabo, A Normalization Methods for Backpropagation: A Comparative Study, Sci. J. Univ. Zakho, vol. 5, no. 4, pp. 319323, 2017.

- [11] S. P. Mohanty, D. P. Hughes, and M. Salath, Using Deep Learning for Image-Based Plant Disease Detection, Tech. Adv. Plant Sci. a Sect. J. Front. Plant Sci., vol. 7, pp. 110, 2016.
- [12] A. Nagpal, Over-fitting and Regularization Towards Data Science, 2017. [Online]. Available: <https://towardsdatascience.com/over-fitting-and-regularization-64d16100f45c>. [Accessed: 07-May-2019].
- [13] N. J. SALKIND, Ed., Encyclopedia of Measurement and Statistics. 2007.
- [14] O. Hssjer, On the coefficient of determination for mixed regression models, J of Statistical Planning and Inference, vol. 138, no. 2008, pp. 3022-3038. 2007.
- [15] K. Kumar and P. Sahoo, Artificial Neural Network Modeling for the Prediction of Surface Roughness in Artificial Neural Network Modeling for the Prediction of Surface Roughness in ECM, Int. J. Appl. Eng. Res., vol. 9, no. 26, 2014.
- [16] H. Huang, J. Li, and C. Xiao, A proposed iteration optimization approach integrating backpropagation neural network with genetic algorithm, Expert Syst. Appl., vol. 42, no. 1, pp. 1461-155, 2015.

Predicting the gold jewellery price in Bali: an ANN approach

¹Putu Adi Gunawan, ²Nasyaldha Indrianto, ³Eka N Kencana

¹Department of Mathematics, Udayana University|Kampus Bukit Jimbaran, ID
^{2,3}Centre of Excellence in Tourism, Udayana University|Kampus Sudirman, ID

E-mail: ¹putuagun@gmail.com, ²nasyaldhai@yahoo.com,
³i.putu.enk@unud.ac.id
[1]. Corresponding author.

Abstract. The development of trend fashion in Indonesia is influenced by many factors such as fashion designers, culture, as well gold jewellery price. Gold jewellery is very common in the fashion with its price could be affected by the gold price. In addition, the gold price is also influenced by some macroeconomic variables, for example, inflation and the exchange rate. By making a good prediction of gold jewellery price, the designers can optimise their profit through the products were sold. This study aims to predict the gold jewellery price (GJP) by considering two macroeconomic variables, namely the monthly inflation rate in Bali (INF), and the exchange rate (EXC) of Rupiah on AUD. The second aim is to build model that is capable to predicts the contribution of GJP on Bali's Gross Regional Domestic Products (GRDP). Two artificial neural network (ANN) models are built by putting GJP, INF, and EXC in the input layer. All of the variables combination are tested. We found that the architecture with 1 neuron in the input layer represents INF in current month, 8 neurons in the hidden layer, and 1 neuron in the output layer represents the GJP, is the best model to predict the next month's GJP. The obtained model has an average MSE equals to 0.25 percent and it has a low overfitting level, so the model is quite good in predicting the gold jewellery price. In addition, our second ANN architecture to predict the GJP's contribution for Bali's GRDP has an average MSE

0.184 percent. We conclude our models are worth to predict the gold jewellery price as well its contribution to the Bali's GRDP.

1. Introduction

Fashion, a creative industry [1], is rapidly growing in Indonesia. According to Kisfaludy [2], fashion can be interpreted as something that someone wears such as clothing and accessories, that be influenced by all of life aspects. Like the other businesses, fashion is also affected by some environment factors such as its internal environment, microeconomic, as well macroeconomic environment [3]. For Bali, the 2018 data showed fashion industries such as textile and apparel industries grew 39.62 percent and 6.38 percent, respectively. In addition, both contribute 0.41 percent of Bali's Gross Regional Domestic Product (GRDP) [4].

Meanwhile, fashion accessories especially gold jewellery, has a great market in Bali. The demand for gold jewellery has increased over time, especially near the holiday or Hindu ritual days. In order to help the fashion designers make right decision in buying gold jewellery, prediction the gold jewellery price is important. Furthermore, the price of gold jewellery is also used by the end users to invest [6]. Previous research had confirmed the demand of gold

jewellery correlated with the gold price volatility [7], and the gold price has a relationship with the inflation rate [8], as well the exchange rate [9].

Refer to the significant raising of fashion industry as well the increasing demand of gold jewellery in Bali, this paper aims to predict the gold jewellery price (GJP) by considering the monthly inflation rate (INF), the exchange rate of Rupiah on AUD (EXC), and previous GJP. In addition, the contribution of gold jewellery on Bali's GRDP is also forecasted. Both aims are done by building artificial neural network (ANN), a soft modeling technique that, nowadays, is utilised more often than other soft techniques such as ARIMA, support vector machine (SVM), and random forest (RF) algorithm.

2. Research methods

To predict the GJP and forecast its contribution on Bali's GRDP, the supervised learning ANN were built with 1 input, 1 hidden, and 1 output layer [10]. The monthly data of GJP, INF, and EXC for January 2011 to December 2016 as well the yearly data of textile and apparel industry contribution on Bali's GRDP for the year 2011-2016 were collected from Bali Statistics Office. The matrix data with total 72 observations is divided into 2 subsets; the first subset with 54 observations is set as the training data, and the second subset with 18 observations is set for the validation process. The maximum number of iteration is a hundred [11]. Each of ANN architectures were built and tested in JupyterLab software.

Knowing the variables have different unit of measurement, before entering the architecture, GJP, INF, and EXC were normalized by applying Min-Max function (Eq. 1) so its values lie within [0; 1] interval [12]. On Eq. 1, X_{Max} and X_{Min} represent the maximum and the minimum value of each variable being normalised.

$$X_{new} = \frac{X_{original} - X_{min}}{X_{max} - X_{min}} \quad (1)$$

In general, computing process of neurons' weight on ANN architecture involves two sequential steps, i.e. computation on feedforward neural network (FNN), and computation on backward neural networks (BNN) [14, 15]. For the first step (FNN), a set of neurons' initial weight were randomly generated and these weights enter the selected activation function to generate prediction value. For the second step, BNN is taken place to adjust the weights. Adjustment is needed to minimise the prediction error. It is common to express the prediction error by counting the mean square error (MSE) [16] that is defined as

$$MSE = \frac{1}{n} \sum (Y - Y_1)^2 \quad (2)$$

$$Y = \frac{1}{n} (f(W^{(1)} \cdot X) W^{(2)})$$

where $W^{(1)}$, $W^{(2)}$, and X represent the neurons' weight connecting the input and the hidden layers; the neurons' weight connecting the hidden and the output layers; and the neurons' values on the input layer, respectively. The $f(x) = \frac{1}{1 + e^{-x}}$ is a binary sigmoid function to get the predicted

value. After the prediction has been made on FNN step, weights adjustment were conducted on BNN step [17]. This study utilised the gradient descent method to adjust the neurons weight. This method adjusts $W^{(2)}$ and $W^{(1)}$.

3. Result and Discussion

3.1. Modeling the Gold Jewellery Price

To predict GJP on certain month, 7 ANN's architectures were tested and ran for 5 to 25 neurons on the hidden layer with 100 iterations. The architectures is described on Table 1.

Table 1. ANN's Architectures in Predicting Gold Jewellery Price

Architecture	Input(s)		Output
A1	INF	In ation Rate	Gold Jewellery Price
A2	EXC	Exchange Rate	Gold Jewellery Price
A3	GJP	Gold Jewellery Price	Gold Jewellery Price
A4	INF	In ation Rate	Gold Jewellery Price
	EXC	Exchange Rate	
A5	INF	In ation Rate	Gold Jewellery Price
	GJP	Gold Jewellery Price	
A6	EXC	Exchange Rate	Gold Jewellery Price
	GJP	Gold Jewellery Price	
A7	INF	In ation Rate	Gold Jewellery Price
	EXC	Exchange Rate	
	GJP	Gold Jewellery Price	

The results showed that A1 architecture|1 neuron on input layer represents current INF, 8 neurons on the hidden layer, and 1 neuron on output layer represents current GJP; is the best architecture because of its smallest MSE as much as 0.0028 compares to others architectures. Despite this nding, we found some architectures experienced over tting in predicting GJP because the neurons (nodes) on the hidden layer (HL) greater than the trained samples. According Long et al. [18], an ANN's architecture should has the nodes on its hidden layer less than the number of trained observations. To overcome this problem, we add a small constant

$= 0:0001$ for the activation value $b_i w_i^2$ that connect the hidden with the output layer. This process is called the regularization of ANN architecture [18]. Table 2 lists the MSEs for all of the architectures after adding $= 0:0001$.

Table 2. The MSEs of ANN architectures

Architecture	neuron P of on HL	The MSE
A1	8	0.00250
A2	24	0.01350
A3	23	0.01189
A4	25	0.00953
A5	16	0.01102
A6	20	0.01173
A7	16	0.01103

Table 2 shows the best architecture is A1 with its MSE as much as 0.0025, slightly less than the MSE before regularization process. The plot of MSE for A1 before and after the regularization is depicted on Fig. 1 and Fig. 2.

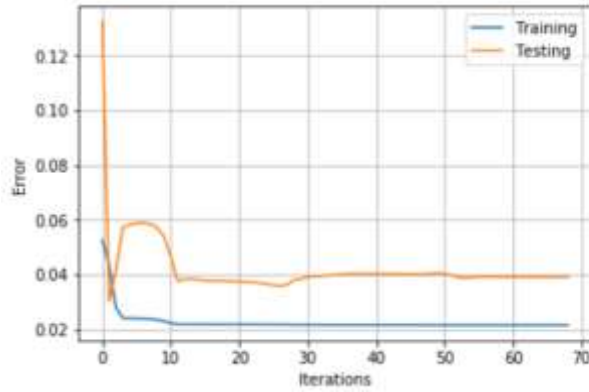


Figure 1. Before Regularization 0:0028

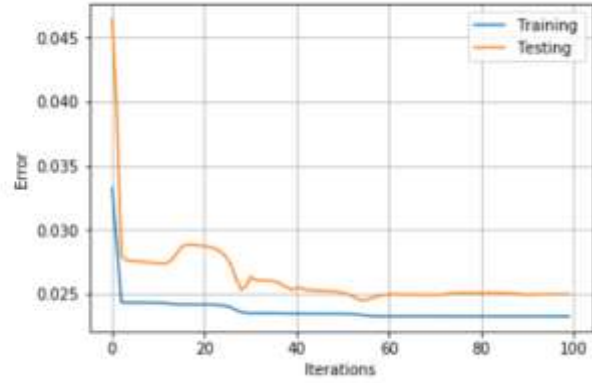


Figure 2. After Regularization 0:0025

After observing the A1 architecture is still the best compared to others, then we used it to predict the GJPs for January{July 2017 using in ation rates at the same period. The prediction and the errors are listed on Table 3 and plot of MSE is depicted on Fig. 3. From Table 3, we know the out-of-sample average forecasting error rate (AFER) as much as 6.43 percent, an indication that ANN architecture with 1, 8, 1 nodes on each of input, hidden, and output layers has good performance to predict the GJP based-on the in ation rate.

Date	Actual	Prediction	jError
Jan 2017	508 843.8	489 811.2	19 032.6
Feb 2017	508 843.8	484 535.3	24 308.5
Mar 2017	522 504.3	487 940.0	34 564.3
Apr 2017	519 730.3	479 495.6	40 234.7
May 2017	508 436.1	477 277.4	31 158.7
Jun 2017	519 330.6	476 741.8	42 588.8
Jul 2017	524 804.2	483 772.7	41 031.5

Table 3. Predicting the GJPs and Errors

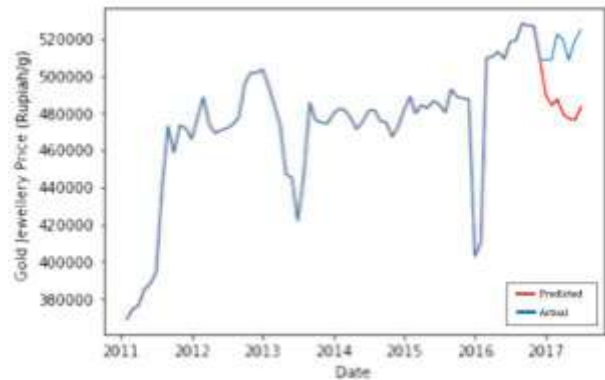


Figure 3. Plot of GJPs and the Prediction

3.2. Modeling the Gold Jewellery Price

The second aim of this paper is to make an ANN architecture in predicting the contribution of gold jewellery to the formation of Bali's GRDP. Previously, we decomposed the yearly GRDP data into monthly terms by utilizing the following formula:

$$GRD it = \frac{1}{2} (GRD Pt + \frac{1-6.5}{12} \cdot GRDP t - GRDP t - 1) \quad (3)$$

where i = 1; 2;; 12; and t represents the transformed year, t = 2011; ; 2016.

The ANN architecture for this purpose is built by putting 12 neurons represent 12 consecutive months of GJP in the input layer, 5{25 neurons in HL, and one neuron represents the monthly Bali's GRDP on the same year. All architectures were ran for 100 iterations on JupyterLab software. A regularization value ($= 0.0001$) is also applied in evaluating the performance of the architectures. The best architecture is chosen for the lowest MSE. Table 4 summarises the MSE for all number of nodes on hidden layer were tested. The error plot of the best architecture is drawn on Fig. 4. We found the best ANN architecture for counting the gold jewellery contribution on Bali's GRDP is 12, 15, 1 nodes on the input, the hidden, and the output layers. The MSE for this architecture is 0.18 percent.

Nodes	MSE	Node	MSE
5	0.00473	16	0.00372
6	0.00453	17	0.00342
7	0.00554	18	0.00267
8	0.00420	19	0.00445
9	0.00646	20	0.00407
10	0.00485	21	0.00360
11	0.00393	22	0.00357
12	0.00480	23	0.00468
13	0.00373	24	0.00408
14	0.00367	25	0.00374
15	0.00184		

Table 4. The MSE of Architectures

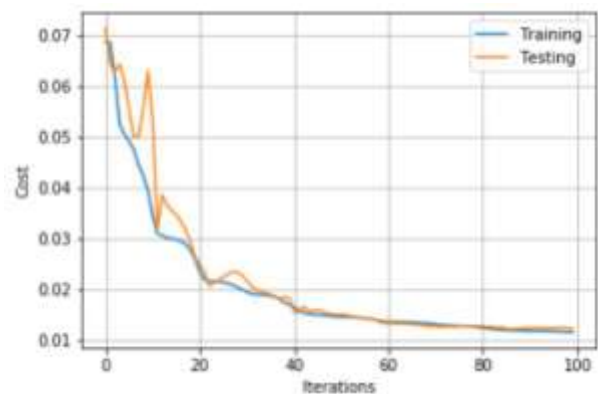


Figure 4. Plot of Errors for 15 Nodes

4. Conclusion and Suggestion

For the best of our knowledge, research regarding the gold jewellery as an integral part of fashion industry is very limited. By doing this study we hope we could fill the gap. Our research found some interesting conclusion, namely:

- [12] Soft modeling technique, i.e. artificial neural network, can be applied to model the gold jewellery price based-on some determinants such as inflation rate, currency exchange rate, as well the gold jewellery price on previous period;
- [13] The best ANN architecture for predicting the gold jewellery price is an 1{8{1 architecture with a single node on the input layer represents the inflation rate on current month, and a single node on the output layer represents the gold jewellery price on current month;
- [14] The in-sample and out-of-sample AFER for the best architecture as much as 0.25 percent and 6.43 percent, respectively; and
- [15] The best ANN architecture for determining the contribution of gold jewellery on Bali's GRDP is an 12-15-1 architecture with the MSE as much as 0.18 percent.

We suggest the next similar research is conducted by trying another activation function as well as adding another determinant such as household's income or another microeconomic variables in predicting the gold jewellery price.

References

- [14] E. Astuty, A. Rahayu, Disman, and L. A. Wibowo, 2018 Breakthrough in Indonesian Creative Industry through Soft Innovation Inter. J. Entrepreneurship 22 1-10
- [15] M. Kisfaludy, 2008 Fashion and Innovation Acta Polytechnica Hungarica 5 59-64

- [16] R. B. Chavan, 2018 Analysis of Fashion Industry Business Environment trends in textile and fashion design 4 212-219
- [17] Bali Provincial Statistics Center, Produk Domestik Regional Bruto Provinsi Bali Menurut Penyelesaian 2014-2018, BPS Bali, 2019
- [18] N. Oktaviana and N. Amalia, 2018 Gross Regional Domestic Product Forecasts using Trend Analysis: Case Study of Bangka Belitung Province J. Ekonomi dan Studi Pembangunan 19 142-151
- [17] P. L. Rompas, 2015 A Qualitative Research of Woman Perception of Gold Jewelry as Investment in Manado J. EMBA 3 192-200
- [18] R. Grynberg, T. Kaulihowa, and F. Singogo, 2018 Gold Jewellery Demand and Gold Price Volatility: A Global Perspective J. Economics, Management, and Trade 10 1-13
- [19] S. Tufail and S. Batool, 2013 An Analysis of the Relationship between Inflation and Gold Prices: Evidence from Pakistan The Lahore J. Economics 18 1-35
- [20] G. K. Nair, N. Coundhary, and H. Purohit, 2015 The Relationship between Gold Prices and Exchange Value of US Dollar in India Emerging Markets Journal 5 16-25
- [21] Christopher M. Bishop, Pattern Recognition and Machine Learning. Springer, 2006.
- [22] E. O. Salawu, M. Abdulraheem, A. Shoyombo, A. Adepeju, S. Davies, O. Akinsola, and B. Nwagu, 2014 Using Artificial Neural Network to Predict Body Weights of Rabbits Open J. Animal Sciences 4 182-186
- [23] M. K. O. Ayomoh, 2012 Neural Network Modeling of a Tuned PID Controller European J. Scientific Research 71 283-297
- [24] S. Tasdemir, B. Yaniktepe, and A. B. Guher, 2018 The Effect on the Wind Power Performance of Different Normalization Methods by using Multilayer Feed-forward Backpropagation Neural Network I. J. Energy App. and Tech. 5 131-139
- [25] A. J. Izenman, Modern Multivariate Statistical Techniques Regression, Classification, and Manifold Learning. Springer, 2008.
- [26] K. Vora and S. Yagnik, 2014 A Survey on Backpropagation Algorithm for Feedforward Neural Networks IJEDR 1 193-197
- [27] M. M. Zahra, M. H. Essai, and A. R. A. Ellah, 2013 Robust Neural Network Classifier IJEDR 1 326-331
- [28] N. Kayarvizhy, S. Kanmani, and R. V. Uthariaraj, 2014 ANN Models Optimized using Swarm Intelligence Algorithm WSEAS Transactions on Computers 13 501-519
- [29] J. Long, K. Xueyuan, H. Haihong, Q. Shinian, and W. Yehong, 2004 Study on the Overfitting of the Artificial Neural Network Forecasting Models Acta Meteorologica Sinica 19 (2) 216-225

Fuzzy Logic in The Navigation of Line Follower Robot

C Widyawati¹ and Sugiyarto²

Department of Mathematics, Ahmad Dahlan University,
South Ringroad, Yogyakarta, Indonesian

e-mail : ¹ widyawati1500015026@webmail.uad.ac.id
² sugiyartophd@gmail.com

Abstract. Fuzzy controllers are widely used because the control design is relatively easy, flexible and efficient compared to conventional controllers. The purpose of this research is to compare the results between the triangular and gbell fuzzifier method to determine which system is more accurate to use. This research transform to fuzzy logic controls on the line follower robot from the PID (Proportional-Integral-Derivative) machine that has been installed in the robot microcontroller to control the movement of the robot. The research method used is triangular fuzzifier and gbell with the largest maximum defuzzification method. The input variables needed include the distance, angle and speed variables. The three entries are then processed by the fuzzy logic controller to obtain the output value in the form of the robot time moves. The error in the triangular fuzzifier is smaller than the gbell so that the triangular fuzzifier is more accurate than the use of gbell fuzzifier on the system.

Introduction

Nowadays fuzzy logic is widely applied to solve problems that occur in daily life, one of which is in controlling a work process. One solution that can be done to control it is that to use the Fuzzy Logic Controller (FLC) system. FLC is a fuzzy system known as a basic or basic system of rules. This fuzzy system is known as the IF-THEN fuzzy rule. At present there are many control methods used. Controllers based on fuzzy logic are the controlling methods included in the FLC. The purpose of the FLC system is to control complex processes by means of human experience [1]. Completion of the case using FLC does not require a mathematical model of the system, because this method works based on the rules according to the input data that has been given previously. Previous research, Puspitasari [2] conducted Fuzzy Logic research on the Two Wheeled Robot Equilibrium System by using a triangular fuzzifier and the largest of maximum defuzzifier method produced time data for robot movement and compared with the factual results. Meanwhile, Zhao's [3] research on Mobile Robot Navigation using Optimized Fuzzy Controller by Genetic Algorithm by means of optimizing fuzzy controllers so that robots reach their destination faster. The difference which is being carried out in this study is the method used, namely in the fuzzifier stage, the triangular fuzzifier with Gbell fuzzifier is compared, as well as the use of the largest of maximum defuzzifier at the defuzzifier stage.

In this study, the discussion will be FLC in the navigation systems of line follower robots. Line follower robots can detect the color of the track they are going to in accordance with the color they recognize (black) [4]. The core step needed is to analyze the primary data on the line follower robot which are on the distance of the sensor with the aim to be achieved, the time needed by the robot to move, the speed of movement of the robot and the angle of movement of the robot. Based on this background the researcher was interested in discussing "Fuzzy Logic in the Navigation of Line Follower Robot".

2. Fuzzy Logic Control

The general control using fuzzy stages on the line follower robot is shown in Figure 1.

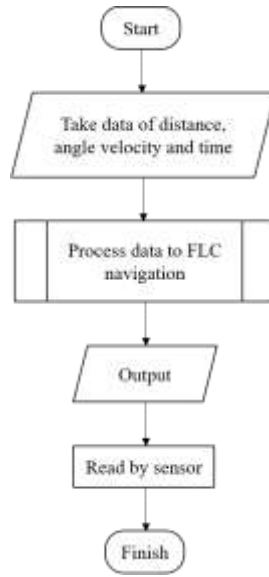


Figure 1. FLC Flowchart in Robot

From line follower robot that used to this research, it used Proportional-Integral-Derivative (PID) machine to control the robot. Then, the machine will change to fuzzy control machine so the robot can move automatically without setting the machine.

The first step as a data collection process is to determine the variables that determine the results of the research and the methods used in data collection. The variables to be examined are as follows.

Input Variables

This variable is denoted by X which consists of three variables.

- X_1 (distance) = the distance of the sensor to the destination to be achieved (in cm).
- X_2 (angle) = the crossing of the path that the robot passes to get to the destination point (in degrees).
- X_3 (velocity) = the speed of the direction of movement of the robot from the starting point to the point of destination (in radians per minute).

Output Variable

This variable is denoted by the letter Y which is the time of line follower robot movement from the starting point to the destination point (in seconds).

Determination of variables, both input and output variables and universe talk of experimental results is obtained in table 1.

Table 1. Universe Talk and Fuzzy Sets Input and Output

Function	Variable Name	Universal Talk	Fuzzy Sets
Input	Distance	[0, 250]	VC, C, M, F, VF
	Angle	[-180, 180]	LiR, LoR, LoL, LiL
	Velocity	[30, 80]	S, Me, Fa
Output	Time	[0.38, 8.48]	VFe, Fe, SW, Mu, VMu

The meaning of each fuzzy sets as follows, very close (VC), close (C), medium (M), far (F) and very far (VF) on the distance input variable. The fuzzy parameters on the input variable angles include a little right turn (LiR), turn right a lot (LoR), turn left a lot (LoL) and turn left a little (LiL), while the input variable speed includes a slow (S), medium (Me) and fast (Fa). Time output variables consist of very few (VFe), few (Fe), somewhat (SW), much (Mu) and very much (VMu).

Variable of distance get the number of universal talk from the track that made before. Variable of angle get the number because the robot just know turn left or turn right. The universal talk's value of velocity got from PID machine that installed in the line follower robot and finally for variable of time get the number from the results of this experiment.

2.1 Fuzzification

As a robot is designed, so that a robot can move according to the instructions. The robot must have a performance design. The focus of the research was the transformation of the PID machine installed on the robot microcontroller to the fuzzy control method in the robot's navigation settings. Input variables obtained previously are transformed into a particular linguistic variable. The data that has been obtained is represented by a triangle curve and gbell.

2.1.1 Triangular Curve

This method is a combination of the two linear lines, namely linear up and linear down. The membership function is defined as

$$\mu(x) = \begin{cases} 0, & x \leq a \text{ or } x \geq c \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ \frac{c-x}{c-b}, & b \leq x \leq c \end{cases} \quad (1)$$

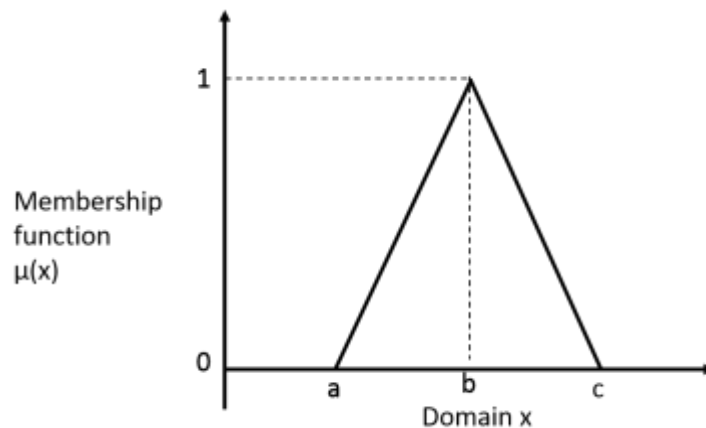


Figure 2. Triangular Curve Membership Function

2.1.2 Gbell Curve

In general, the bell curve has the following functions.

$$\mu(x; a, b, c) = \begin{cases} 0, & x \leq c - 2a \text{ or } x \geq c + 2a \\ \frac{1}{1 + \left| \frac{x-c}{a} \right|^{2b}}, & c - 2a \leq x \leq c + 2a \end{cases} \quad (2)$$

with a is half the width of the curve, b is the slope of the curve and c is the center point.

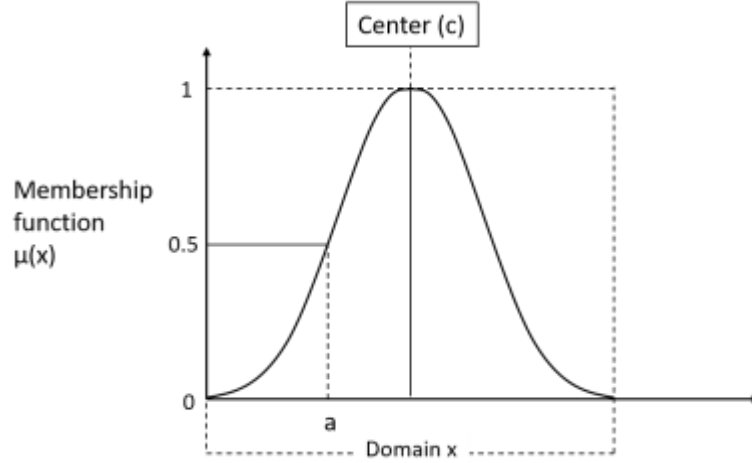


Figure 3. Gbell Curve Membership Function

Rule Base

The next step to solve this case is the fuzzy rule base stage or the determination of fuzzy basic rules. Determining the rules of fuzzy logic rules in this study is based on experience because there are no specific rules in the organization. The number of fuzzy rules formed is obtained from the multiplication of the number of fuzzy sets that exist in each input variable, so that the total rules formed in this study are 60 rules. The form of IF-THEN rules is

$$\text{IF } x_1, x_2, \text{ and } x_3 \text{ THEN } y \quad (3)$$

Defuzzification

Defuzzification is the process of converting fuzzy output to crisp output. After obtaining the evaluation rule results from these rules, the last step to get the FLC result is to work on the defuzzifier stage. The defuzzifier stage in this case will be solved using the largest of maximum defuzzifier method. This method formula is defined as follows

$$y^* = \sup\{y \in \text{hgt}(B')\} \quad (4)$$

with

$$\text{hgt}(B') = \{y \in V \mid \mu_{B'}(y) = \sup_{y \in V} \mu_{B'}(y)\} \quad (5)$$

Determining the crisp value of each of these rules is determined by returning the fuzzy value of the previous rule evaluation results to the consequent initial membership function.

3. Data Testing and Analysis

From data research, then the data will be form to fuzzy number by triangular and gbell fuzzifier. The membership functions of input and output can be seen in figure 4 and 5.

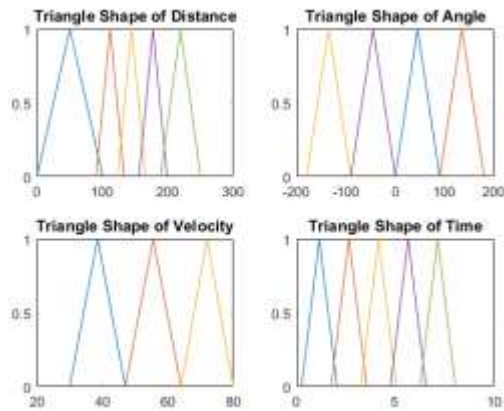


Figure 4. Triangular Curve Membership Function

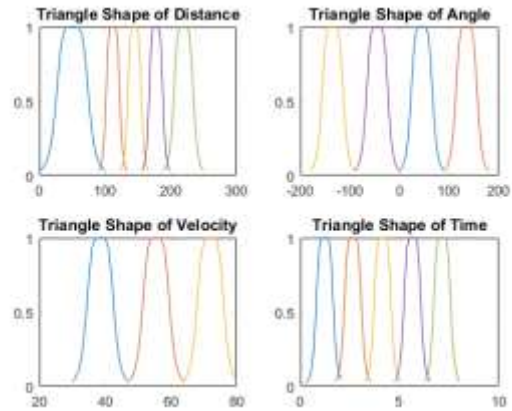


Figure 5. Gbell Curve Membership Function

After that, from the data value then the value will represent in fuzzy rule base. The fuzzy rule base that had make before are representing by table 2.

Table 2. Fuzzy Rule Base

Rule	If x_1	x_2	and x_3	Then y
R1	Very Close	Little Turn Right	Slow	Few
R2	Very Close	Little Turn Right	Medium	Few
R3	Very Close	Little Turn Right	Fast	Very Few
⋮	⋮	⋮	⋮	⋮
R58	Very Far	Little Turn Left	Slow	Very Much
R59	Very Far	Little Turn Left	Medium	Much
R60	Very Far	Little Turn Left	Fast	Much

By substituting the value of fuzzification stage to fuzzy rule base, so from this stage will get the conclusion of the data. Then, the number will be find the actual results on defuzzification stage. Because there are use two methods in fuzzification, so there has two results too in the last stage. The results of the FLC system testing as a whole can be seen in figure 6.

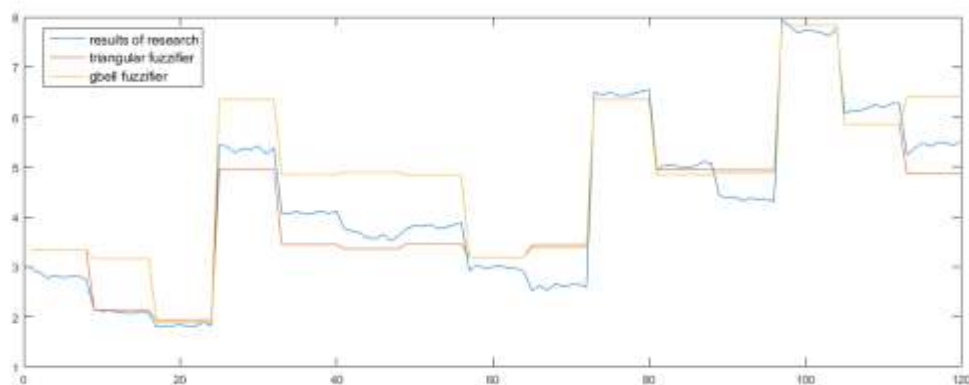


Figure 6. The Results of FLC System

Based on the graph, it can be seen that the defuzzification of the triangular fuzzifier method is more accurate than the gbell fuzzifier. The results of using triangular fuzzifier have less difference compared to the FLC results with gbell fuzzifier.

After the FLC process finished, then the value of defuzzification use triangular fuzzifier compared with results of gbell fuzzifier. To obtain the error of the two fuzzifier used relatif error formula as

$$E_R = \left| \frac{y - y^*}{y} \right| \quad (6)$$

The results relatif error of triangular and gbell fuzzifier representation can be seen in figure 7.

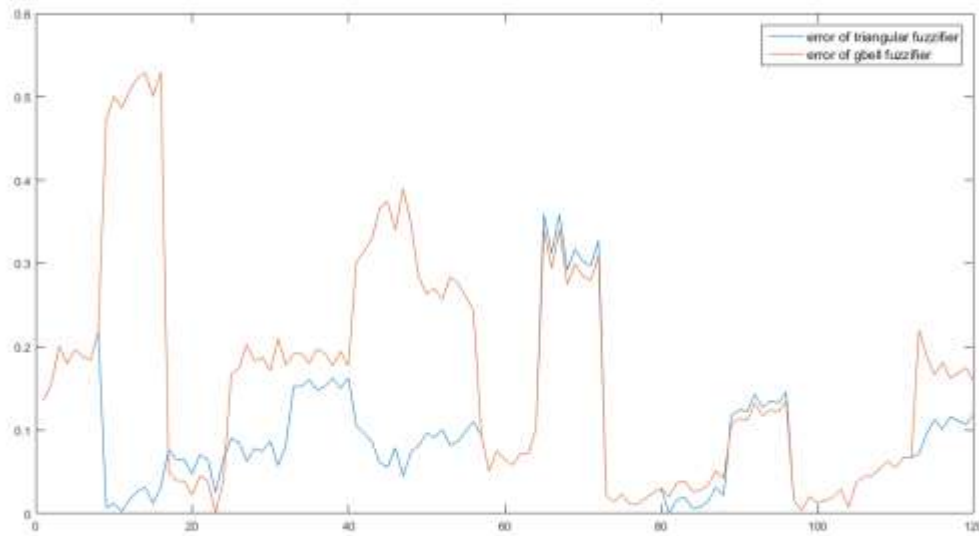


Figure 7. Error on the Results of Triangular and Gbell Fuzzifier

The error rate results in the triangular fuzzifier method between 0%-36% while the results of gbell fuzzifier method between 0%-53%. Difference results in the triangular and gbell fuzzifier method show that triangular fuzzifier more accurate than gbell for the results of research. The results of this experiment show that PID machine can be transformed into fuzzy solutions (in this case is fuzzy controller).

4. Conclusions

The application of FLC on line follower robots in this experiment uses triangular and gbell fuzzifier methods. The stages in compiling a FLC system successively form a fuzzy set in the fuzzifier process by using triangular fuzzifier and gbell fuzzifier methods, followed by determination of IF - THEN rules and the final stage is the defuzzifier process. The comparison of the results of the triangular fuzzifier algorithm with gbell fuzzifier on the experimental results can be seen from the error between the two methods along with the results of the experiments obtained. Based on the FLC that has been formed, triangular fuzzifiers generally produce more accurate results than gbell fuzzifiers because the error of triangular fuzzifier more little than gbell fuzzifier. Meanwhile, the factors that can hinder the course of the FLC in this system include the formation of membership functions in the system and the measurement of experimental results that are less accurate on the results of the time of the robot movement.

5. Acknowledgments

The authors would like to say thank you to University of Ahmad Dahlan for the funding and permission to publish this paper.

References

- [1] Zimmermann H-J 1996 *Fuzzy Set Theory and Its Applications* (London: Kluwer Academic)
- [2] Puspitasari S, Nusantara G D, and Muslim M A 2015 *Implementasi Kontrol Logika Fuzzy pada Sistem Keseimbangan Robot Beroda Dua* **2** 1-6
- [3] Zhao R, Lee D H and Lee H K 2015 *Mobile Robot Navigation using Optimized Fuzzy Controller by Genetic Algorithm* **15** 12-9
- [4] David 2016 *Kendali Logika Fuzzy pada Robot Line Follower* **3** 15-25
- [5] Dewantoro G, Susilo D and Adi P P 2017 *Implementasi Pengendali Logika Fuzzy pada Navigasi Robot Penjejak Dinding* **16** 72-7
- [6] Kusumadewi S, etc 2006 *Fuzzy Multi-Attribute Decision Making (Fuzzy MADM)* (Yogyakarta: Graha Ilmu)
- [7] Hernadi, J 2017 *Teori dan Praktikum Metode Numerik-1* (East Java: Umpo)
- [8] Supani, A and Azwardi 2015 *Applying Fuzzy Logic and Pulse Width Modulation for Speed Control System of Line Follower Robot* **9** 1-10
- [9] Wajiansyah A, Bramanto A, Supriadi and Nur S 2018 *Implementasi Fuzzy Logic pada Robot Line Follower* **5** 395-402

Decision Support System for Outstanding Lecturers Selection at Dhyana Pura University by the Combination of Analytical Hierarchy Process Methods and Simple Additive Weighting

P W Rahayu¹, I G A Gunadi², I M Candiasa³

^{1, 2, 3} Magister Program of Computer Science Universitas Pendidikan Ganesha

E-mail : wprastyadi@gmail.com¹, igedearisgunadi@pasca.undiksha.ac.id²,
made.candiasa@pasca.undiksha.ac.id³

Abstract. The outstanding lecturer selection at Dhyana Pura University still done manually by ranking and assessment methods which influenced by the viewers' point of view. Based on these problems, this study aimed propose a Decision Support System based on the combination of the Analytical Hierarchy Process (AHP) methods and Simple Additive Weighting (SAW). AHP was chosen because in the selection process there was no method applied to give a score to each candidate along with the criteria. Whereas, SAW was chosen because in the process of the selection, it is required a method to rank the final score which had been given in the AHP process. Based on the condition that the experts scored more than one candidate, it is necessary to combine the score of criteria and sub-criteria using the Geometric Mean Method (GMM) and the Weighted Arithmetic Mean Method (WAMM). GMM was assumption if each expert has the same score in building an opinion, while the WMM was assumption if each expert has an unequal score. The results obtained by the university and the previous system were tested using Mean Average Precision. The results accuracy obtained from the comparison was 60%, which can be concluded that the DSS was feasible to be applied at Dhyana Pura University.

1. Introduction

The selection of lecturer achievers at Dhyana Pura University was carried out by the Institute for Research and Community Service (LP2M). However, until now the selection of lecturer achievers at Dhyana Pura University is still done manually by ranking and assessment methods that are still influenced by the viewers' point of view. The plot of manual lecturer selection begins by determining the top five ranks of lecturer achievers. The names of the selected lecturers would be taken to the rector to be concluded together and from the results of the meeting determined one lecturer achiever. Seeing the selection system of lecturer achiever who are still manual and influenced by the assessors' point of view, required a system that can help management to resolving fewer objective results in the selection of outstanding lecturers at Dhyana Pura University. Decision makers sometimes use their experience and often use intuition to make decisions and sometimes the results are inappropriate decisions. For this reason, decision-making methods are very important in helping decision makers make decisions [1].

This study aimed to propose a Decision Support System. Decision support system (DSS) is a computer-based system which designed to improve the effectiveness of decision makers in solving problems that are semi-structured or unstructured. Decision support system is also referred to as the science of compiling decision making which is more precise than a number of criteria which are mostly not fixed on a condition and a rule, but more than two rules [2]. The Analytical Hierarchy Process (AHP) method [3] was chosen because in the process of selecting lecturer achievers at Dhyana Pura University, there is no method used to give quality to each lecturer achievers and their criteria. Meanwhile, the Simple Additive Weighting (SAW) method [4] was chosen because in the process of selecting lecturer achievers, a method is needed to rank the final values that have been given weight in the weighting process by the AHP. Because the AHP and SAW methods are methods that are in accordance with the problems experienced by Dhyana Pura University, this research will propose a computerized Decision Support System that can help the process of selecting outstanding lecturers, which methods used in the DSS are AHP and SAW.

2. Research Method

2.1. Research Procedure



Figure 1. Research Design

2.2. Data Collection

In conducting research to obtain data and information, the methods used in the data collection process are carried out as follows:

2.2.1. Interview

It is a method of collecting data by means of question and answer directly to experts who become informants in this study.

2.2.2. Literature Review

Review the documents of lecturers' excellent achievements in the fields of education and learning, research, and community service at Dhyana Pura University in 2015, 2016 and 2017, the lecturer guidance document of Kementerian Riset dan Pendidikan Tinggi (Kemenristekdikti) [5] and related journals with the method used in this study.

2.3. Transformation, Normalization, and Cleaning Data

Transformation

Is a process of processing raw data obtained by removing some of the attributes that have no connection with the research topic.

Normalization

Normalization of data in question is to select the data used to avoid data redundancy and remove the redundancy.

Cleaning Data

It is a process of cleaning up irrelevant data including lost data and outlier data.

2.4. Determination of Criteria and Sub-Criteria

Determination of criteria and sub-criteria begins with matching the Outstanding Lecturer Criteria in the Ministry of Research, Technology and Higher Education (Kemenristekdikti) version. It is based on the Outstanding Lecturer Criteria at Dhyana Pura University that obtained from the results of interviews with informants, namely the Vice Rector of Academic, Head and Staff of research and community service institutions. Then, a screening process was carried out on the two criteria to obtain the outstanding lecturers criteria that will be used as a reference in determining the outstanding lecturers at Dhyana Pura University for this year and the following year.

Table 1. Criteria for Outstanding Lecturers proposed as a reference for the selection of Outstanding Lecturers at Dhyana Pura University

No	Criteria	Source
1	Education and Learning	Kemenristekdikti
	A. Education Level	Undhira
	1) S2	Undhira
	2) S3	Undhira
	B. Textbook/Text	Undhira
2	Research Criteria	Kemenristekdikti
	A. Writing Publication	Kemenristekdikti
	1) International Journal	Undhira
	2) Accredited National Journal	Kemenristekdikti
	3) Non-Accredited National Journal (Has ISSN)	Undhira
	B. Scientific Forum	Kemenristekdikti
	1) Ordinary International Speakers	Undhira
	2) International Keynote Speakers	Kemenristekdikti
	3) Ordinary National Speakers	Undhira
	4) National Keynote Speakers	Kemenristekdikti
3	Community Service Criteria	Kemenristekdikti
	A. Empowerment Community Model	Kemenristekdikti
	B. Partnership Development Model	Kemenristekdikti

2.5. Weighting Criteria and Sub-Criteria by Using the AHP Method Manually

The first step is distributing the criteria and criteria weighting questionnaire which will be filled out by 4 respondents. The respondents in question are the Rector of Dhyana Pura University, Vice Rector of Academic, Head and Staff of the Institute for Research and Community Service (LP2M). The next step is to calculate the results of each questionnaire using the AHP method manually (using a spreadsheet application) to get the weight of each criterion and sub-criteria. The third step, conduct a consistency test on the assessment of the questionnaire that has been done. If consistent, the weights of each criterion and sub-criteria are valid.

2.6. Combining the Criteria and Sub-Criteria Weight by Using GMM and WAMM Method Manually

After getting the weights of each criterion and sub-criteria based on a questionnaire from each respondent, the next step is to unite the criteria weights using GMM and WAMM to get one weight of criteria and sub-criteria (using a spreadsheet application).

2.7. Do Ranking by Using SAW Method Manually

After getting the weight calculation using the AHP method and uniting the weights using GMM and WAMM the next step is to rank each alternative that has been collected. The alternative in question is the data of Dhyana Pura University lecturers. The ranking process is done by multiplying the weights by alternatives so that the sequence of outstanding lecturers is obtained based on the highest total scores.

3. Research results

3.1. Geometric Mean Method

The result of the combination of the AHP weights from the sub-criteria obtained from the questionnaire from the Rector of Dhyana Pura University, Vice Rector of Academic, Head and Staff of the Institute of Research and Community Service.

Table 2. AHP & GMM Calculation results

No	Sub-Criteria	Rector	Vice Rector of Academic	Head of the Research and Community Service Institute	Staff the Research and Community Service Institute	GMM
1	S2	0.07	0.12	0.11	0.25	0.12
2	S3	0.21	0.36	0.34	0.25	0.28
3	Textbook/Text	0.06	0.16	0.15	0.10	0.11
4	International Journal	0.19	0.06	0.10	0.11	0.10
5	Accredited National Journal	0.07	0.14	0.04	0.05	0.06
6	Non-Accredited National Journal (Has ISSN)	0.02	0.02	0.01	0.01	0.02
7	Ordinary International Speakers	0.01	0.01	0.01	0.01	0.01
8	International Keynote Speakers	0.02	0.02	0.02	0.01	0.02
9	Ordinary National Speakers	0.005	0.003	0.003	0.004	0.003
10	National Keynote Speakers	0.00	0.02	0.02	0.01	0.01
11	Empowerment Community Model	0.17	0.03	0.13	0.18	0.10
12	Partnership Development Model	0.17	0.08	0.07	0.03	0.07

3.2. Weighted Arithmetic Mean Method

The weight of each expert / respondent who involved in decision making was Rector = 2, Vice Rector of Academic = 2, Head of the Research and Community Service Institute = 3, and Staff of the Research and Community Service Institute = 3. The weight was obtained by looking at the conditions at Dhyana Pura University. The Rector and Vice Rector of Academic only decide on the outstanding lecturers in accordance with the rank of outstanding lecturers that have been made by the Head and Staff of the Research and Community Service Institute.

Table 3. AHP & WAMM Calculation results

No	Sub-Criteria	Rector	Vice Rector of Academic	Head of the Research and Community	Staff the Research and Community	WAMM
----	--------------	--------	-------------------------	------------------------------------	----------------------------------	------

				Service Institute	Service Institute	
1	S2	0.07	0.12	0.11	0.25	0.13
2	S3	0.21	0.36	0.34	0.25	0.28
3	Textbook/Text	0.06	0.16	0.15	0.10	0.11
4	International Journal	0.19	0.06	0.10	0.11	0.10
5	Accredited National Journal	0.07	0.14	0.04	0.05	0.06
6	Non-Accredited National Journal (Has ISSN)	0.02	0.02	0.01	0.01	0.02
7	Ordinary International Speakers	0.01	0.01	0.01	0.01	0.01
8	International Keynote Speakers	0.02	0.02	0.02	0.01	0.02
9	Ordinary National Speakers	0.005	0.003	0.003	0.004	0.003
10	National Keynote Speakers	0.00	0.02	0.02	0.01	0.01
11	Empowerment Community Model	0.17	0.03	0.13	0.18	0.11
12	Partnership Development Model	0.17	0.08	0.07	0.03	0.06

3.3. Ranking Results with the SAW Method Manual

The following are the top 5 ranking results of ranking using the SAW method which is divided into two, namely through weighting AHP + GMM + SAW and AHP + WAMM + SAW.

3.3.1. AHP+GMM+SAW results

Table 4. AHP+GMM+SAW results

No	Lecture Name	Ranking
1	Lecture 5	1
2	Lecture 11	2
3	Lecture 2	3
4	Lecture 3	4
5	Lecture 10	5

3.3.2. AHP+WAMM+SAW results

Table 5. AHP+WAMM+SAW results

No	Lecture Name	Ranking
1	Lecture 5	1
2	Lecture 11	2
3	Lecture 2	3
4	Lecture 3	4
5	Lecture 10	5

3.4. Mean Average Precision

MAP is used to compare the results of ranking at Undhira with the ranking results that obtained from the system namely AHP + GMM + SAW and AHP + WAMM + SAW.

3.4.1. MAP AHP+GMM+SAW results

The following are the results of MAP AHP+GMM+SAW.

Table 6. MAP AHP+GMM+SAW results

AHP+GMM+SAW results			
<i>Rank</i>	<i>R/T</i>	<i>Recall</i>	<i>Precision</i>
1	R	1	1
2	T	0	0
3	T	0	0
4	R	1	1
5	R	1	1
	AP		0,6
	MAP		60%

3.4.2. MAP AHP+WAMM+SAW results

The following are the results of dari MAP AHP+WAMM+SAW.

Table 7. MAP AHP+WAMM+SAW results

AHP+WAMM+SAW results			
<i>Rank</i>	<i>R/T</i>	<i>Recall</i>	<i>Precision</i>
1	R	1	1
2	T	0	0
3	T	0	0
4	R	1	1
5	R	1	1
	AP		0,6
	MAP		60%

4. Conclusion

Based on the results of the study, the conclusions obtained from this study include the following:

1. This system is designed using a combination of AHP and SAW methods in which the AHP method is used to give the weight to each criterion and the outstanding lecturer sub-criteria while SAW is used to rank from the weighting results of the AHP method. Data on criteria is obtained through the merging of Kemenristekdikti criteria with the criteria that exist at Undhira. And then, uses the GMM and WAMM method to combine the weight of each expert's questionnaire.
2. The Implementation of this Outstanding Lecturer Decision Support System has been tested to assess 2018 Outstanding Lecturers at Undhira. This system was tried in March 2019. The trial began with the administrator inputting lecturer data, the Outstanding Lecturer criteria data, lecturers' tri dharma history data and configuration. The expert filled out the Outstanding Lecturer's questionnaire. Public can see the ranking results for the configuration year (2018).
3. Referring to the results of the MAP AHP + GMM + SAW & AHP + WAMM + SAW the results were 60%. 60% is a good accuracy, but there are still a number of different ranking results at Undhira with the results of the AHP + GMM + SAW & AHP + WAMM + SAW system because ranking at Undhira is identified to still contain elements of subjectivity. Subjectivity in question is the criteria used are not clear. Whereas the results obtained in the GMM & WAMM system were obtained from the merging of the Ministry of Research, Technology and Higher Education (Kemenristekdikti) criteria with Undhira criteria which obtained a new criteria. To get the weight on the new criteria was used AHP method, and also used the GMM & WAMM method to combine the weight of questionnaires of each expert, and the SAW method for ranking outstanding lecturers. After going through the process of analyzing the system using MAP, it can be concluded that the DSS of Achieving Lecturers is feasible to be applied in the Undhira

References

- [1] B. Surarso and E. A. Sarwoko, "Sensitivity Analysis of The AHP and TOPSIS Methods for The Selection of The Best Lecturer Base on The Academic Achievement," pp. 2–8, 2010.
- [2] T. Limbong, "Implementasi Metode Simple Additive Weighting (Saw) Untuk Pemilihan Pekerjaan Bidang Informatika," *Semin. Nas. Ilmu Komput. 2013 FIKOM Univ. Methodist Indones. Medan*, no. August, pp. 111–115, 2013.
- [3] T. L. Saaty, "Analytical Hierarchy Process (AHP)," in *Analytical Hierarchy Process (AHP)*, New York: McGraw-Hill, 1980.
- [4] P. . Fishburn, *Additive Utilities with Incomplete Product Set: Application to Priorities and Assignments*. 1967.
- [5] Kemenristekdikti, "Pedoman Pemilihan Dosen Berprestasi Kategori Sains Teknologi dan Sosial Humaniora Tahun Anggaran 2018," 2018.

Help With Math: A Serious Game For the 3rd Grade Elementary School Students in Plane Geometry

Kadek Arya Teguh Raharja¹⁾ and Sukajaya IN²⁾

^{1,2} Educational Mathematics Department, FMIPA, Universitas Pendidikan Ganesha

¹⁾raharjateguh23@gmail.com , ²⁾nyoman.sukajaya@undiksha.ac.id

Abstract. Let's Help With Math is a serious game based-learning used as mathematics learning media in understanding the concept of plane geometry for the 3rd elementary school. It is a single player serious game of adventuring genre. The game's challenges are distributed into 3 levels of game. The first and second level is regarding basic characteristics of a quadrilateral is categorized as a rectangle from low and medium level of difficulty. The third level is about the circumference of rectangle. For the players who did not get the problems' solution yet, the game displays twice hint gradually from hidden to unhide hint. The players who solve all problems from those three levels of challenges is stated as winners, but they who did not and have submitted wrong solution three times are stated failed (game over). Those players who are stated as winners are classified mastery in rectangle's subject. We implemented the 4D model of game development which is practically conducted only until the third step. The game's prototype has been tested by seven students from 3rd grade of elementary schools. Five among seven students looked very enthusiastic during playing the game. They also more interested in learning because the game raises real life problems associated with the properties and circumference of a rectangle. We conclude that the delivery of plane geometry subject, especially the properties and circumference of rectangles through learning media based on the game "Let's Help With Math" is more interesting than conventional learning.

Keyword: Serious Game Based-learning, Plane Geometry, Rectangle Learning Media.

1. Introduction

The development of technology from day to day is getting faster. One sector that is affected is education, namely easy access to learning resources that can be utilized by students. Education does not have to be based on books, but rather optimizes the utilization of technology. Teachers as educators must be able to follow the development of technology and information and be able to develop subject matter based on technology and information as learning media. Learning media are learning aids that are used to display certain facts, concepts, principles or procedures to be seen more clearly (Sujoko, 2013). These tools can provide a more tangible experience, and can increase students' understanding of learning material. The learning process becomes more interesting if the teacher can provide appropriate learning media to students. One of the interesting learning media and utilizing technology is game-based learning media

Game development can be used as an alternative learning. Games in general are a means of entertainment, but now the game has begun to be developed as a learning tool. In accordance with the nature of the game that is entertaining, learning through games can package the delivery of subject matter to students to be fun, so the lessons become easier to understand.

The essence of game-based learning is as a supporter and provider of experiential learning environments in building knowledge independently.

Through games, children experience learning (Widyastuti, 2010). Learning material will be more easily absorbed by children if the material is inserted into the game. One alternative learning media that can be used is learning media in the form of serious games. Serious game is a game that has the intent and purpose of more than just a means of entertainment, but there is also an educational element that is delivered.

Mathematics is abstract ideas which are given symbols arranged hierarchically and deductive reasoning, so learning mathematics is a high mental activity. These abstract ideas can be more easily understood if there are visualizations in serious games. Most students find it easier to remember things when they see and are given a picture or directly involved in it. This shows the importance of real visualization for students to understand something. This is where the role of serious games is to provide learning media that can provide visualization and give students the opportunity to play a role in it

the mathematics Problems experienced by elementary school students lies in understanding the concept. One way to overcome this is to provide a visualization of the subject matter and provide a pleasant learning environment. properties and circumference of rectangles in third elementary school tend to be more easily understood by students if the material is lifted from objects that are around, The limited time available does not allow students to go directly to the field. This can be tricked by using serious games, because this game raises the problems that are around. In addition, with serious game based learning, students tend to be more active and interested in following the lessons.

Several studies have shown that serious games play an important role in education, including Ahmad Fariq Arbor (2012) entitled "Mathematics Adventure Games" berbasis Role Playing Game (RPG) sebagai media pembelajaran mata pelajaran matematika kelas VI SD Negeri Jetis 1" stated that the application "Mathematics Adventure Games" that was developed was suitable to be used as a medium in the process of learning Mathematics in class

VI of SDN Negeri 1 Jetis. In a Fuqoha (2015) is study titled "Pengembangan Game RPG (Role Play Game) sebagai Media Pembelajaran Berbasis Guide Inquiry pada Materi Segiempat dan Segitiga untuk Siswa SMP Kelas VII" states that the RPG Game (Role Play Game) developed can be used for junior high school students in class VII B of SMPN 4 Purbalingga or other students who have similar characteristics.

Based on this, in this paper will discuss about game-based learning media in mathematics learning, entitled **"Let's Help With Math: A Serious Game For the 3rd Grade Elementary School Students in Plane Geometry"**

2. Literature Review

2.1 Conventional Learning and Technological Based Learning

Conventional learning is a teacher centered learning model. (Sudjana, 2001) states that teacher-centered learning activities emphasize the importance of teacher atifita in teaching students. Students act as passive followers and recipients of the learning activities carried out.

Information Technology based learning is a learning process that uses a variety of information technology as learning media. In IT-based learning, the teacher's role as the sole authority of knowledge is transformed into a facilitator for students to interact with various learning resources

2.2 Learning Media

According to (Pribadi, 2004) learning media is something that can bring information and messages from the sender or source of information to the recipient or learner. Learning media is a tool that serves to convey learning messages. The more learning objectives that can be achieved with the help of learning media, the better the media.

(Ena, 2000) proposes six criteria for assessing interactive learning media, namely a) Ease of navigation, a program must be designed as simple as possible so that students do not need to learn computer first to be able to use it as interactive learning media; b) The content of cognition, interactive learning must contain cognition or knowledge in accordance with the expected learning objectives; c) Knowledge and presentation of information, knowledge or information must be conveyed and presented correctly; d) Media integration, media must be designed in such a way that it can integrate aspects and skills that students must learn; e) Aesthetics, to attract students' interest, interactive learning must have an artistic appearance. Therefore aesthetics are also a criterion that must receive important attention; and f) The function as a whole, the interactive learning program developed must provide the learning desired by students, so that when students finish running a program students feel they have learned something.

2.3 Serious Game

Serious games can be interpreted as games that are built for non-entertainment purposes without omitting the entertainment function (Trisna Hady, 2016). Serious game can also be interpreted as an application that is designed so that students can engage in a fun and challenging learning environment that is conditioned so that it is similar to the real situation in the real world (Eko, 2016). Based on these explanations, it can be concluded that serious games are digital games created not with the primary purpose of pure entertainment, but with the intention of serious use as in training, education and health care.

The main objective of serious games is to grow, educate, and motivate players for a particular purpose. The purpose of the serious game in this paper is to instill the concept of the properties and circumference of a rectangle to grade 3 students of primary schools, with fun and interactive learning. Serious games can make students tend to easily absorb knowledge through role playing (Cheng, 2013). With role playing, students feel participating in the game. According to (Prensky, 2002), by using serious games into the learning process, in addition to learning more fun, interesting and interesting, but also more effective and efficient. A number of studies show that in its development, serious games can improve students' competence in terms of problem solving skills, making decisions, collaborating (E Klopfer, 2005) including in terms of honing their ability in language and mastering science and mathematics lessons (Mayo, 2007).

3 . Research Methodology

3.1 Type of Research

This research was conducted with a research and development approach. Research and development is carried out to produce specific products and test the quality of these products. Based on this understanding, this study aims to produce research products in the form of game-based multimedia

3.2 Research Design

This study was designed based on the Four D (4D) research and development model. The stages of the development of the 4D model consist of four stages, namely the stages of defining, designing, developing and disseminating. However, due to limited time,

cost, and ability of researchers, this research was only carried out until the development stage (develop)

3.3 Research Procedure

In this research, the 4D development model is only carried out until the third stage, namely the stage of defining, designing, and developing. The following will be given Table 3.1 which outlines the stages of development activities along with the expected outcomes and indicators of achievement.

Table 1. Expected Stages of Activities, Outputs and Indicators of Achievement

Steps	Activities	Outputs and Indicators of Achievement
Definition	a) Identify the problem at hand	Identification of problems in learning mathematics sub-subject of the properties and circumference of a rectangle
	b) Analyze the curriculum	Known sub-material boundaries of the properties and circumference of the rectangle
Design	a) Designing the game storyline	The game storyline is composed with sub-subjects of the properties and circumference of the rectangle
	b) Make a game interface	The game interface is generated
	c) Implementing game storyline into multimedia in the form of serious games	The resulting multimedia product is in the form of a serious game in accordance with the scenario that has been designed
Development	a) Evaluating multimedia developed learning products	The resulting multimedia learning has been evaluated by the supervisor
	b) Make improvements to the developed multimedia learning products	The resulting learning multimedia has been improved by the supervisor
	c) Testing	Obtained results about the practicality and efficiency of multimedia in the form of serious games

3.3.1 Define Stage

The first stage carried out in the development of multimedia based on serious games is the define stage. At this stage the author observes the material in mathematics that is felt to require visualization in understanding the material, and the material is obtained geometry that is the properties and circumference of a rectangle. this material can also be learned by using the topic of objects around the environment. Furthermore, the

Curriculum analysis and description of teaching material activities are conducted for even 3rd semester students. Next is the distribution of questions that have been adjusted to the stages of learning rectangles in grade 3 elementary schools

3.3.2 Design Stage

The initial design of the game is made at the design stage. At this stage, two main activities are carried out namely creating game scenarios and creating game interfaces. Following are the steps in the define stage

A. Making a Story Line

A Story line is the storyline in the game from beginning to end. The story line is made in such a way that game users feel the real experience while playing while at the same time able to capture the learning material delivered by the game. In this game, it is told that a child (player) who lives in a village must find a medicinal plant named Andredera to treat his sick mother. In order to get the Andredera plant, the child must venture to a place with Andredera plants. But on the way, the child must be able to face the problems found. The problem is related to the material properties and circumference of the rectangle.

B. Making a Game Interface

Game interface is the game display that is seen by the player. To attract the attention of players, creativity is needed in making the game interface. The game user target developed by the writer is third grade of elementary school student, for that the writer chooses bright colors and makes interesting visualizations about objects, trees, figures, and others. The author uses the Adobe Photosop application to create certain designs, and uses several templates that have been provided by RPG Maker.



Figure 1. Game's Interface

C. Making the Initial Game Design

In making the initial design of the game, the author uses the RPG Maker software. This software is used to make adventure games, so it is suitable for learning rectangular material.

3.3.3 Development Stage

The development phase is carried out through three main stages, namely product evaluation, limited trials and the revision stage. The details of the stages can be described as follows:

A. Evaluating Products

After the game has been designed, the supervisors conduct an evaluation before the game is tested. Evaluation is done in terms of appearance and game scenarios. The activity carried out by the supervisor is to review game products and provide suggestions for improvement regarding deficiencies found in the game.

B. Fixing Product Deficiencies

From the results of evaluating the multimedia game in the form of a serious game, it will be known that the shortcomings. Product improvement is done by taking into account recommendations and suggestions from experts, so that a prototype is ready to be tested

C. Testing

This game was tested on 7 third grade of elementary school children. Where previously the seven children had obtained material about the properties and circumference of the rectangle through conventional learning. The obstacles faced by the seven children are difficulties in understanding the concept of material and visualization of rectangular material. This game was tested on the seven children in turn through a computer provided by the author.

4 . Result

In this sub-chapter, the results obtained during the development of serious games will be explained as follows:

4.1 General Description of Let's Help With Math

Lets Help With Math is a serious adventure game (adventure) tells the adventures of a child (main character) trying to find medicinal plants in a place for his sick mother. In the journey to find the drug he must solve the challenges encountered on the road and solve the challenges of certain characters during the trip. These challenges and problems are related to the resolution of questions about the nature and circumference of squares and rectangles. In this game there are 3 levels which contain several questions. Players must be able to solve problems in each challenge to advance to the next level. This game is intended for users of 3rd grade age. this is because in this game in addition to entertainment there is an educational element that can increase knowledge for children. This game takes place in a rural setting, in which there are rural roads, rivers, gardens and houses. When logging in the game, the game will be display a tile screen and than the player chooses "start game". Then the player will be directed to the next stage

4.2 Continue to the next or Stop up to current level

The game's challenges are distributed into 3 levels of game The first and second level is regarding basic characteristics of a quadrilateral is categorized as a rectangle from low and medium level of difficulty. The third level is about the circumference of rectangle. For the players who did not get the problems' solution yet, the game displays twice hint gradually from hidden to unhide hint.



Figure 2. The Game's Hint

4.3 A Winner State

The players who solve all problems from those three levels of challenges is stated as winners, but they who did not and have submitted wrong solution three times are stated failed (game over). Those players who are stated as winners are classified mastery in rectangle's subject. When the player successfully completes all the challenges, the player will get the Andredera plant that is sought, then the player goes home and gives the plant to his mother

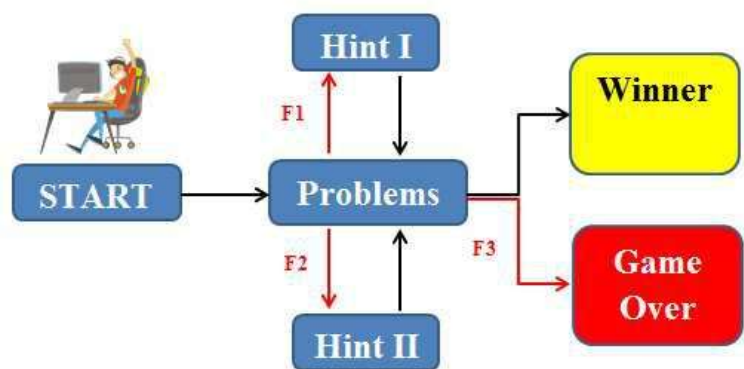


Figure 3. Winner State

Information:

F1= False I

F2= False II

F3=False III

4.4 Experimental Result

This table is the result obtained from testing a prototype game on seven students of the third grade elementary school

Table 3. The Result of testing prototype

Player	Completed level	Result
Player 1	Second level	Good
Player 2	First level	Not good
Player 3	Second level	Good
Player 4	Second level	Good
Player 5	Third level	Very good
Player 6	First Level	Not good
Player 7	Second level	Good

From the seven children who were given learning using the game Let's Help With Math, 5 children felt more interested and more understanding about the material nature and circumference on the rectangle. Real visualization according to the conditions in the field

makes students more enthusiastic in learning and understanding the concept of the nature and circumference of a rectangle

5. Conclusion

This paper describes the development of a serious game-based learning media called Let's Help With Math. This game is used as mathematics learning media in understanding the concept of plane geometry for the 3rd elementary school. The game's challenges are distributed into 3 levels of game. The first and second level is regarding basic characteristics of a quadrilateral is categorized as a rectangle from low and medium level of difficulty. The third level is about the circumference of rectangle. We implemented the 4D model of game development which is practically conducted only until the third step. . Five of the seven students looked very enthusiastic during playing the game. We conclude that the delivery of plane geometry subject, especially the properties and circumference of rectangles through learning media based on the game "Let's Help With Math" is more interesting than conventional learning.

References

- [1] C. S. Loh, Y. S. (n.d.). Serious game analytics. *Theoretical Framework*.
- [2] Cheng, Y. M. (2013). Investigating elementar school students technology acceptance by applying digital game based learning to environmental education. *Australasian Journal of Education Technology*.
- [3] E Klopfer, S. Y. (2005). Developing games and simulations for today and tomorrow's tech Savvy Youth. *Tech trends: Linking Research & Pratice to Improve Learning*.
- [4] Eko, I. R. (2016). Kajian penerapan konsep serious game dalam bingkai pedagogis: Mencari konteks pemenuhan kebutuhan pembelajaran modern.
- [5] Ena, O. T. (2000). Membuat media pembeljaran interaktif dengan piranti lunak prestasi.
- [6] J., M. M. (2007). Games for science and engineering education . *Communication of the ACM*.
- [7] Mayo. (2007). Games for science and engineering education. *Communication of the ACM*.
- [8] N, S. (2001). *Penilaian hasil proses belajar mengajar* . Bandung: Remaja.
- [9] Prensky, M. (2002). *The motivation of gameplay* . On the Horizon.
- [10] Pribadi, B. A. (2004). Ketersediaan dan pemanfaatan media dan teknologi pembelajaran di perguruan tinggi. *Jurnal pendidikan*.
- [11] S, W. (2010). Metode mendidik anak secara komunikatif. *Jurnal Pendidikan* .
- [12] Sudjana, N. (2001). *Penilaian hasil proses belajar mengajar*. Bandung: Remaja.
- [13] Sujoko. (2013). Pemanfaatan teknologi informasi dan komunikasi sebagai media pembelajaran .

Jurnal Pengembangan Pendidikan, 71-77.

[14]Trisna Hady, P. (2016). *Serious game jaringan komputer berbasis simple additive weighting*.

Singaraja: Universitas Pendidikan Ganesha.

[15]Widyastuti, S. (2010). Metode mendidik anak secara komunikatif. *Jurnal Pendidikan*.

Captain Math: An Educational Game For The 5th Grade of Elementary School Students In Weight-Unit Conversion

Damurrosysi M¹ and Sukajaya I N²

^{1,2}Educational Mathematics Departmen, FMIPA, Universitas Pendidikan Ganesha

¹⁾dmujaheidain@gmail.com, ²⁾nyoman.sukajaya@undiksha.ac.id

Abstract. In the 21st century; the study about educational game was greatly improved. It is due to that educational game is believed having positive impact toward the advancement of education. In this research, we developed an educational game for learning weight-unit conversion for 5th grade of elementary school students. The game was developed as a single player game of adventuring genre and divided into three levels of play. Each level follows content semantic of subject: sequence, conversion, and implementation. The first level contained challenge in the form of sorting weight unit from the largest (kg) to smallest (mg). For the second level; players are challenged to determine a value that is similar to a given value from other weight unit. The last level has the highest difficulty challenge, in which players are challenged to look for an answer to a problem given as the operation of weight-unit. This game was developed following 4D principle: define, design, develop, and disseminate. This game also available in two versions: a computer and a mobile version. For a mobile version it has been designed in two operating systems: Android and Windows Phone. The prototype of this game has been tested involving 15 players who were 5th grade of elementary school student. An interesting interface display in this game makes students especially like this game and it seems there is discussion among them to complete the challenge. The learning process looks more optimal through Captain Math.

Keywords: Educational Game, Elementary School Students, Weight Unit Conversion

1. Introduction

The change of curriculum that always been done by the Government provides various impacts to education in Indonesia. It started from the beginning of its changes in 1947 until its final change to the curriculum 2013 or K13. These impacts are certainly felt immediately by educational actors from the teacher to student. If you see urgency in education, curriculum change is very necessary because it is always needed renewal in various aspects that are required to always follow the times.

But a significant curriculum change was evident in the year 2013 that then changed the KTSP to K13. K13 is a competency based curriculum that was actually previously initiated on the Kurikulum Berbasis Kompetensi (KBK) 2004, but had not been resolved due to strong urges to directly implement KTSP 2006. In addition, the establishment of K13 also according to the mandate of UU No. 20 year 2003 about national education and also Peraturan Presiden year 2010 about national mid-scale development plan. The curriculum changes from KTSP to K13 can be said to have the most significant influence because of the many completely changing systems and directly affects teachers and student.

One of the things that is very influential for the KTSP to K13 is the Student Learning Center implementation. This approach is not a new thing in the education but a new thing in education in Indonesia since the curriculum changes to K13. Characteristic of Student Learning Center which is the type of learning that initially only teachers and student become teachers-student-the natural environment-as well as other media sources (including the Internet). In student learning center, students are required to seek their own learning resources from some of the surrounding media. It is expected to increase the competency for student. But in fact, this increasingly makes students not focus is caused by some of the negative impacts of the use K13 such as the learning time due to the added hours of the lesson so that it is difficult for student. This must also happen to student of elementary school and will be very risky because understanding the initial concept are all given in elementary school.

Therefore, it needs special attention when the negative impact of the use of this K13 occurs in student of elementary school. And student of elementary school will be difficult to accept the concept of lessons especially mathematics. Because of that the developer thinks there are several solutions for elementary school mathematics learning. And one of the solutions that will have a good impact we think is the use of educational games on learning mathematics in elementary school.

The use of educational games for learning is also not something new because the development of the game in the world increasingly dash every time including in Indonesia. Games gave many important roles as a means of entertainment even on education or training facilities for all ages ranging from children to parents. Now crowded games are digital based games that are very easy to get in the providers free paid apps. Besides being useful as entertainment, many also use this media game as a means of education and usually used for learning media read, write, calculate for early childhood.

Attractive interface and colorful design will be relevant if this digital game is used for math learning media especially for elementary schools. With the help of educational game, mathematics learning in elementary school will be more optimal than using classical media in learning like pencil and paper. By implementing educational games in some mathematical materials especially in the planting of concepts, then the negative effects of the use K13 on elementary school students as they have been contested will be resolved little by little.

For example in the summation material given summation educational game, later student of elementary school will be more challenged to solve the problems given about the summation material. If the student is already interested, then the student's desire to seek and deepen himself more about the material he gets will be done by itself. Therefore, indirectly the expectation of the use of K13 is that students seek their own teaching materials from various sources will be slightly carried out and the result will be much more optimal.

From here, developer are interested in making "Captain Math" educational games with elementary school mathematics material. Because understanding the concept is important then the developers makes an educational game with weight unit conversion material. This simple material is one of the basic mathematical materials of elementary school that many are not interested by student of elementary school due elaborate depictions and explanations.

Captain Math educational game is given an interesting visualization of this material as well as a challenging game that allow students to also be challenged to understand the weight unit conversion material to complete all the challenges of the Captain Math game. So the transformation of science from teacher to student will also be much easier with Captain Math.

2. Literature Review

2.1 Serious Game

Since ancient times games have often been used as a tool for learning. Various aspects of learning many use the game as a medium. As for social learning skills, psychological, to physical. "Non-digital

games ... adult behavior" (Ulicsak, 2010). At that time digital games had not yet appeared and traditional games were used as tools for learning. Looks more optimal in learning activities, games have become a tool for learning to date. But in its type, there is one type of game that is prioritized as a learning medium called serious games. In the past, there were many serious games at that time such as predictions, strategies for war and others. Then after the game mechanics began to develop a lot, new rules in the game began to increase a lot to limit and increase the level of difficulty in the game. Crawford proposes five main categories in which games may fall: board, card, athletic, children and computer games (Crawford et al., 2003), and all types of games disclosed, all serious aspects can be added to them other than entertainment.

One of the five main categories in games is computers where computer games are games that are played on a computer and the main players and enemies are usually in the same computer. Games are very quickly becoming part of the computer, so many programmers who immediately make a variety of games for computers to become very much when commercially available. Since then, the term video game became known.

All of these games can have more serious goals besides entertaining goals. This term is commonly referred to as serious gaming. Serious games can be defined as “a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives” (Zyda, 2005).



Figure1. Areas in which Serious Games are being used (Zyda, 2005).

The definition explains that SG can be designed and developed, by stating that video games can be used for purposes other than just entertaining such as education, health, and increasing public interest about problems in the global world (Magnenat-Thalmann & Kasap, 2009).

2.2 Edutainment and Serious Game For Learning

This section will explain the development towards using SG and edutainment as tools to help on education. While SGs and edutainment have the same final toward, the pedagogical approach to learning is different between them. Edutainment became less important; on the other side research on educational use of SGs increases rapidly.

“Experiences with digital game natives, those who have grown up playing games, indicated that a game-centered research and educational program could offer many positive benefits” (Zyda, 2005).

Researchers are beginning to theorize the cognitive processes during game playing, bringing a better understanding of educational game design and leading to new research (Dondlinger, 2007).

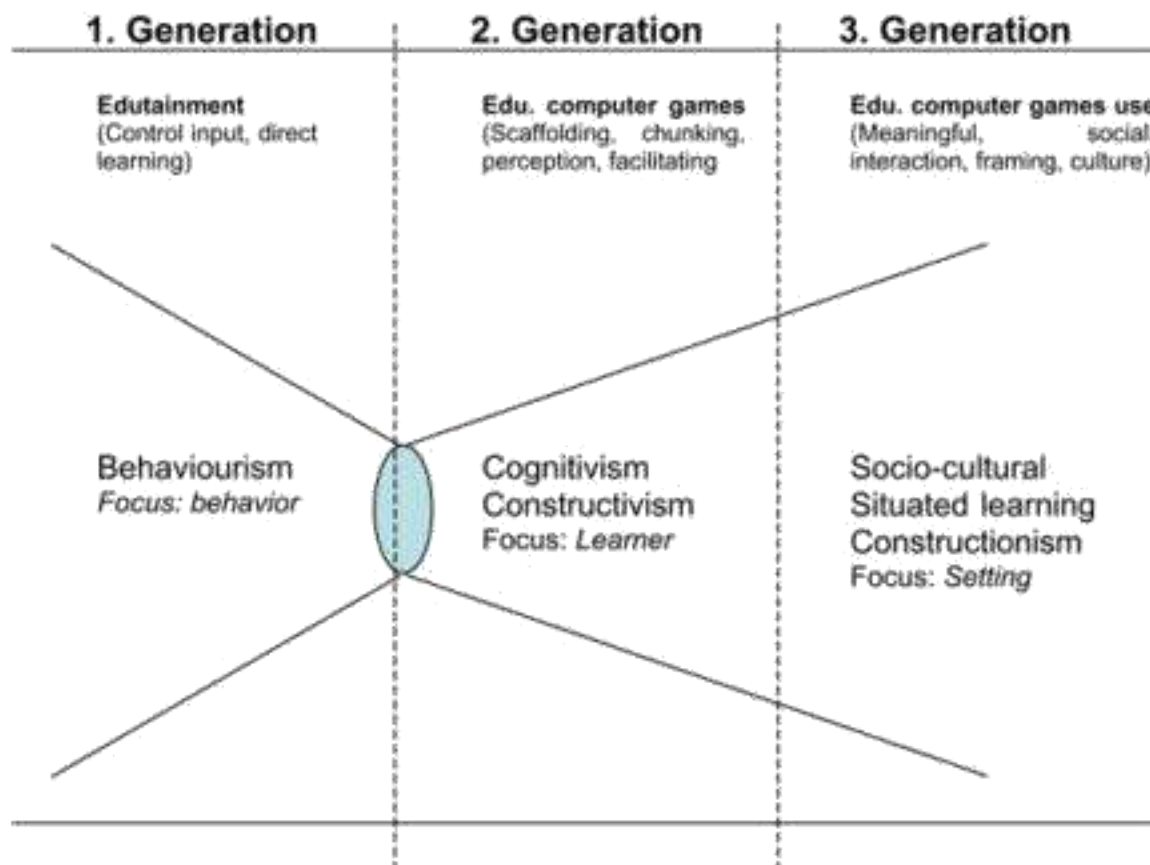


Figure2. Generations of educative software and games (Egenfeldt-Nielsen, 2003).

Edutainment and educational games were once praised to revolutionize the education system because their ability to educate and entertain, but they have received bad acceptance due to combining the lowest form of education, drill and practice, masked with boring gameplay (Charsky, 2010).

The lack of sophistication, poor depth of learning and boring game play offer a point of The reviews of the evolution of edutainment and instructional games shows what the problems are and the advances done through research in that area. The separation of the term edutainment from the research on SGs is necessary since it is not well accepted by scholars.

3. Research Methodology

1.1. 4D Model

The development model of the 4D Model was suggested by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel (1974). This model consists of 4 stages of development, namely Define, Design, Develop, and Disseminate [14]. But we have only reached the third stage, namely Develop.

1.1.1. Define The define stage is the stage for defining and defining learning requirements. This define phase includes five main steps, namely front-end analysis, learner analysis, task analysis, concept analysis and specifying instructional objectives.

1.1.2. Design The design phase aims to design learning tools. As for those designed at this stage are as follows:

- 1 Scenario of This Game

The scenario in this game is an alien story that will attack and rule the earth. With his crime, aliens will face their enemies who will always guard the earth namely Captain Math. Captain Math will defeat and frustrate the plans of the evil aliens who will rule the earth in three levels. At each level Captain Math must defeat the evil aliens with the concept of the Heavy Unit Conversion.

At the first level, the challenge accepted by Captain Math is a matter of a terminology meaning an introduction to the concept of unit weight conversion. Captain Math is required to sort the weight units from the largest to the smallest. Surely the evil aliens will continue to block Captain Math.

On the second level, the challenge of captain math is getting more difficult namely having to find blocks containing numbers that are worth the questions given. The challenge will be more difficult when aliens also have the additional power of shooting.

At the third level, the final and most difficult challenge is that Captain Math must find a block which is the completion of the operation of two different units of weight. Coupled with more difficult challenges captain math will be more difficult to solve challenges on the third level.

[2]. Rule of The Game

Win

Players will be declared victorious if they successfully complete all the challenges at each level. But each player will get a different point. Point-points are obtained from picking up gems, getting answers, killing aliens. If at every level the player kills many aliens and takes the gems, Then the final point gained will also be more.

Lose

Players will be declared defeated if all life given (5 lives) has expired. And life will be reduced by one if :

Touching Alien

Exposed Alien Shots

Falling into the abyss/outside of the arena

Wrong take an answer

1.1.3. Develop The development phase is the stage to produce development products which are carried out through two steps, namely: (1) expert appraisal followed by revision, (2) developmental testing. The purpose of this development phase is to produce a final form of learning tools after going through revisions based on expert or practitioner input and trial data.

2.1 Challenges

In each level, we provide different challenges. Semakin tinggi level, maka semakin susah tantangan dan soalnya. Berikut rangkaian soal dari game Captain Math.

Table1. Distribution of Material Concept

Level	Material	Quantity	Diffiqlty Question		
			E	M	H
1	short the weight unit from the largest (kg) to the smallest (mg).	7	7		
2	find the number	6	3	3	

	worth of the given problem.
3	seek the 5 3 2 completion of
	different weight unit conversion

4. Result

4.1 Interface Game Captain Math



Figure3. Interface of Main Menu

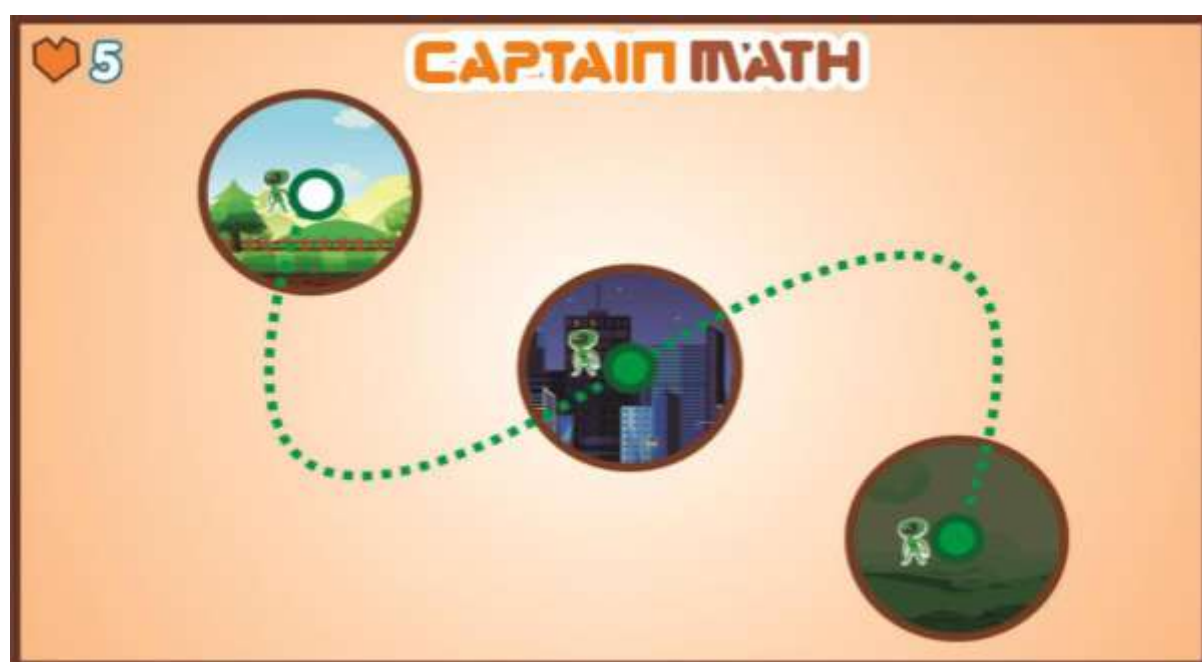


Figure4. Interface Of Map



Figure5. Interface Of Level1



Figure6. Interface Of Level 2



Figure7. Interface of Level 3



Figure8. Interface of Win Page



Figure9. Interface of Lost Page

those are the display pictures of this game from the start page to the end page. The interface is filled with attractive colors so students can comfortably play and finish the game well.

4.7 Players Score

The score in this game is determined by picking gems, killing aliens, and get the true answer. From 3 student who can finishing this game until last level, the result are shown in the table below.

Table 2. Players Score	
Name	Final Score
Gusta	125
Dedi	277
Karmawan	252
Desak	157
Nanang	170

This score shows the enthusiasm of players in completing this game. If the score has been obtained, it means that the player has completed this game to the last level well even with different scores from each other.

5. Conclusion

The prototype of this game has been tested involving 15 players who were 5th grade of elementary school student. An interesting interface display in this game makes students especially like this game and it seems there is discussion among them to complete the challenge. The learning process looks more optimal through Captain Math.

Captain Math is able to answer it because the output of the use of Captain Math as a learning math media is The creation of discussion activities between students to solve challenges, and critical thinking will appear automatically in the discussion activities and Finally Formula 4c will be formed in class. This really helps the SCL activity done optimally.

And with this, it is hoped that many new innovations in education will have an impact on improving the quality of education in Indonesia.

References

- [1] Drigas, A. S., & Pappas, M. A. (2015). On line and other game-based learning for mathematics. *International Journal of Online Engineering*, 11(4), 62–67. <https://doi.org/10.3991/ijoe.v11i4.4742>
- [2] Kato, Enrique, Ricardo Goncalves, Joao Xavier, and Antonio Coelho. 2011. Serious Game for Introductory Programming. *Lecture Notes in Computer Science* 6944: 1-12.
- [3] Novak, Jeannie. 2008. *Game Development Essentials: An Introduction* 2nd ed Canada: Delmar Cengage learning.
- [4] Akkerman, S., Admiraal, W., & Huizenga, J. (2008). Storification in history education: a mobile game in and about medieval Amsterdam. *Computers & Education*, 52(2), 449–459.
- [5] Ishaq Madeain. 2010. *Desain Pengembangan Pembelajaran Berbasis Teknologi Informasi dan Komunikasi (TIK) Pada Mata Kuliah Aplikasi Komputer*. [Tesis]. Makassar (ID). Universitas Muhammadiyah Makassar.
- [6] Thiagarajan, S., Semmel, D. S & Semmel, M. I. 1974. *Instructional Development for Training Teachers of Exceptional Children*. Minneapolis, Minnesota: Leadership Training Institute/Special Education, University of Minnesota.
- [7] Crawford, Chris, Sue Peabody, The Art, Computer Game Design, World Wide Web, and Donna Loper. 2003. *The Art of Computer Game Design*. Osborne/McGraw-Hill.
- [8] Magnenat-Thalmann, Nadia, and Zerrin Kasap. 2009. Virtual Humans in Serious Games. 2009. *International Conference on CyberWorlds*: 71-79. doi:10.1109/CW.2009.17. <http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=5279708>.
- [9] Bandura, A., Ross, D. & Ross, S. 1961. Transmission of aggression through imitation of aggressive models. *Journal of Abnormal and Social Psychology*, 63, 575-682.

Story of Math: A Serious Game Based-Learning for Improvement of Students Achievement in Time Unit Conversion

P Rika Sahriana¹ and Sukajaya I N¹

¹ Educational Mathematics Department, FMIPA, Ganesha University of Education

rikasahriana28@gmail.com

Abstract. We developed a serious game entitled "Story of Math". The game is developed as a learning media in understanding a subject matter of 3rd grade of elementary school students, that is Time Unit Conversion. The development model which is implemented in developing the Story of Math is 4D model (Define, Design, Develop, and Disseminate). We only conducted the first three among four procedures of the 4D model. The Story of Math game is a single player game of adventuring genre. Challenges are presented as time unit conversion's problems distributed in three levels. Problems for the first level involve time unit conversion from hours to minutes, minutes to seconds, and hours to minutes. For the second, problems involve conversion from minutes to hours, seconds to minutes, and seconds to hours. For the last, problems involve addition and subtraction operations for operand from either similar or different time unit. Feasibility of the game implementation has been tested through User Acceptance Test involving 5 students of 3rd grade elementary school students. The results shows that students are very interested and enthusiastic in playing game. The response was reflected in gestures and expressions of their faces look so curious. They have no problem or easily understand how to play this serious game. They also understand the subject that is integrated into the game showed through quick response for the quiz given after playing the game. It infers that the Story of Math serious game is interesting and potentially help the students to understand the concept of subject time unit conversion.

Keyword: Serious Game Based-learning, Time Unit Conversion, Improvement of Students Achievement

3. Introduction

In the era of globalization, the use of technology has certainly become commonplace. Almost everyone has a capable gadget. This certainly has a positive impact if it can be used appropriately. Most children use these gadgets to look for entertainment such as watching videos, surfing the internet or playing games. Most games have an addictive effect on children because they make them forget the time, so fun to play games. It also causes children to put aside their study time and instead spend a lot of time playing games.

The impact of addiction in playing games is huge, ranging from decreased learning achievement and lazy to learn. To be able to take part in learning at school properly, surely they must increase their study hours at home because they cannot rely solely on study hours at school. The large number of subjects is also sometimes a reason for children to be lazy to learn, not to mention there are lessons they do not like. Mathematics is one of the lessons that students dislike, the reasons are very diverse. Some of them, namely: 1) Because it is not comfortable with the teacher who teaches, 2) The number of materials that only use numbers or abstracts, 3) There are negative experiences in the process of learning mathematics, 4) There is an assumption that mathematics is a difficult subject and scary. Because of these factors, not a few Indonesian children become "phobias" towards learning mathematics so that the right method is needed to overcome them. In addition to the factors mentioned above, Indonesia's geographical factor which is a large country, consisting of many islands, each of which has different conditions, also greatly influences the abilities of children in each of these regions.

Because of these different conditions, not all Indonesian children have adequate learning facilities and infrastructure so that the abilities of rural and remote children will be different from the abilities of children in urban areas.

Recent research on mathematics education shows that students face difficulties in understanding mathematical concepts and to develop logical thinking and strategies for dealing with mathematical problems. In an effort to analyze what makes it difficult to learn mathematical concepts and skills, consider problems of immediate attention, cognitive processing problems, hearing problems, memory problems, and metacognitive deficits [1].

From a survey conducted regularly every four years by Trends in International Mathematics and Science Study (TIMSS) [2]. Indonesia first participated in 1999 and obtained an average value of 403, after that in 2003 it got an average value of 411, in 2007 it got a value of 411, and in 2011 it got an average value of 386. The value obtained by Indonesia is still below the average standard value set by TIMSS which is 500. In addition, based on a survey of the Program for International Student Assessment (PISA) conducted for students aged 15 years in 2015, Indonesia's ranking is 63 out of 72 countries that take the test. Similar to TIMSS, the average standard set is 500. Therefore, it can be concluded that the mathematical abilities of Indonesian students are still classified as very alarming so there is need for innovation in improving and enhancing the overall mathematical abilities of Indonesian students.

Problem-solving skills and understanding of concepts as basic abilities that students must have require special attention in order to face competition in the future which will become increasingly difficult. The competition that will be faced later is not only with fellow human beings, but also with sophisticated technology. Technological advancements have led to automation in almost all fields, so that over time, technology has slowly replaced human work. In addition, Indonesia is predicted to experience a demographic bonus in 2030-2040 where the productive age will be more than the nonproductive age. The population of productive age is estimated to reach 64% of the total population of Indonesia, which is estimated at 297 million. Therefore, the large number of people of productive age must be followed by an increase in quality, both in terms of education and skills starting from early childhood which will greatly affect the ability to compete in the global labor market considering unemployment is one of the severe threats that must be faced in the future with Indonesia's open unemployment rate in the high category, namely in February 2017 amounting to 5.33% or 7.01 million of the total 131.55 million workforce people [3].

Seeing the various problems above Serious Game is the best solution to be applied. By packaging mathematics learning into a game that provides concept inclusion, it certainly reduces students' fear of mathematics. Serious Games focuses on designing specific games for the learning process, creating virtual scenarios that represent professional contexts with an interactive and immersive graphic environment. Usually, this game follows a story line, situation or context that illustrates a real problem. The added interactivity makes it possible to assess the impact of a player's actions, through his reaction to specific situations in a virtual scenario. But the most striking effect in the use of Serious Games is increased motivation and involvement [4].

Based on this the authors are interested in developing Serious game for the inclusion of mathematical concepts.

4. Literature Review

4.1. *Serious Game*

Serious games have been proposed as a means to engage students with a particular focus on the Science, Technology, Engineering and Mathematics (STEM) curriculum. However, limited research has been conducted on the effectiveness of serious game elements and the respective teaching practices. In particular, there is limited understanding of pragmatic design principles for serious games [5].

There is no single definition of serious games, though they are generally held to be games used for training, advertising, simulation or education. Alternative definitions include the application of game concepts, technologies and ideas to non-entertainment applications. Clark Act was the first author who used this term in 1970. For him, serious games are effective teaching and training devices for students of all ages in many situations because they are highly motivating and because they communicate very

efficiently the concepts and facts of many subjects. They offer us a rich field for a risk free active exploration of serious intellectual and social problems [6].

Serious games are simulations of real-world events or processes designed for the purpose of solving a problem [7]. Although serious games can be entertaining, their main purpose is to train or educate users, they may also have other purposes such as marketing or advertising. Serious games are, in a very general sense, “any form of interactive computer-based game software for one or multiple players to be used on any platform and that has been developed with the intention to be more than entertainment [8]. Serious Games focus on the specific design of games for the learning process, creating virtual scenarios representing professional contexts with interactive and immersive graphical environments [9].

Normally, these games follow a story, situation or context lines that portrait a real issue. Added interactivity makes possible to assess the impact of the player’s actions, through its reaction to those specific situations in the virtual scenario [10]. But the most striking effect in the use of Serious Games is an increased motivation and engagement. This was seen in the all the sectors that currently use Serious Games like education, defense and health.

4.2. Serious Game for Mathematics Learning

Previous work on the educational use of games has highlighted strategies for employing popular commercial games (e.g., Rovio's Angry Birds) in a Physics course [11], but it has not provided any actual implementation of the respective concepts. Several studies describe what the optimal conditions are for learning math. Cognitive research has shown that learning mathematics is most effective when four fundamental characteristics are present: 1) Active engagement, 2) Participation in groups, 3) Frequent interaction and feedback, and 4. Connections to real world contexts [12]. That means in addition to actively constructing knowledge from experience, interpretation and structured interactions with peers and teachers, there must be meaningful math problem solving connected to real world contexts. Engaging prior understanding, and self-monitoring opportunities, in addition to factual and conceptual information are also important components of learning mathematics [13].

Games are an ideal way to test understanding because the player is continuously being assessed, and can only advance if they master the system (provided the game is well-designed). Moreover, testing is part of the gameplay as opposed to a separate activity that students fear. Players can be rewarded for creativity and group work, as well as content specific knowledge. There have been several studies that propose using serious games as assessment tools. Performance assessment is intertwined with game play. Especially at the end of a level, the player can have a chance to solve problems that encompass concepts learned up to that point before advancing to higher levels. Level assessment can also be determined by the system's artificial intelligence to follow the player's learning curve and provide assistance when needed. All of that data can be collected and analysed and sent to the teacher as well as the player to inform them what they know best and what they need to work on. Otherwise, there can be a divide on how material was presented and how students must show understanding.

There are several things that need to be considered in making a good serious game, namely:

1. Integration

When developing a learning game, we need to install learning and the game integrates with each other. The point is that between games and learning objectives must be combined or join a complete association and to complete this game, we must master the learning objectives in it.

2. Motivation

We have to make sure this game provides possible motivation. The main key to providing motivation is to make games interesting and fun. Motivation must be in line with the requirements of the game, which are given such as balance, an appropriate reward system, consideration in the game and fast feedback from players. In a game some of these requirements are referred to as "challenges". When a player gets a challenge or challenge, he will be asked to be motivated to complete the challenge given.

3. Game Focus

The last thing that is important in making a good learning game is "game focus" or game focus. The aim of the game is aimed at the players. Providing clear goals for the players can help provide

concentrated learning in accordance with learning objectives that are integrated with the game being made.

One reason for the effective use of serious games in education is because it can help the mood of students or players. Playing games as a means of entertainment can also change moods according to the roles or characters we use, for example roles in characters that are increasing complexity such as sadness, happiness, and increasing can change the hearts of players. Serious games that effectively form a positive mood to encourage players to continue the game, which leads to increased interest in the game, as well as better academic improvement.

4.3. Time Unit Conversion

Conversion of time units is changing time units to other time units, from the smallest value to the largest or vice versa. The time unit itself is a time interval that is used as a determinant of the duration of time or an event. Units of time generally indicate a period of time, for example such as hours, minutes, seconds, days, weeks, years, decades, centuries and many other units of time.

5. Research Methodology

5.1. 4D Model

The development model of the 4D Model was suggested by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel (1974). This model consists of 4 stages of development, namely Define, Design, Develop, and Disseminate [14]. But in this study, we have only reached the third stage, namely Develop.

3.1. *Define* The define stage is the stage for defining and defining learning requirements. Activities carried out at this stage are initial analysis and curriculum analysis. Preliminary analysis is conducted to find out common problems that occur in the field related to learning time unit conversion material. This initial analysis activity was carried out by conducting interviews with several mathematics teachers at SDN 3 Kesiman. Furthermore, curriculum analysis activities are carried out to find out basic competencies, learning indicators and time unit conversion teaching material description for grade III students. The results of this stage are identified common problems in learning and known limitations in unit time conversion material for grade III students.

3.2. *Design* The design phase aims to design or prepare the Serious Game prototype and its evaluation tools. The initial step of this stage is the creation of a Serious Game design based on the results obtained at the defining stage. The design of a building or storyboard is a series of texts that contain descriptions, flow and simple descriptions of the components that will be contained in the Serious Game from start to finish. With the design of the building will facilitate the process of making the Serious Game. Furthermore, the design was implemented to be Prototype I Serious Game: Story of Math with the help of Adobe Photoshop software as an application for making maps and characters, Kinemaster as an application for editing videos and RPG Maker Mv as the main application in making this Serious Game. Prototype 1 which will be used in a limited trial which later when the results of the limited trial comply with good criteria, prototype 1 can be said to have reached the final prototype.

The design phase aims to design learning tools. The complete description of the designed device is as follows:

- **Game Scenario**

Story of math game is a single player game that adopts the flow of folklore. The aim is in addition to planting mathematical concepts, it is hoped that players insights about folklore will also increase. At the time of starting the game, the player will be given instructions on what to do. The challenges in this game in the form of a way for players to help each non-player character encountered.

In the story of math, adopt the story of Rama and Shinta. Players will act as the main character who will help Rama to save the goddess Shinta. When entering the game, the player can move the characters in the game to the right, left, front, back using the keyboard, and to continue the dialogue /

conversation with the NPC can use the left click on the mouse or can press the enter key. Players will look for instructions by walking around on the map available in the game.

There are 3 places that become the main map in this game, namely forests, mountains and castles. Each of these places has different levels of difficulty. Problems for the first level involve time unit conversion from hours to minutes, minutes to seconds, and hours to minutes. For the second, problems involve conversion from minutes to hours, seconds to minutes, and seconds to hours. For the last, problems involve addition and subtraction operations for operations from either similar or different time units.

For each level 9 questions will be scattered in various challenges. In answering 1 question will be given the opportunity to answer 3 times. When a player fails to answer for the first time, a clue is given to help the player, but still makes the player think. If on the second occasion the player is still wrong then there will be a more detailed clue than before. If on the third occasion the player still answers incorrectly, the player will get the game over and must repeat the game from the save point.

When the player successfully answers a question, another question will appear that has the same level of difficulty at that level. Until the player answers 9 questions in different scenes and completes one object on the map, the level for the next question will increase. By giving 3 times the opportunity to answer and give a clue to the player, the player is expected to have a strong understanding of the concept.

- Rule of Game

As explained earlier, when players get challenge will be given 3 times the opportunity to answer the challenge. When a player answers incorrectly at the first opportunity, a clue is given which aims to direct the player's thoughts towards the right answer. Then if the player answers incorrectly on the second chance, the clue given will be even more detailed than the previous clue but still makes the player think in determining the answer. On the last occasion, namely the third chance, if the player is still wrong answer will be given a game over, which player must restart at the specified save point. The chart below shows the clue system contained in the story of math game. When a player starts the game, the player will follow the story or the storyline contained in the game. During the storyline, the player will be confronted with a challenge in the form of questions relating to the unit time conversion material. The black line at the bottom shows the normal flow, but when the player answers a question incorrectly there will be 2 more chances so that the player can return to the correct channel to finish the game. The blue line shows when a player uses his second chance to answer a question, while the yellow line shows a player using his last chance to answer a question. In brief, the clue system in this game can be shown in the following chart.

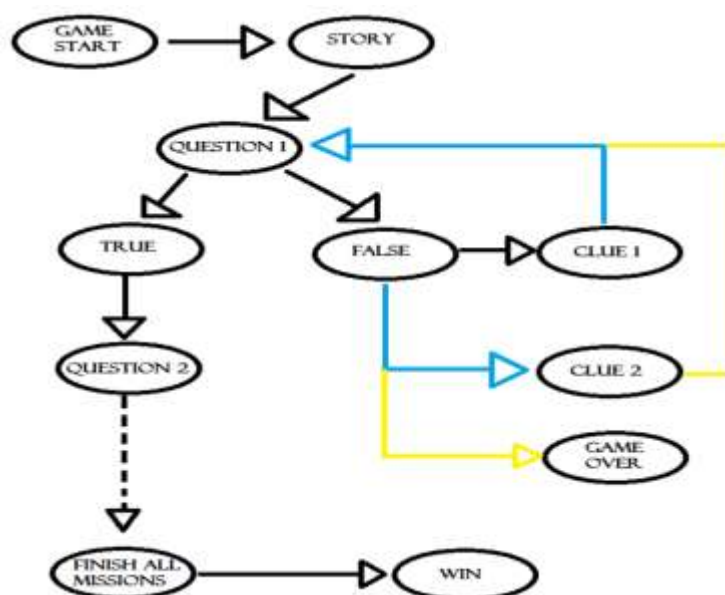


Figure 1. Question and clue system

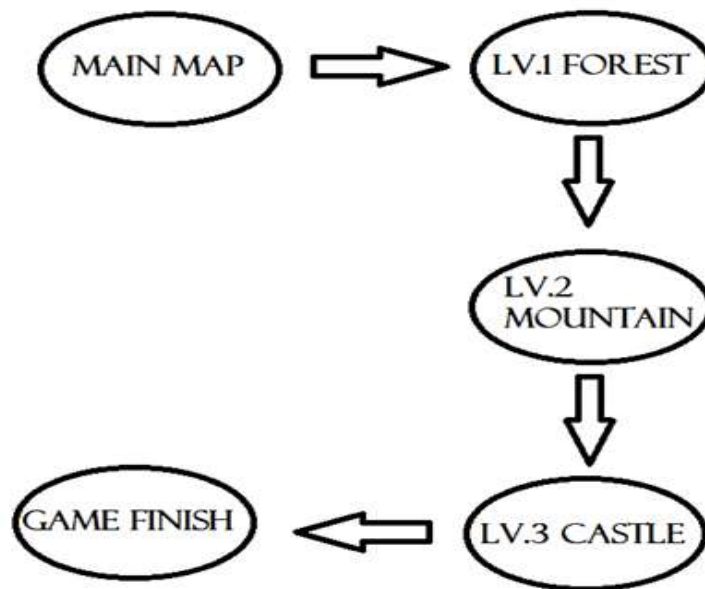


Figure 2. Maps level in Story of Math

3.3. *Develop* The purpose of this development stage is to produce the final form of learning tools or Prototype Final Serious Game after going through revisions based on expert / practitioner input and trial data. The development phase includes expert testing, product revisions and limited trials. The following is a description of the activities at the development stage.

a. *Expert Test* The purpose of the expert test is to find out the validity of the learning media that has been designed. Serious Game Validity: This Story of Math is determined by learning device experts and material experts. The selected expert is a person who has knowledge or ability in a particular field of study based on education, profession, experience and achievements that have been achieved. The expert test involved two experts namely one Undiksha Department of Mathematics lecturer as a learning device expert and one mathematics teacher at SDN 3 Kesiman as a material expert. Activities carried out by experts are reviewing products and providing suggestions for product improvement by filling out the evaluation questionnaire provided.

b. *Product Revision* After the Serious Game Learning Media: Story of Math is assessed and its weaknesses and weaknesses are identified, a revision is made to the Serious Game learning media. Product improvement is done by taking into account recommendations and recommendations from experts, so that a valid Prototype II is obtained.

c. *Limited Trial* The main focus in this activity is to determine the practicality of Prototype II which has been validated by experts. By conducting a limited trial through the questionnaire responses of students and teachers, the practicality criteria of the product developed will be seen. In this study involved third grade students at SDN 3 Kesiman to conduct learning using the Serious Game: Story of Math learning media. The selection of SDN 3 Kesiman in the trial activities was based on consideration of affordability and feasibility. Affordability is meant as ease of access so that fluency in research can be guaranteed. While the feasibility referred to as an opportunity for product realization. The trial is carried out by UAT in the form of a questionnaire which can later show the quality of learning media in the form of a serious game: story of math.

5.2. UAT (User Acceptance Test)

UAT (User Acceptance Test) is a process of testing carried out by the user with the results of the output of a test result document that can be used as evidence that the software has been received and

has met the requirements requested. Feasibility of the game implementation has been tested through User Acceptance Test involving 5 students of 3rd grade elementary school students from SDN 3 Kesiman. Students will be given a questionnaire with a Likert scale. Likert scale is a scale used to measure perceptions, attitudes or opinions of a person or group regarding an event or social phenomenon, based on operational definitions set by the researcher. In the questionnaire given questions that emphasize the psychological aspects of the player when playing Story of Math. The questions given in the questionnaire were 5 items. In that question, there are 5 points, namely Strongly Agree (SS), Agree (S), Doubt (RG), Disagree (TS) and Strongly Disagree (STS). The assessment applied is to give a score of 1 to 5 on the related unit. Finally the scores from each respondent are matched with the available categorization intervals.

Table 1. Answer categories on the questionnaire

Categories	Point
Strongly Agree (SS)	5
Agree (S)	4
Doubt (RG)	3
Disagree (TS)	2
Strongly Disagree (STS)	1

Table 2. Evaluation interval for questionnaire answers

Interval	Categories
0% - 19,9%	Very Poor
20% - 39,9%	Poor
40% - 59,9%	Enough
60% - 79,9%	Good
80% - 100%	Very Good

6. Result

6.1. Interface Game Story of Math

The story of math game has an initial menu display that is new game, continue and options. Illustration as follows:



Figure 3. Initial display before starting the game



Figure 4. Display World Map of Rama and Shinta

Figure 3 shows the main display when the player starts the game. There are several menu choices, including New Game, Continou and Option. The function of New Game is to start the game from the beginning, Contiou to continue the game that has been previously saved, and Option to adjust the volume of background music and the sound of character music. Whereas in Figure 4 the world of Rama and Shinta is shown where the forest and mountains seen on the map will allow the player to enter there.

6.2. *Non-Playing Character*

Non-Playing Character (NPC) is any character in a game which is not controlled by player. The function of NPC is to help or provide instructions to players in completing the game. The following is an illustration of the NPC in the story of math game:



Figure 5. NPC that gives information to player

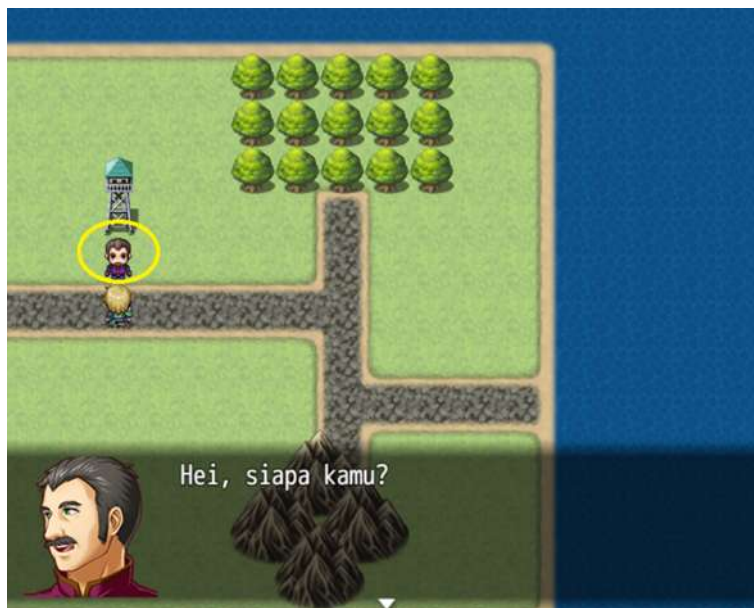


Figure 6. NPC that gives players instructions

6.3. Challenge

To win the story of math game, player must complete all the challenges given



Figure 7. The challenges given by the NPC are in the form of questions

6.4. *Clue*

If a player makes a mistake in answering the question, then the player will given a clue related to the problem, so it is hoped that the next question the player can answer correctly. In Figure 8, one example of CLUE is used in the game story of math. The clu is a digital clock video illustration showing changes in numbers in minutes and seconds. When seconds show the number 60, the minutes change to 1.



Figure 8. Examples of clues given to players

6.5. *Last Boss*

So that the game gets a pleasant playing experience, at the end is given a challenge to fight Rahwana who is the last boss in this game. In figure 9 an illustration is shown when the player is dealing with Ravana, the player must defeat Ravana in order to save the goddess Shinta.



Figure 9. Display when fighting against Rahwana

6.6. Win/Lose Condition

The condition to win the story of math game is to complete all challenges until Shinta is saved. Meanwhile the condition of losing is when the player fails to complete the challenge given.



Figure 10. Display when the player wins

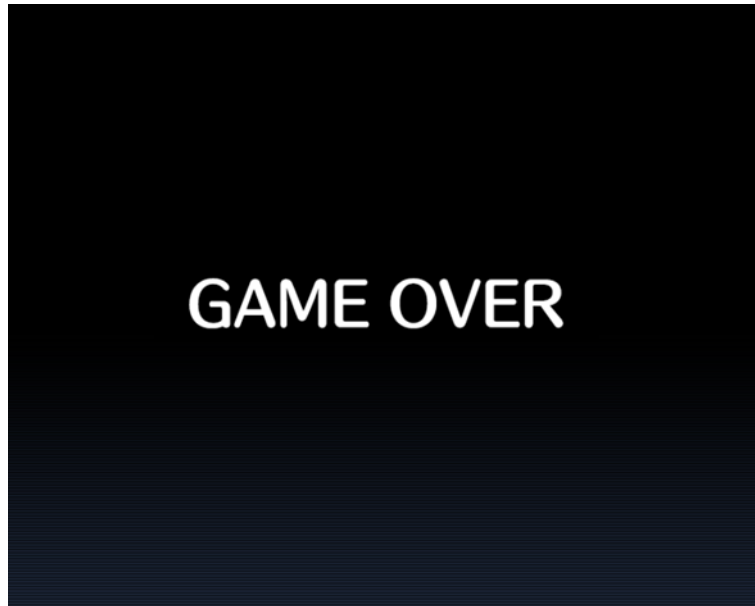


Figure 11. Display when the player loses

6.7. *Serious Game Performance Against The Students*

When testing students, there are no significant obstacles. Students are very enthusiastic and interested when trying to play this game. The clue system used is very helpful for students in understanding the concept of unit time conversion material. When players answer incorrectly, they get a chance to answer back which was previously given a clue so that they better understand the problem given. By using serious games as learning media, students become more interested compared to using conventional methods that are usually used in schools in general, namely using textbooks. Inserting learning material in the game reduces student anxiety in learning because students feel that they are playing a game, not learning. It also provides a sense of relax and makes it easier for them to understand the concepts inserted in the game.

6.8. *Players Score*

As explained before, the score in this game is determined by the duration in playing this game. Which is played by students is the result of prototype 1 game story of math. From 5 students who took the trial test, the results are shown in the table below.

Table 3. Players Score		
Name	Time Played	Game Over
Pradnyan	25 minutes	1 times
Adit	29 minutes	3 times
Ryan	26 minutes	2 times
Anggi	35 minutes	5 times
Lili	31 minutes	3 times

6.9. *Questionnaire*

Likert scale questionnaire is given to players after they play the game of math story which is still in the form of portotype 1, while the results were as follows:

Table 4. Results of players' responses to the questionnaire

N o	Statement	SS	S	RG	TS	ST S
1	The story of math game provides a fun math learning experience	3	2			
2	The story of math game makes it easy to learn unit time conversions	2	2	1		
3	The story of math game is easy to play	4	1			
4	The instructions provided in the game story of math are very helpful in solving challenges	1	3	1		
5	The challenges given in the story of math game are easy to understand	4	1			

Max score = $5 \times 5 = 25$

Min score = $5 \times 1 = 5$

- Statement 1

Answer SS = 3 respondents $\times 5 = 15$

Answer S = 2 respondents $\times 4 = 8$

Total score = 23

$$\text{Index (\%)} = \frac{23}{25} \times 100 = 92\%$$

- Statement 2

Answer SS = 2 respondents $\times 5 = 10$

Answer S = 2 respondents $\times 4 = 8$

RG Answer = 1 respondent $\times 3 = 3$

Total score = 21

$$\text{Index (\%)} = \frac{21}{25} \times 100 = 84\%$$

- Statement 3

Answer SS = 4 respondents $\times 5 = 20$

Answer S = 1 respondent $\times 4 = 4$

Total score = 24

$$\text{Index (\%)} = \frac{24}{25} \times 100 = 96\%$$

- Statement 4

Answer SS = 1 respondent $\times 5 = 5$

Answer S = 3 respondents $\times 4 = 12$

RG Answer = 1 respondent $\times 3 = 3$

Total score = 20

$$\text{Index (\%)} = \frac{20}{25} \times 100 = 80\%$$

- Statement 5

Answer SS = 4 respondents $\times 5 = 20$

Answer S = 1 respondent $\times 4 = 4$

Total score = 24

$$\text{Index (\%)} = \frac{24}{25} \times 100 = 96\%$$

So in accordance with table 2. Then the category for all statements is **VERY GOOD**

From the five statements above, all received very good categories so that prototype 1 from the game story of math can be said to have fulfilled the practical criteria in a learning medium, which then prototype 1 could be the final prototype.

7. Conclusion

From the players data scores at table 3, we can see the students who completing the Story of Math succeed in getting the fastest time of 25 minutes and 1 game over. While the longest is 35 minutes, and get game over 5 times. If we get game over many times it is make we need the longer time to complete the game. Seen in the Anggi's case, because she have many times game over, it means that students understanding of concepts still needs to be improved. It different with Pradnyan's case who only get 1 times game over and finished with a faster duration of time, which indicated that students had a good understanding of the concepts.

From the questionnaire we can conclude that the story of math game can help students learn mathematics fun, especially in learning to convert time units.

So overall serious games have great potential to be used as a learning media because they are very positive effects on the learning process of its users. The mechanisms used in serious games also strengthen learning in a dynamic, interactive, motivating and entertaining way.

References

- [1] Drigas, A. S., & Pappas, M. A. (2015). On line and other game-based learning for mathematics. *International Journal of Online Engineering*, 11(4), 62–67. <https://doi.org/10.3991/ijoe.v11i4.4742>
- [2] [Kementrian Pendidikan dan Kebudayaan. Peringkat dan Capaian PISA Indonesia Mengalami Peningkatan. <https://www.google.co.id/url?q=https://www.kemdikbud.go.id/main/blog/2016/12/peringkat-dan-capaian-pisa-indonesia-mengalami-peningkatan&sa=U&ved=2ahUKEwjPxNCNjfcAhVROSsKHYHFBt8QFjAAegQIBBAB&usg=AOvVaw3KuX5wW47RbkZbvV5Nzbx>
- [3] Badan Pusat Statistik. Tingkat Pengangguran Terbuka (TPT) Sebesar 5,33 Persen. <https://www.bps.go.id/pressrelease/2017/05/05/1376/tingkat-pengangguran-terbuka--tpt--sebesar-5-33-persen.html>.
- [4] Andrade, A., Gouveia, D., Escudeiro, P., & Van De Carvalho, C. (2014). Can SME managers learn from games? *ACM International Conference Proceeding Series*, 10-12-September-2014, 560–586. <https://doi.org/10.1145/2662253.2662349>
- [5] Chorianopoulos, K., Giannakos, M. N., & Chrisochoides, N. (2014). Design Principles for Serious Games in Mathematics. (June), 1–5. <https://doi.org/10.1145/2645791.2645843>
- [6] Abt, C (1970). *Serious Games*. New York: Viking Press
- [7] Sawyer, B. (2002). Improving public policy through game-based learning and simulation, foresight and governance project: Woodrow Wilson International Center for Scholars, publication 20002-1
- [8] Ritterfeld, U., Shen, C., Wang, H., Nocera, L., & Wong, W.L. (2009). Multimodality and Interactivity: Connecting Properties of Serious Games with Educational Outcomes. *Cyberpsychology & Behavior* 12 (6), .DOI: 10.1089=cpb.2009.0099.
- [9] Carlos Vaz de Carvalho, Games for e-Learning, *IJITCS - International Journal of Information Technology & Computer Science*, pp. 61-67, Vol. 4, Issue Jul/Aug 2012, ISSN 2091 – 1610
- [10] Ricardo Baptista, Carlos Vaz de Carvalho, TimeMesh – A Serious Game for European Citizenship, *EAI Transactions on Game-Based Learning* 13(01-06): e2, ISSN: 2034-8800
- [11] Rodrigues, M., & Carvalho, P. S. (2013). Teaching physics with Angry Birds: exploring the kinematics and dynamics of the game. *Physics Education*, 48(4), 431.

- [12] Roschelle, J.M., Pea, R.D., Hoadley, C.M., Gordin, D.N. & Means B.M. (2000). Changing How and What Children Learn in School with Computer-Based Technologies. *The Future of Children* 10 (2), 76-101.
- [13] Donovan, S. & Bransford, J. (2005). Ch 9: Scientific Inquiry and How People Learn. In *How students learn: history, mathematics, and science in the classroom*. Retrieved from http://books.google.se/books?id=2wwwnKJ69UAC&pg=PA397&lpg=PA397&dq=donovan+and+bransford&source=bl&ots=yUyGlF9QgK&sig=6F9qQcyPgD6xzXpSWq1oOZv1GU&hl=sv&ei=j0nITdykNo_xsGbJmr2oAw&sa=X&oi=book_result&ct=result&resnum=5&ved=0CD0Q6AEwB A#v=onepage&q&f=false
- [14] Thiagarajan, S., Semmel, D. S & Semmel, M. I. 1974. *Instructional Development for Training Teachers of Exceptional Children*. Minneapolis, Minnesota: Leadership Training Institute/Special Education, University of Minnesota.

A Lower Bound For Irregularity Strength of The Complete Graph of Power Two Vertices

Kadek Riska Savitri¹⁾ I Nengah Suparta²⁾

^{1,2}Educational Mathematics Department, FMIPA, Universitas Pendidikan Ganesha

¹⁾riskasavitri79@gmail.com ²⁾nengah.suparta@undiksha.ac.id

Abstract. Let $G(V, E)$ be a graph with vertex set $V(G)$ and edge set $E(G)$. A vertex k labeling $\varphi : V(G) \rightarrow \{1, 2, 3, \dots, k\}$ is called k -labeling for some positive integer k . The *weight* of an edge xy in $E(G)$, denoted by $W_\varphi(xy)$, is the sum of the labels of two vertices x and y which are incident with edge xy or $W_\varphi(xy) = \varphi(x) + \varphi(y)$ if $W_\varphi(uv) \neq W_\varphi(xy)$ for any distinct edges uv and xy in $E(G)$, we call φ as an *edge irregular k -labeling*. The minimum k for which the graph G has an edge irregular k -labeling is called the *edge irregularity strength* of G , and is denoted by $es(G)$. In this talk, we introduce a lower bound for $es(K_n)$ where K_n is the complete graph of $n = 2^m$ vertices for some positive integer $m \geq 2$. For these complete graph K_n , we show that

$$es(K_n) \geq \left\lceil \frac{E(G)+3}{2} \right\rceil$$

Keywords : edge irregularity strength, k -labeling, complete graph.

1. Introduction

The graph is a data structure that is defined by two components which are vertices and edges. The first problem in graph theory dates to 1736, and is called the Seven Bridges of Königsberg. The idea to solve this bridge problem using graph was sparked by L. Euler, mathematician from Switzerland.

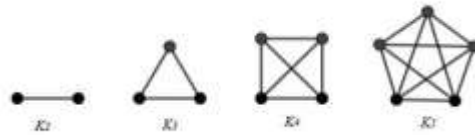
The two parts most important in a graph's representation are vertices and edges. So it can be said that a graph is a set of vertices and edges. There are so many kind of the graph, thus are simple graph, connected graph, bipartite graph, etc.

In mathematical discipline of graph theory, a graph labeling is the assignment of labels, traditionally represented by integers, to edges and/or vertices of a graph. There are three labeling based on element that given label thus are vertex labeling, edges labeling, and total labeling. There are the types of graph labeling, thus are magic label, antimagic labeling, and irregular labeling. In this article, we talk about an edge irregular k -labeling.

2. Definition And Notation

A Graph G consists of a pair (V, E) , where V is the set of vertices and E is the set of edges (K. Thulasiraman, 2011). We write $V(G)$ for the vertices of G and $E(G)$ for the edges of G . The number of vertices on a graph G is called an order graph, denoted by $|V(G)|$, and the number of the edges on a graph G is called size graph, denoted by $|E(G)|$. If no two edges have the same endpoints we say there are no multiple edges, and if no edge has a single vertex as both endpoints we say there are no loops. There are so many kind of graph, for example is simple graph.

Let G is called a simple graph if it does undirected graph that has no loops (edges connected at both ends to the same vertex) and no more than one edges between any two different vertices (Jonathan L. Gross, 2003). One of simple graph is complete graph. A complete graph with n -vertex, denoted by K_n . Complete graph is a simple graph with n -vertex and every two distinct vertices connected by an edge. Because each vertex on the complete graph is connected to each other through the edges, the degree of each vertex in a complete graph G is $n - 1$. So that the number of edges in a complete graph G is $\frac{n(n-1)}{2}$.



Picture 1. Complete Graph

A graph labeling is an assignment of integer to the vertices or edges or both with subject to certain condition(s) (Gallian, 2018). There are three labeling based on element that given label thus are vertex labeling, edges labeling, and total labeling. Vertex labeling is the labeling with gives label on the vertex only and the domain of the mapping is the set of vertices. Edge labeling is the labelling with gives label on the edge only and the domain of the mapping is the set of edges. Total labeling is the labelling with gives label on the vertex and edge. The domain is $V(G) \cup E(G)$.

In this talk, we intruduce about edge irregularity strength. A vertex k -labeling $:V \rightarrow 1,2,3,\dots, k$ is called k -labeling for some positive integer k . The *weight* of an edge xy in $E(G)$, denoted by $w(xy)$ is the sum of the labels of two vertices x and y which are incident with edge xy or $w(xy) = (x) + (y)$. If $w(uv) \neq w(xy)$ for any distinct edges uv and xy in $E(G)$, we call as an *edge irregular k -labeling*. The minimum k for which the graph G has an edge irregular k -labeling is called the *edge irregularity strength* of G , and is denoted by $es(G)$.

6 Main Results

Theorem 1.1 by Ahmad A., Gupta A., Simanjuntak R., in (Ahmad A., 2018).

Theorem 1.1 Let $G = (V, E)$ be a simple graph with maximum degree $\Delta(G)$. Then, $es(G) \leq \max \left\{ \frac{\Delta(G)+1}{2}, \Delta(G) \right\}$.

In this talk, we introduce a lower bound for $es(K_n)$ where K_n is the complete graph of $n = 2^m$ vertices for some positive integer $m \geq 2$.

$$\begin{aligned} E(K_n) &= 1 + 2 + 3 + \dots + (n-1) \\ &= \frac{n(n-1)}{2} \end{aligned}$$

For $n = 2^m$

$$\begin{aligned} E(K_n) &= \frac{2^m(2^m-1)}{2} \\ E(K_n) &= 2^{m-1}(2^m-1) \end{aligned}$$

Because one and two is impossible as weight of the edge in graph K_n , therefore the highest weight of the edge is higher than or same with $2^{m-1}(2^m - 1) + 2$. The highest label of point should more than or same with $\frac{2^{m-1}(2^m - 1) + 2}{2}$. Because $\frac{2^{m-1}(2^m - 1) + 2}{2} = 2^{m-2}(2^m - 1) + 1$ cannot be a label of two or more distinct points, we have to raise one of the endpoint labels. So that, the highest label of point more than or equal to $2^{m-2}(2^m - 1) + 2$.

$$\left\lceil \frac{|E(G)|+1}{2} \right\rceil = \left\lceil \frac{2^{m-1}(2^m-1)+1}{2} \right\rceil$$

$$= 2^{m-2}(2^m-1)$$

theorem 1.1 in the article Ahmad A., Gupta A.,

So

$$\left\lceil \frac{|E(G)|+1}{2} \right\rceil = \left\lceil \frac{2^{m-1}(2^m-1)+1}{2} \right\rceil$$

$$= 2^{m-2}(2^m-1)$$

$$2^{m-2}(2^m-1)+2 > \left\lceil \frac{|E(G)|+1}{2} \right\rceil$$

$$es(G) > \left\lceil \frac{|E(G)|+1}{2} \right\rceil$$

le that :

$$es(G) > \left\lceil \frac{|E(G)|+1}{2} \right\rceil$$

References:

- Ahmad A., G. A. (2018). Computing the edge irregularity strengths of chain graphs and the join of two graph. *Elect. J. Graph Theory and Applications* , 201-207.
- Gallian, J. A. (2018). A dynamic survey of graph labeling. *Electronic Journal of Combinatorics* .
- Jonathan L. Gross, J. Y. (2003). *Handbook of Graph Theory*. Washington: CRC Press.
- K. Thulasiraman, M. N. (2011). *Graph: Theory and Algorithms*. Canada: Corcodia University.

Developing *Geogebra* Mathlet On Geometry Transformation Oriented *Ikrar* Strategy To Improve Students Mathematical Problem Solving Skills

I Dewa Gede Putra Ardinata¹, I Gusti Putu Sudiarta², I Gusti Putu Suharta³

¹SMA Negeri 4 Denpasar, Jl. Gunung Rinjani. Denpasar, Bali, Indonesia

²Ganesha University of Education, Jl.Udayana No.11 Singajara, Bali, Indonesia

dewaardinata1@gmail.com, gussudiarta@undiksha.ac.id, putu.suharta@undiksha.ac.id

Abstract. One of the problems faced by junior high school teachers in teaching geometry transformation is the difficulty of students to understand the concept of geometry transformation. This study aims to obtain learning device (Media of *GeoGebra*) oriented to IKRAR Strategy to improve mathematical problem solving for grade VII students at SMP Negeri 7 Denpasar. The development of learning device follows the design research procedure of Plomp (preliminary research, prototyping phase, and assessment phase). Data were collected using validity sheets, observation sheets, student response questionnaires, teacher response questionnaires, and tests of mathematical problem solving skill. The collected data is then analyzed descriptively. The results showed that the learning device fulfilled the criteria: (1) valid, based on the opinion of two validators; (2) practical, based on the implementation of easy-to-use learning device based on the observer's point of view, teacher's response, and student's response; (3) effective, based on completeness of students in learning material that exceeds KKM. Characteristics of *GeoGebra* media include: (1) presenting close daily problems of student activities; (2) Conveying understanding of material concepts easily and structured; (3) Has an attractive display so that it can increase student motivation, (4) provide practice exercises that hone students mathematical problem solving skills.

1. Introduction

Transformation geometry is a branch of geometry where students learn to identify and draw the movement of a point or build up the geometry [7]. According to Edward [2] geometric transformation is very useful for students to build spatial abilities, geometric reasoning abilities, and strengthen mathematical proofs. These skills are important for students to explore mathematical concepts; so that, they will be expected to be succeses in solving mathematical problems in the future [10].

The ability to solve mathematical problems is one of the competencies of student skills which must be achieved in mathematics learning [11]. [9] considered problem-solving skills as the primary goal of mathematics education. In relation to this, the concept of geometric transformation must be completely mastered by the students. Because of a strong understanding of concepts, students are able to use the concept in order to solve problems in mathematics, problems in other sciences and problems in everyday life [3]; [13].

Based on the observations of researcher at SMP Negeri 7 Denpasar, the material of geometry transformation was often felt difficult when it was studied by students. Students found it difficult to imagine the result of the reflection, rotation and dilatation of a plane. Some students had not been able to generalize that the reflection of point A (x, y) to X axis

would produce a shadow $A'(x, -y)$. This was also supported by the student's learning outcomes that still did not meet the Minimum Exhaustiveness Criteria (KKM) established in the school. In the international context, the same problem was found [4] which revealed that students had difficulty in understanding the concepts and variations which was showed in identifying transformations including translation, reflection, and rotation. In addition, students also had difficulty in building evidence of algebraic geometric transformation [8]. Therefore, visualization aid plays an important role in understanding the concept of geometric transformation [1]. The same thing was proposed by [16] which concludes that educators should teach geometry transformation materials with clear drawings to be easily understood by students. This was also supported by [8] which states that the most effective technique for understanding the material of geometry transformation is learning with a combination of visualization and analytics.

In order to overcome these problems and to open opportunities students understand, try, train a variety of visualization on the subject of geometry transformation then one of the right media used is *GeoGebra*. Lavisca in [5] states that *GeoGebra* can encourage the process of discovery and experimentation of learners in the classroom. The features contained in *GeoGebra* can effectively help learners to visualize algebraic and geometric concepts that tend to be abstract. So that the use media of *GeoGebra* is very beneficial for teachers and learners [14]. But if the media of *GeoGebra* is created without the right strategy then the media function will resemble a tool for finding results regardless of the delivery or the unclear concept to be taught [6]. Therefore, in order to optimize the function media of *GeoGebra*, it needs the right strategy, so that students are able to understand the concept easily and able to apply the concept in handling a problem in mathematics especially on Geometry Transformation material. Based on that there is a strategy that is aimed at students to be able to handle a problem by understanding the concept and construction of student knowledge first by applying the *IKRAR* strategy. The *IKRAR* strategy is a constructivist learning strategy that adopts and modifies the problem-oriented learning model through the process of adaptation of the values contained in the social life of Indonesian society as well as the characteristics of students with the aim to overcome the problems of mathematics learning experienced by students [15].

Based on this the focus of this research is to answer the following problems; (1) how the characteristics media of *GeoGebra* are oriented to *IKRAR* strategies which can improve students' mathematical problem solving abilities. Therefore, this research is conducted as an effort to overcome the problems found by developing mathematics-teaching learning materials in the form media of *GeoGebra* for transformation geometry materials oriented *IKRAR* strategy that is valid, practical, and effective.

2. Methods

This study aims to develop learning device (media of *GeoGebra*) for geometric transformation materials oriented to *IKRAR* Strategy in an effort to improve students mathematical problem solving skills. Criteria of developed learning media must be valid, practical and effective [12]. Learning media are said to be valid if they meet the content validity and construct validity. Learning media are said to meet content validity if the media developed is based on a development theory that is used as guidelines and in accordance with curriculum demands. While the construct validity is seen from the consistent linkages of each component of the learning media that is developed with the characteristics of the applied learning model. Meanwhile, learning media are said to be practical if the developed media are useful and easy to use by teachers and students. Then learning media are said to be effective if

they can achieve the stated learning goals, in this case able to improve students' mathematical problem solving abilities.

The procedure of developing learning device (Media of *GeoGebra*) based on Plomp Model consist of (1) Preliminary Research, conducted an analysis of the learning situation to find problems in the learning process in class. Literature review is also carried out to support the problems found and design solutions (2) Prototype Phase, aims to create and test learning device (Media of *GeoGebra*) in the field; (3) The Assessment Phase is carried out to obtain the final product from the developed learning. The final product has valid, practical, and effective characters that are obtained based on the validator's advice, field trials, as well as the advice of teachers and students who have used the media of *GeoGebra*.

This research was held at SMP Negeri 7 Denpasar. The sample of this study were students who had the same level of ability based on the choice of the teacher and the results of tests at school, so as many as 81 students were obtained to be used as research samples. There are several instruments that were used in this study, namely :

Table 1. Research instruments

Num.	Instrumen	Subjek	Data type	Time
1.	Questionnaire	Teacher	Teacher Teaching Skills	Preliminary Research
2.	Observation Sheet	Students	The Activities of Problem Solving Ability	Preliminary Research
3.	Validation Sheet	Validator	Validity of instructional devices and research instruments (valid)	Prototype Phase
4.	Observation Sheet	Observer	Learning implementation (practical)	Limited Test, Field Test I, Field Test II
5.	Student Questionnaire	Students	The response of the students toward learning process being implemented (practical)	Field Test I & Field Test II
6.	Teacher Questionnaire	Teacher	The response of the teacher toward learning process being implemented (practical)	Field Test I & Field Test II
7.	Mathematical Problem Solving Test (Essay)	Student	The score of Problem Solving Skill (effective)	Field Test I & Field Test II

So, this research will get quantitative data based on the use of the above instrumentes. This quantitative data will be matched with a criterion so that it is known whether the media of *GeoGebra* have valid, practical and effective criteria.

3. Results and Discussion

Based on the research methods and procedures above, it was found that the developed media of *GeoGebra* had valid, practical and effective criteria. Media of *GeoGebra* can be valid because this media fulfilment of the content validity and the construct validity based on expert judgement, and media of *GeoGebra* can be fullfilment of the practical aspects because easy to use by students and teachers, which can be seen from the results of the analysis of the implementation of learning device, student questionnaire responses, and teacher response questionnaires. The fulfillment effectiveness aspects of learning device (Media of *GeoGebra*) too due to the achievement of the expected learning objectives that can improve students mathematical problem solving skills which can be seen also from the results of trials that have been carried out where the average test scores of students mathematical problem solving abilities above the minimum criteria of mastery learning (KKM) determined by the school.

Media of *GeoGebra* was used to grow enthusiastic learners in learning geometry especially geometry transformation, because the media of *GeoGebra* provided an elegant look and had interesting pictures with colorful mixed innovations in order to impress the learning atmosphere more alive and exhilarating so that it could increase the interest of the students in following learning. Media of *GeoGebra* and teacher manuals were written with words, sentences, and languages which made it easier for teachers and students to understand the purpose and objectives of each learning activity. Many students had understood the concept of geometri transformation, because media of *GeoGebra* presented a sequential and systematic understanding of the material supported by visualization, so that students easily connected between concepts and problems. Besides being used as an introduction to the understanding of material concepts, the developed media *GeoGebra* was also able to improve students' math problem solving skills. Because media *GeoGebra* presented challenging and non-routine questions that could hone students' thinking skills. This can be seen from the results of each student's problem solving test scores on field trials above the minimum criteria of mastery learning (KKM).

The characteristics of learning using media of GeoGebra oriented by IKRAR strategy that is; 1) *Inisiasi*, learning begins with introducing students to real phenomena and problems in daily life related to the material being studied. The daily phenomenon that be related with the lesson can be obtained through observations or directions given by the teacher in the form of questions such as the GeoGebra figure 1 below.



Figure 1. Examples of learning using media of GeoGebra at the *Inisiasi* stage

2) *Konstruksi*, train students very easily and structured to understand mathematical concepts visually. In this study students are given direction assistance in each step in finding mathematical concepts in accordance with the desired goals. The assistance provided can be in the form of instructions and warnings so that this helps students find a concept and arrange it in a conclusion. The example of learning is shown in Figure 2 below.

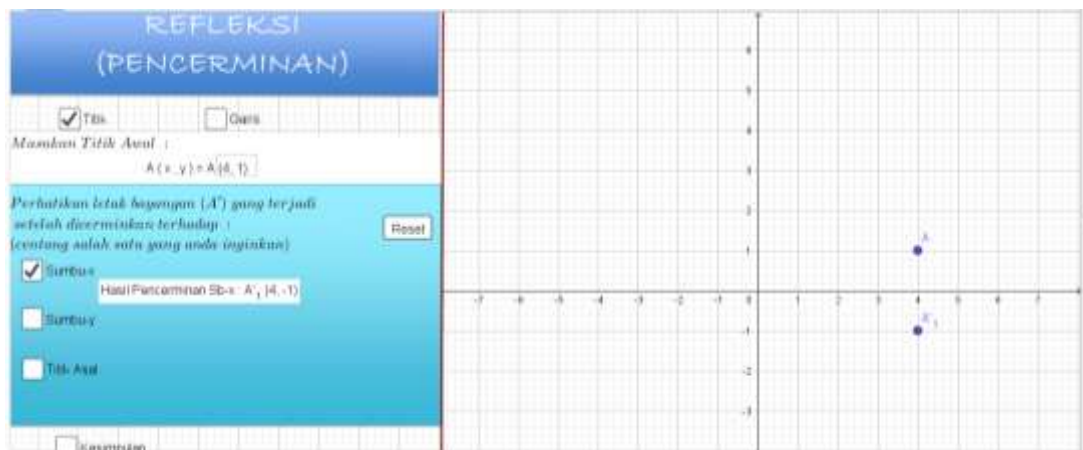


Figure 2. Examples of learning using media of *GeoGebra* at the *konstruksi* stage

3) *Rekonstruksi*, this learning directs students to apply the concept of material that has been obtained at the *konstruksi* stage. Like determining the result of reflection from a point or shape, so students are used to do it; 4) *Aplikasi*, giving open ended practice questions can train students to develop mathematical problem solving skills. This can encourage student's habits to be able to understand problems, plan solutions, and do calculations so as to get a solution of the problem; 5) *Refleksi*, gives freedom of opinion and discussion so as to foster student courage in expressing their opinions. The teacher encourages students to demonstrate their skill of communicate, both verbally and in writing. Student's freedom to express their understanding in their own language shows how well students understand the material being studied.

Besides having positive benefits, media of *GeoGebra* also has weaknesses, namely (1) the material developed is limited to the basic material of geometric transformation (reflection, translation, rotation, and dilation). (2) learning using media of *GeoGebra* currently can only be used through a laptop or computer. The suggestions based on the weaknesses of the research obtained, namely (1) Media of *GeoGebra* can teach the material of the next stage of geometry transformation that is the composition of the geometry transformation and geometry transformation using a matrix; (2) *GeoGebra* media can be developed using smartphones, so learning can look more flexible and innovative.

4. Conclusions

Based on the results of this study and discussion above, it can be concluded that the criteria of learning device (Media of *GeoGebra*), namely: (1) valid, because media of *GeoGebra* oriented by IKRAR which is includes subject matter in accordance with the 2013 curriculum objectives; (2) practical, media of *GeoGebra* is usefull and easy to use in learning by teachers and students; and 3) effective, it can increase learning motivation and improve students mathematical problem solving skills. The characteristics of the media of *GeoGebra* media in this study are: 1) Presenting close daily problems of student activities; 2) Conveying understanding of material concepts easily and structured; 3) Has an attractive display so that it can increase student motivation, 4) provide practice exercises that hone students mathematical problem solving skills. With that, *Media of GeoGebra* could be used as a basis for learning mathematics in junior high schools.

Acknowledgements

The researcher would like to thank all those who helped and succeeded this study, especially to the Ganesha University of Education community. This study entirely dedicated to Ganesha University of Education.

References

- [1] Aktas, G. S., & Ünlü, M. (2017). Understanding of Eight Grade Students about Transformation Geometry: Perspectives on Students' Mistakes. *Journal of Education and Training Studies*, 5(5), 103–119.
- [2] Albab, I. U., Hartono, Y., & Darmawijoyo, D. (2014). Kemajuan belajar siswa pada geometri transformasi menggunakan aktivitas refleksi geometri. *Cakrawala Pendidikan*, (3).
- [3] Fatqurhohman, F. (2016). Transition Process of Procedural to Conceptual Understanding in Solving Mathematical Problems. *International Education Studies*, 9(9), 182.
- [4] Guven, B. (2012). Using dynamic geometry software to improve eight grade students' understanding of transformation geometry. *Australasian Journal of Educational Technology*, 28(2).
- [5] Hohenwarter, dkk. (2004). Combination of dynamic geometry, algebra and calculus in the software system GeoGebra. *Computer Algebra Systems and Dynamic Geometry Systems in Mathematics Teaching Conference*.
- [6] Irene, M. (2016). *Feasibility of Using Geogebra in the Teaching and Learning_2.pdf*. Thesis. Tidak Diterbitkan.
- [7] Kirby, J. ., & Boulter, D. . (1999). Spatial ability and transformational geometry. *European Journal of Psychology of Education*, 14(2), 283–294.
- [8] Naidoo, J. (2010). Strategies Used by Grade 12 Mathematics Learners in Transformation Geometry. *Natal: University of Kwazulu*.
- [9] NCTM (Ed.). (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.
- [10] Novrika, D., Putri, R. I. I., & Hartono, Y. (2016). DESAIN PEMBELAJARAN MATERI REFLEKSI MENGGUNAKAN MOTIF KAIN BATIK UNTUK SISWA KELAS VII. *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika*.
- [11] Özcan, dkk. (2017). Analysis of Sixth Grade Students' Think-Aloud Processes While Solving a Non-Routine Mathematical Problem. *Educational Sciences: Theory and Practice*, 17(1), 129–144.
- [12] Plomp, T., & Nieveen, N. (2013). *Educational Design Research, Part A. An Introduction*. Enschede: The Netherlands (SLO).
- [13] Quinnell, L. (2010). Why are mathematical investigations important? *Australian Mathematics Teacher, The*, 66(3), 35.
- [14] Seloraji, P., & Eu, L. K. (2017). Students' Performance in Geometrical Reflection Using GeoGebra. *Malaysian Online Journal of Educational Technology*, 5(1), 65–77.
- [15] Sudiarta, I. G. P. (2012). *Pembelajaran Matematika Inovatif berbasis IKRAR*. Jakarta: Prestasi Pustaka.
- [16] Thaqi, X. (2011). Prospective Teacher's Understanding of Geometric Transformation. 12th International Congress on Mathematical Education. *Seoul:TSG10*.

The Influence of Edmodo Assignment Method towards Students' Motivation and Achievement on Learning Mathematics

Mahayukti, Gst Ayu¹, Dinda Nirmala Suci, Ni Gst Ayu Made² & Sariyasa³

^{1,3} Prodi Pendidikan Matematika

² Alumni Prodi Pendidikan Matematika

Abstract. This research focused on testing the influence of the Edmodo assignment method towards students' motivation and achievement of learning mathematics in the form of post-test-only-control-group design. The population of this research was the 10th grade students of the Natural Science (MIPA) of SMA Negeri 3, Singaraja, year 2018/2019. Those students were divided into 4 groups and samples are determined by the cluster random sampling technique. The data of students' learning motivation was taken by giving questionnaires while academic achievement is taken by giving an academic test. Then, the data was tested by using MANOVA test and one-sided t-test with 5% significance. The pre-condition test was performed before the hypothetical test that used normality test, homogeneity variance, homogeneity matrix variance/covariance, and collinearity. Based on the MANOVA test, it can be seen that there were differences upon motivation and achievement of learning Mathematics between students who follow Edmodo assignment method and those who follow conventional learning method. The one-sided t-test showed that partially, the motivation and achievement of learning for those who follow the Edmodo assignment method was better than those who follow conventional learning method. Therefore, it can be concluded that Edmodo assignment method gives positive impact both simultaneously and partially.

Keywords: academic achievement, assignment method, edmodo, mathematics, motivation

1. Introduction

The success of the teaching and learning process can be seen through students' academic achievement in certain subject [1]. Through formal education in school, students are expected to be able to gain academic achievement maximally. Nonetheless, the formal education is not yet able to guide students to gain academic achievement maximally, especially in mathematics. It can be seen on the average national test score in mathematics that tends to decrease for the last 3 years both in Natural Science and Social Science programs. In Natural Science program, the decrement of national test score drops by 11.01 and 9.88 points simultaneously. While in Social Science program, it drops by 9.01 and 8.91 points simultaneously [2]. Hakim, Sulistiawati & Samsul [3] revealed that there are still a lot of students who do not increase academic achievement yet in mathematics.

Ahmad [4] stated that no matter how good a curriculum is, how complete the medium is, and how great a teacher manages the teaching and the learning process, it will be pointless if the students do not follow the process seriously. It is supported by Wina Sanjaya who argued that in the learning process, motivation is a very important aspect [5]. Students who have strong motivation are encouraged to learn more seriously, while those who have less motivation will worsen the decrement of ability in learning mathematics [6]. This statement is similar to one by Trisnawati & Dhoriva [7] who argued that if students learn with strong motivation, then the learning process can be done seriously and excitedly. In contrast, those who learn with less motivation tend to get lazy even do not want to do the assignment or things relating to learning activities.

Teacher has an important role in students' success. It is because the key of students' success is not only supported by their own ability and their own motivation but also supported by the learning application of the teachers i.e. the learning method they use. One of methods that can be implemented in school is assignment method. It means that teachers give assignment to their students and the students have to be responsible with the assignment. Notwithstanding, in the process, there are problems by which teacher can develop a better modified method [8]. As stated by Roschelle, Mingyu & Robert [9] that "One prominent issue is that students may not receive timely feedback or help as they practice." It is similar to the argument by Seob & Patrick [10] who argued that "Feedback provides information about one's competence and success in a specific assignment. This information is critical for student motivation because it serves as a basis for self-evaluation and self-improvement". The solution for that issue is modify the assignment method by using today's technology advancement. This is similar to the argument by Sudiarta, Sukajaya, & Suharta [11] that in the 21st century, education in mathematics has changed a lot and need some ability to take advantage from internet technology in the learning process. By using such technology, giving the feedback to students in accordance with the assignment surely can be done fast and more easily.

The usage of information technology in education is known as e-learning. It is a kind of effort to make a transformation of learning and teaching process in school digitally which is based on internet technology [12]. Harahap, Nanda, and Binari [13] stated that "The use of technology such as internet in improving the education achievement has increased rapidly." It is because the learning process can be performed by reading, watching, listening, communicating, and discussing anytime and anywhere.

The research based on the usage of e-learning shows varied results. The research by Joordens, et al [14] showed that e-learning had no influence on the students' academic achievement significantly. They said that the reason why this happens is because there are different characteristics of students when they learn. Nonetheless, other researchers show different results for example, Leong & Alexander [15] stated that e-learning had important role in students' learning results because there is a fast feedback so that their level of understanding towards lesson learnt increases. Alzahrani [16] also stated that by online discussion, students can get better learning results. Social interaction and collaboration among students in online discussion are considered the reason why there is increment towards academic achievement. Based on the explanation above, it can be concluded that online discussion has good potent to help students do the assignment given online.

One of the platforms that can be used to implement e-learning is Edmodo. It has a similar design with Facebook's, so it is easy to learn even for novice. In order to support online learning process, Edmodo is equipped with several activities namely quiz, assignment, file and link, library, and many more.

The use of Edmodo as a medium of doing assignment and a place to discuss things which are related to given assignments is expected to increase students' motivation and achievement of learning. It is believed that Edmodo is able to increase learning motivation because it helps teacher in giving appraisal and feedback for students' work. One of the best Edmodo's features is award badges. This feature enable teacher in giving reward to students in the form of utterances namely good question, homework helper, student of the month, and the likes. Assignment can also increase student's academic achievement because it triggers them to practice or to re-learn subjects. Furthermore, Edmodo enables students to interact and to discuss online with other students or teacher in accordance with given assignment. It is similar to the argument by Sukawijaya & Sudiarta [17]. They stated that online discussion makes students ask questions faster and solve problems without waiting for offline class meeting. That makes them prepare themselves for offline class so that the learning process can run smoothly.

Some researchers also have shown that Edmodo is able to help learning activities. For example, a research by Hikmawan and Alit [18] that showed the use of learning media had strong and significant influence toward students' learning motivation. Notwithstanding, the research does not explain the implementation of Edmodo features specifically in order to increase learning motivation. While in this research, the researcher use the Edmodo features i.e. award badges to increase students' learning motivation. In addition, the research by Try Hikmawan and Alit Sarino, only focuses on the measurement towards motivation, meanwhile in this research focuses on motivation and academic achievement.

Based on the explanation above, the researcher assumes that Edmodo assignment method is able to increase motivation and academic achievement in mathematics simultaneously and partially. The formulations of the problems are as follows (1) Are there any differences in motivation and academic achievement in learning mathematics between students who follow Edmodo assignment method and ones who follow conventional learning method? (2) Is motivation of students who follow Edmodo assignment method better than ones who follow conventional learning method? (3) Is academic achievement of students who follow Edmodo assignment method better than ones who follow conventional learning method?

2. Literature Review

2.1. Assignment Method

The assignment method is a kind of method in which teacher gives a certain assignment to students so that they can do the leaning activities [19]. The method is used because there are many materials that students have to master while the learning time is limited. Therefore, teacher needs to give an assignment out of school hours. This method is used to increase academic achievement because by giving assignment, students are triggered to practice or re-learn the school subjects previously, so that the students' experience in learning something can be more integrated [20]. It is supported by the theory of Stimulus-Response (S-R) in the Law of Exercise. The theory says that the more frequently a thing is repeated or trained, the stronger the relation between stimulus and response [21]. This principle shows that the key of successful learning is by repetition. The more repetition, the more successfully students master the material.

The assignment method is divided into three phases or steps namely the phase of giving assignment, the phase of doing the assignment, and the phase of being responsible for the given assignment [19]. The assignment given to students has to focus on these following things namely (1) the purpose of giving the assignment, (2) suitable with students' ability, (3) there are clues or source that can help them do the assignment, and (4) there is time to do the assignment. In the phase of doing the assignment, students should be encouraged first by the teacher before they do it. In the phase of being responsible for the given assignment, the students have to make report orally and written all the things they have done. The next step is discuss the assignment in class in order to know whether the students really understand or not. The last step is make judgment towards the students' work by the teacher.

2.2. Edmodo Assignment Method

In this research, the assignment is given based on the assignment feature in Edmodo. The usage of this method is expected to help students appreciate the process of doing the assignment instead of getting score only. The steps of Edmodo assignment method consist of three main steps. The first step is called giving assignment by the teacher who uses the assignment feature in Edmodo and sets the deadline. The second step is called doing the assignment in which they can discuss the assignment with their teacher and friends online if they find any problem or obstacle. In this step, the teacher monitors how the students can figure out the assignment before the score is uploaded. The third step is called being responsible for the assignment in which the students upload their work before the deadline.

3. Method

3.1. Research Design

This research is quasi experimental with post-test-only-control-group design. It was performed in SMA Negeri 3, Singaraja on January 15th until March 5th 2019. The population in this research was the 10th grade students from Natural Science program in the year 2018/2019 that amounts to 117 divided in 4 classes. By using the cluster-random-sampling technique, 2 classes were chosen i.e. the 10th grade of Natural Science Program (MIPA) 1 and the 10th grade of Natural Science Program (MIPA) 3. Before determining control group and the experimental one, a test was performed to measure their equality by using two-sided t-test. Then a result showed that both of those classes were equal. The next

step was performing the draw to determine which one is the control group and which one is the experimental group. From the draw, obtained that the 10th grade of Natural Science program (MIPA) 1 is the experimental group while the 10th grade of Natural Science program (MIPA) 3 is the control group.

3.2. Data Collection and Analysis

The instrument that was used to collect the learning motivation data was questionnaires while the instrument to collect the academic achievement data was test. The next step was expert judgment's test by three expert lecturers for assignment, motivation questionnaires, and essay test which was quantified by using Aiken's V formula. For the assignment itself, it can be seen that there was index range of 0.83 until 0.92, while based on motivation questionnaires it can be seen that the index range was 0.83 until 1, while academic achievement test produces the index range of 0.75 until 0.92. It means that the instrument is worth it according to the experts. The instrument was tested in SMA Negeri 2, Singaraja. After that, the validity test was performed towards 30 questions that produce 25 valid statements and continued with reliability test that produces the degree of reliability of 0.86 (very high). The test towards the validity of academic achievement is done with 9 valid questions and continued with reliability test that produces the degree of reliability of 0.72 (high).

The analytical data with the MANOVA test was performed in order to know the differences of motivation and academic achievement in mathematics between students who follow the Edmodo assignment method and ones who follow conventional learning method. Then the analysis was performed by using one-sided t-test to know partially (1) whether the students' motivation who follow the Edmodo assignment method is better than ones who follow the conventional learning method, and (2) whether the academic achievement of students who follow the Edmodo assignment method is better than one who follow the conventional learning method.

4. Findings

According to Mertasari [22] there are eight indicators in learning motivation namely active in learning mathematics, looking for the new things that related with mathematics, independence, avoid teacher punishment, getting the good result, getting praise, make parents proud, and gain recognition. In this research, the maximum score for each statement in motivation questionnaires was 5. The average score of each indicator are shown in Table 1 while the summary of motivation data analysis can be seen on Table 2.

Table 1: The Average Score of each Indicators of Learning Motivation

Indicator	Research Class	
	Experimental	Control
Active in learning mathematics	4.2	3.7
Looking for the new things that related with mathematics	3.5	3.1
Independence	3.9	3.5
Avoid teacher punishment	4.3	3.9
Getting the good result	4	3.9
Getting praise	4	3.7
Make parents proud	4.2	3.9
Gain recognition	4.1	3.8

Table 2: The Summary of Motivation Data Analysis

Variable	Group	
	Experiment	Control
N	28	29
\bar{X}	100.39	91.59
SD	10.22	9.91

Based on the Table 1 and Table 2, the average score of students' motivation who follow the Edmodo assignment method is higher than the average score of those who follow the conventional learning method both for each indicators and generally. Other paragraphs are indented (BodytextIndented style).

The average score of each cognitive dimension are shown in Table 3 while the summary of academic achievement data can be seen on the Table 4.

Table 3: The Average Score of Each Cognitive Dimension of Academic Achievement

Cognitive dimension	Research Class	
	Experimental	Control
C2 (understand)	6.43	6.15
C3 (apply)	8.17	4.38

Table 4: The Summary of Academic Achievement Data Analysis

Variable	Group	
	Experiment	Control
N	28	29
\bar{X}	61.36	51.86
SD	3.85	5.59

The data in Table 3 and Table 4 shows that the average score of students' academic achievement in mathematics who follow the Edmodo assignment method is higher than the average score of those who follow the conventional learning method both for each cognitive dimension and generally.

Before the hypothetical test was performed, the test towards assumption was performed beforehand like normality test, homogeneity variance, homogeneity matrix variance/covariance and collinearity score towards learning motivation and score towards academic achievement in mathematics. The result of the normality test with Lilliefors Test can be seen on the Table 5.

Table 5: The Summary of Liliefors Test Result

Research Class		Lmeasurement	L_{table}	Conclusion
Experimental Class	Learning Motivation	0.06	0.17	Normal
	Academic Achievement	0.12	0.17	Normal
Control Class	Learning Motivation	0.11	0.16	Normal
	Academic Achievement	0.11	0.16	Normal

Based on the Table 5, the result of normality test with the Lilliefors test shows that the distributive data is normal.

The score of homogeneity variance test towards learning motivation and academic achievement was taken by Levene test. The W score for learning motivation is 0.03 while the W score for academic achievement is 3.60. F_{table} is determined with significant rate of 5%, while the degree of free numerator equals 1, and the degree of free denominator equals 55. Therefore, the F_{table} is 4.02. The W score for learning motivation is less than F_{table} therefore, the score for learning motivation in mathematics in the experimental group and the control group homogeneous. The same thing goes to the W score for academic achievement which is less than F_{table} therefore the score for academic achievement in mathematics from experimental and control group homogeneous.

The result of homogeneity matrix variance/covariance test produces the value of Box's M that amounts to 5.94 with 0.13 of significance which is means more than 0.05 so that it can be concluded that the matrix variance/covariance between motivation and academic achievement in mathematics is homogenous.

The result of collinearity test of motivation and academic achievement in mathematics from the experimental group is $r_{y1y2}=0.59$ which means it less than 0.8. Therefore, collinearity among variables

does not occur. The same thing goes to the control group i.e. $r_{y1y2}=0.28$ that means it is less than 0.8. Therefore, collinearity among variables does not occur.

After fulfilling the pre-conditional test, a hypothetical test is done. The first hypothetical test is done by using the MANOVA with the help of SPSS 16 for Windows. The MANOVA test summary can be seen on Table 6.

Table 6: MANOVA Test Summary

		Multivariate Tests ^b				
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0.994	4.760E3 ^a	2.000	54.000	.000
	Wilks' Lambda	0.006	4.760E3 ^a	2.000	54.000	.000
	Hotelling's Trace	176.304	4.760E3 ^a	2.000	54.000	.000
	Roy's Largest Root	176.304	4.760E3 ^a	2.000	54.000	.000
	Pillai's Trace	0.504	27.384 ^a	2.000	54.000	.000
Treatment	Wilks' Lambda	0.496	27.384 ^a	2.000	54.000	.000
	Hotelling's Trace	1.014	27.384 ^a	2.000	54.000	.000
	Roy's Largest Root	1.014	27.384 ^a	2.000	54.000	.000

Based on the information on Table 6, it can be seen that the F value for Hotelling's Trace equals 27.38 with significance of 0.00 which means it is less than 0.05 so that the H_0 is rejected. It means that there are differences on motivation and academic achievement in mathematics between those who follow the Edmodo assignment method and those who follow conventional learning method.

The second and the third hypothetical test is done by using one-sided t-test. For learning motivation, it can be seen that the value of $t_{\text{calculation}}$ equals 3.30 and the value of t_{table} equals 1.67. Due to the fact that $t_{\text{calculation}} > t_{\text{table}}$ therefore H_0 is rejected. Moreover, it can be concluded that the motivation of those who follow the Edmodo assignment method is better than ones who follow conventional learning method. For the academic achievement, it can be seen that the value of $t_{\text{calculation}}$ equals 7.44 and the value of t_{table} equals 1.67. Due to the fact that $t_{\text{calculation}} > t_{\text{table}}$ therefore H_0 is rejected. Therefore, it can be concluded that the academic achievement of those who follow the Edmodo assignment method is better than the ones who follow conventional learning method.

5. Findings

Based on the result of hypothetical test, it can be concluded that Edmodo assignment method had positive impact both simultaneously and partially. When class begins, both learning by Edmodo assignment method and conventional learning method have the same steps. The teaching and the learning begin with informing the purpose and the advantages of the learning process. In the class who follow conventional learning, teacher giving chances to students to ask if they still do not get it or something is considered unclear when they do the assignment. However, when it comes to the class who follow Edmodo assignment method, those things are unnecessary due to the fact that the students have discussed the material beforehand in Edmodo before uploading their work. At the end of the learning process, in the experimental class, the teacher informs the students that they have to access Edmodo because all assignment is given via Edmodo. In contrast, to the controlled class, the teacher gives assignment to students that they have to submit their work in the next meeting. They have to take notes about the assignment given.

The Edmodo learning method starts after the teacher upload the assignment including the information about the deadline. This is considered a positive activity because it means that the teaching and the learning activities are not only done in school but also out of the school hours without direct meeting with the teacher. After downloading the assignment, the students start doing the assignment and they are allowed to ask question whenever they need via Edmodo. The activities can

alter the common presumption about assignment as burden to students. The discussion between student and teacher can minimize boredom in doing assignment. This good progress can increase students' motivation.

The Edmodo assignment method prioritizes how the students can learn and do the assignment happily and meaningfully so that they can increase their academic achievement. By the presence of assignment, the students are trained to memorize, to increase their understanding towards the material given in school and also to be able to apply the knowledge to the assignment given. The uploaded questions by the students are answered by other students who understand or by the teacher who guide them until they understand by themselves what to do.

The next step is that the students upload the work based on the deadline given by the teacher. Then, the teacher has to check out each student's work as soon as possible and then gives the feedback. The faster the feedback is given, the faster the students notice their errors. It is better than doing the same thing in the next meeting. After that, in order to increase the learning motivation, the teacher uses award badges feature. With this feature, the teacher gives reward to the students for their hard work. In addition, the teacher gives appreciation frequently through praises and encouragement so that they can get more motivated.

The research by Sabriani [23] which is similar to this research stated that giving structured assignment by including feedback can increase the academic achievement and motivation in the teaching and the learning process upon the 10th grade students of SMK Negeri 6, Watampone. In this research, by implementing the Edmodo assignment method, feedback can be given faster. It increases the students' motivation and academic achievement. Based on the above explanation, it can be concluded that the Edmodo assignment method gives positive impact towards students' academic achievement and motivation in mathematics.

6. Conclusion

Based on the result of hypothetical test, it can be concluded that (1) there are differences on motivation from learning achievement in learning mathematics between a group of students who follow learning process with Edmodo assignment method and ones who follow conventional learning, (2) motivation of students who follow the learning with Edmodo assignment method is better than achievement of those who follow conventional learning, (3) the achievement of students who follow Edmodo assignment method is better than those who follow conventional learning. Those things signify that Edmodo assignment method gives positive impact both simultaneously and partially.

References

- [1] Yasna L T 2016 'Pembelajaran matematika dengan pendekatan cooperative learning ditinjau dari prestasi belajar, motivasi, dan ahlak mulia siswa' *Phytagoras: J. Pendidikan Matematika* **11** 45-58
- [2] Ministry of Education and Culture 2017
- [3] Hakim A R, Sulistiawati and Samsul A 2018 'Hubungan antara kecerdasan emosional dan motivasi belajar dengan prestasi belajar matematika siswa SMP' *J. Teorema: Teori dan Riset Matematika* **3** 165-176
- [4] Ahmad R S 2016 'Pengaruh math pobia, self efficacy, adversity quotient dan motivasi berprestasi terhadap prestasi belajar matematika siswa SMP' *J. Riset dan Pendidikan Matematika* **3** 259-272
- [5] Emda A 2018 'Kedudukan motivasi belajar siswa dalam pembelajaran' *Lantanida Journal* **5** 172-182
- [6] Syaripah 2016 'Pengaruh persepsi pembelajaran matematika terhadap motivasi belajar siswa dalam bidang matematika di SMAN 1 Curup T.P 2014/2015' *J. Edutech* **2** 40-57
- [7] Trisnawati and Dhoriva U W 2015 'Perbandingan keefektifan quantum teaching dan TGT pada pembelajaran matematika ditinjau dari prestasi dan motivasi' *J. Riset Pendidikan Matematika* **2** 297-307
- [8] Try S 2012 'Pengaruh pemberian tugas terstruktur terhadap hasil belajar siswa pada mata diklat

- otomotif dasar siswa kelas X teknik kendaraan ringan SMK Muhammadiyah 3 Yogyakarta' *Thesis Universitas Negeri Yogyakarta*
- [9]Roschelle J, Mingyu F and Robert F 2016 Online mathematics homework increases student achievement *Aera Open* **2** 1-12
- [10]Seob t and Patrick 2010 The effect of peer-and self-referenced feedback on student's motivation and academic performance in online learning ebvironments *MERLOT Journal of Online Learning and Teaching* **6**
- [11]Sudiarta I G P, Sukajaya I N and Suharta I G P 2017 Investigation on student's mathematical online discussion: a case study in grade 8 SMPN 1 Denpasar *Journal of Physics: Conference Series*
- [12]Hernawati K 2012 'Desain e-learning adaptif berbasis cognitive style untuk pembelajaran matematika SMA kelas XII IPA' *Phytagoras: J. Pendidikan Matematika* **7** 43-56
- [13] Harahap F, Nanda E A N and Binari M 2019 The effect of blended learning on student's learning achievement and science process skills in plant tissue culture course *International Journal of Instruction* **12** 521-538
- [14]Joordens S, Le A, Grinell R and Chryostomou S 2009 Eating your lectures and having them too: is online lecture availability especially helpful in "skill-based" course? *Electron. J. E Learn* **7** 281-288
- [15]Leong K E and Alexander N 2013 Exploring attitudes and achievement of web-based homework in developmental algebra *Turk Online J. Educ. Technol* **12** 75-79
- [16]Alzahrani M G 2017 The effect of using online discussion forum on student's learning *TOJET: The Turkish Online Journal of Educational Technology* **16** 164-176
- [17]Sukawijaya I M G and Sudiarta I G P 2018 Developing blended learning environment to improve learning performance and self-reliance for junior high school students *Journal of Physics: Conference Series*
- [18]Hikmawan T and Alit S 2018 'Pemanfaatan media pembelajaran berbasis edmodo terhadap motivasi belajar siswa sekolah menengah kejuruan' *J. Pendidikan Manajemen Perkantoran* **1** 78-85
- [19]Djamarah S B 2009 *Strategi belajar mengajar* (Jakarta: Rineka Cipta)
- [20]Roestiyah 2008 *Strategi belajar mengajar* (Jakarta: Rineka Cipta)
- [21]Hergenhahn and Matthew H O 2008 *Teori belajar* (Jakarta: Prenadamedia Group)
- [22][Mertasari N M S 2003 Pengaruh model tes terhadap motivasi belajar dengan mempertimbangkan kesukaran tes (eksperimen pada Sekolah Lanjutan Tingkat Pertama di Kota Singaraja) *Thesis IKIP Negeri Singaraja*
- [23]Sabriani S 2013 'Penerapan pemberian tugas terstruktur disertai umpan balik pada pembelajaran langsung untuk meningkatkan motivasi dan hasil belajar siswa (studi pada materi pokok struktur atom kelas X6 SMA Negeri 3 Watampone)' *CHEMICA* **13** 39-46

Development of Contextual Fable Module Charged with Characters in Problem Based Learning to Improve Students Concept Understanding and Mathematical Motivation

N M W Pradnyawati¹, I G P Suharta², I N Suparta³

¹SMP PGRI 8 Denpasar, Jl. Cokroaminoto Gang Angsoka Denpasar, Bali, Indonesia

^{2,3}Ganesha University of Education, Jl. Udayana No.11 Singajara, Bali, Indonesia

widiapradnyawati.wp@gmail.com, putu.suharta@undiksha.ac.id

nengah.suparta@undiksha.ac.id

Abstract The purpose of this study was to obtain contextual fable modules (student's modules, and teacher's book) that was made based on Problem Based Learning in focus to increase students' concept understanding and mathematical motivation. This research is development research with design research by Plomp (preliminary research, prototyping phase, and assessment phase). Data were collected by using validation sheets (validity assessment), implementation sheet, student's response questionnaire, teacher's response questionnaire (practicality assessment), and concept understanding test and mathematical motivation test (effectiveness assessment). The collected data were analyzed descriptively. The result of this research showed that developing mathematics-fable module are categorized: (1) valid, with average scores equal to 3.48; (2) practice, with average scores equal to 3.16, (3) effective, with average scores equal to 77.75 and 58.56. The student's book contained: (1) basic competencies and learning objectives; (2) guided exercises to construct students concept understanding; (3) character values; (4) contextual problems; and (5) spaces for students to write conclusions and reflections. The teacher's guidance book contained: (1) learning steps and matching with student module, (2) notes for teacher how to develop student character; and (3) alternative actions and alternative answers.

1 Introduction

Learning mathematics in elementary schools is the basis for learning mathematics at the next level. Zulkardi states that "mathematics lessons emphasize understanding concepts", meaning that in learning mathematics, students must understand mathematical concepts in order to be able to apply these learning in the real life [1]. If understanding concepts in mathematics learning is not achieved, it will reduce students' interest in learning mathematics and students will assume mathematics is difficult [2]. Based on the researcher's random survey on primary and junior high schools students, they enjoy reading the fable stories because that books contain interesting and colorful picture stories [3]. Therefore story can be used as invaluable resources that can support children with contextualization in classroom learning [4]. One example is the fable story.

Fables is fictional or imaginary stories that tell the lives of animals that behave like humans [5]. The characters contained in these animals are considered to represent human characters and are told to be able to speak and act like humans [6]. Coles said that fables can improve memory, the ability to recall, the application of concepts in new situations, understanding and enthusiasm for learning on subject topics [7]. Fable stories that contain many moral values and advice can help students shape the expected character in the education process [8]. In accordance with Cengizhan, there are three effect factors that they managed to get by making the concept of fable; the level of interaction in the classroom, how much accuracy the students have, and the role of the teacher [9]. Based on this, fables are the right media to create fun mathematics learning and can contribute to the growth of character education values.

The problem found by the writer when making observations at SD N 2 Padangsembian is that students seem less enthusiastic about learning mathematics. When given a problem,

especially a story problem, many students complain that the questions given are difficult, not in the book, and do not match the example so they are lazy to work on it. This shows that students do not have a motivation to learn. Based on the results of interviews with mathematics teachers, the learning resources used by teachers only rely on textbooks and Student Worksheets which according to the teacher that have more questions and there are still few activities that can help students find concepts independently. Seeing these problems, the idea emerged to combine the attractiveness and benefits of fables as a medium for the introduction of mathematics in teaching materials in the form of modules.

Module is a learning material of instructional that is relatively short and specific content that is arranged to achieve the learning objectives. The module usually has a well-coordinated series of activities related to material, media and evaluation [10]. Modules can make students learn independently so they can support the teacher's role in the learning process [11]. Fable is inserted into the module as a medium for delivering problems where the fable contains several problems that have been adapted to the learning material. The fable used should be contextual fable which includes characters and stories that involve an environment that is close to students so that students easily understand the characters in the story. This contextual fable module is organized based on problem based learning where this model provides opportunities for students to hone their creativity in problems solving related to the concepts [12] and can deliver students to the steps of the discovery of mathematical concepts, relationships between concepts, especially related to the material [13]. In addition, this module provides opportunities for students to solve problems related to their daily lives such as those contained in fables so that students feel motivated. Especially in the fable module contain interesting animal stories and colorful images so students are more interested in reading modules. High motivation from students can make students learn without waiting for instructions directly from the teacher [14]. That is, students have their own initiative to learn about the material being discussed.

Based on the description above it is important to develop teaching materials that are fun for students and increasing mathematical concepts understanding. The learning device developed is a contextual fable module charged with character consisting of student modules and teacher's books and also learning plan arranged based on a problem-based learning model. in this study it is important to discuss the characteristics and quality of learning modules in order to obtain quality modules and give consideration to the development of innovative mathematics learning modules.

1 Methods

This type of research used in this research is Research and Development. It was conducted at grade IV of SD N 2 Padangsembian in Academic Year 2018/2019 on the subject of matter and multiples of number. The development research steps used were adapted from the model developed by Plomp. The brief description of the module development pathway in the mathematical fable media is as follows: At the Preliminary Research stage the researcher looks at an overview of the state of the school, namely: (1) analyzing the Mathematics Textbook. 2013 curriculum class IV textbooks are divided into two types of books, namely student books and teacher manuals, (2) conducting interviews with teachers and students of mathematics textbooks to obtain constraints and information about implementing mathematics books that have been used in the learning process takes place according to the 2013 curriculum.

Next is the prototype phase, the results at the preliminary research stage are used to design the prototype, which is the module with contextual fable media. The results of this design are then referred as Prototype I. Prototype I was compiled later validated by two teachers in mathematics education based on consideration into the mastery and experience possessed of two lecturers from the University of Education Ganesha and one mathematic's teacher from SD N 2 Padangsembian. Then a revision of the prototype I was conducted which was

validated by the validator, so that the prototype II was obtained which was valid and ready to be tested.

The next step is to do a limited trial. This limited trial was carried out in one class, the results of a limited trial were used to revise the prototype II, in order to obtain prototype III with improved quality. Next, do a field trial I involving one class. The focus of this trial is to improve the quality of learning tools and characteristics of learning with problem-based learning models. In this trial an assessment of the implementation of the learning module was carried out, formative evaluation involving teachers and students, using observation techniques, tests and questionnaires. The results obtained in the first field trial were used to revise prototype III, to obtain prototype IV.

At the stage of assessment conducted field trials II. The final stage of the trial was carried out semi-summative. The assessment results are used as material for revision of prototype IV, so that the student module learning tools and teacher instruction modules are valid, practical and effective so that the final product is obtained.

The instruments used in this study are: 1) Instruments to see the validity of learning devices developed include: student module validation sheets and teacher book, 2) Instruments to see the practicality of learning devices developed include: observation sheets for learning device implementation, student response questionnaires towards student modules developed, and teacher response questionnaires to learning devices namely student modules and teacher instruction modules, 3) Instruments to see the effectiveness of developed learning tools include: instruments for evaluating student motivation and tests of understanding mathematical concepts to understand the understanding of students' mathematical concepts after participating in learning using media developed in this research.

3. Results and Discussion

Learning media that have been successfully developed in this study are learning media in the form of student modules and teacher book that are media contextual fables for grade IV elementary school students on Factors and Multiples. Furthermore, the quality of the instructional media developed will be measured. The quality of learning media includes three things, namely validity, practicality, and effectiveness.

To see the validity of contextual fable module (student modules and teacher book) developed in this study involved two lecturers in the Mathematics Education Study Program at the University of Education, Ganesha and a mathematics teacher (Mathematics Teacher who teaching grade IV in SD N 2 Padangsembian). The validation process is done after the researcher has successfully realized the learning device in the form of prototype I.

Table 1. The Result of Contextual Fable Module Validity

Validator	Student Module	Teacher's book	Lesson Plan
1	3.00	3.00	4.04
2	3.21	3.20	4.09
3	3.36	3.30	4.14
Average	3.19	3.16	4.10
Criteria	Valid	Valid	Valid

It can be seen based on Table 1 that (1) the student module is valid, which means that the student module has fulfilled student activities based on problem based learning and is able to combine the uniqueness of fable with mathematics learning; (2) Teacher's book is valid, which means that the teacher's book has fulfilled the steps of problem-based learning and has been equipped with answers in the student module, alternatives provided by students and teacher's activities can support the teacher in learning to achieve the expected learning objectives; (3) The lesson plan is valid, which means that the lesson plan has met the steps of the problem based learning model. This can help teachers in teaching

students about material factors and multiples and supports teachers to direct students to be actively involved in the learning process, so that they can construct concepts independently and increase students' mathematical motivation. This validity is caused: (1).the components of the learning media in accordance with the indicator indicators needed on the instrument validity; (2) The learning tools that are arranged are in accordance with the demands of the curriculum in the school; (3) Teacher's books and lesson plans which refer to the problem-based learning stage.

The instruments used to measure practicality and effectiveness such as implementation sheet of the learning devices, students' and teacher's responses questionnaire, as well as the student's concept understanding and mathematical motivation were also categorized valid. The prototype I which was validated and declared to be suitable for use was subsequently revised according to the advice of the experts. The revised results of prototype I are then referred to as prototype II which is ready for limited testing in grade IV C and the teacher. During the limited trial implementation, several flaws were found on the learning devices, which were suspected to contribute to the disturbance of the learning implementation on the next trial. The results of the revision of prototype II are called prototype III which is then retested. Field trial I was conducted for all of grade IV A's students and a teacher, some students showed a positive attitude towards the developed learning device, but there were still some weaknesses. All the results of the first field trial were used as material to revise prototype III. which was then retested. The trial hereinafter referred to as the field trial II was carried out on all of grade IV B' students and one teacher. The following is the summary of the practicality of the learning devices.

Table 2. The Summary of the Practicality of Contextual Fable Module in Limited Trial

Phase	Sr	Category
Implementation Sheet	2.80	Practical
Student's Responses	2.98	Practical
Teacher's Responses	3.00	Practical
Average	2.93	Practical

Based on table 2, The practical category obtained by researchers in this limited trial is one reason in making a decision that this learning device can be tested in the next stage, namely the first field trial.

Table 3. The Summary of Practicality of the Contextual Fable Module Based in Field Trial I

Phase	Sr	Category
Implementation Sheet	3.24	Practical
Student's Responses	3.03	Practical
Teacher's Responses	3.23	Practical
Average	3.17	Practical

Based on Table 3, the practical category obtained by the researcher in this field trial I was one of the reasons in making a decision that this learning device could be tested in the next stage, namely field trials II.

Table 4. The Summary of the Practicality of the Contextual Fable Module Based in Field Trial II

Phase	Sr	Category
Limited Trial	3.33	Practical
Field Trial I	3.11	Practical
Field Trial II	3.47	Practical
Average	3.38	Practical

Based on Table 4, Based on the description, the results show that the learning device developed is in accordance with the expectations of the researcher, namely the learning device meets the criteria of practicality as a learning device developed.

Based on practicality tests, learning devices developed are categorized as Practical. This shows that the overall lesson plan can be implemented as expected. learning using modules can be done well. this

can be seen from the positive response of students to student modules. in addition, the teacher's response to the teacher's book that was also developed was good, which made it easier for teachers to do the learning process by using problem-based learning models. In addition to practicality, field trials II also measure the effectiveness of learning tools by using concept understanding tests and students' mathematics learning motivation tests. Mathematical communication ability test results are given in Table 5 below.

Tabel 5. Summary of Mathematical Concept Understanding Test Result

Phase	Average	Category
Field Trial I	77.1	Complete
Field Trial II	78.4	Complete

From the results of the analysis in Table 5 above, it was found that the average test score for understanding mathematical concepts for students in grades IV A and IV B had met the criteria in developing the device. Based on the table above, it is known that the average score of students is 77.1 in the field trial I and 78.4 in the field trial II. This number indicates that the concept understanding test results fall into the "Completed" category because this value located at intervals of $65 \leq X \leq 100$

Tabel 6. Summary of Mathematical Motivation Test Result

Phase	Stage I	Category	Stage II	Category
Field Trial I	47.8	Moderate	58.13	High
Field Trial II	48.8	Moderate	59.0	High

Based the table, show that the results of the student's indicated motivation increase from the "moderate" category to the "High" category and there is an increase in the motivation questionnaire scores shown by students from stage I to stage II. Thus the development of this learning device said to be effective or successful in achieving the expected goals.

Based on the results of the study, it can be concluded that the contextual fable module charged with characters can help students to understand concepts and to improve student's mathematical motivation. It is influenced by several factors, the module has an interesting fable story so students are motivated to do the module. Fables have a clear structure and flow simple, talking directly to the heart of a child. This "symbolizes" the animal, making it easy for children to identify with characters and even absorb moral ideas from the story. animal figures in learning stories foster children's interest in learning mathematics and improve their learning outcomes [7]. Other that using fable module make mathematics more interesting, fun and meaningful so that the atmosphere in the learning process is not monotonous that make students bored and not interested at all to the material presented by the teacher [17]. However they also found that students expected that enjoyable lessons succeed in teaching mathematics regardless of content or context of the lessons.

Fable media is applied in mathematics learning with problem-based learning. Problem Based Learning is a learning model with a model Student learning on authentic problems, so students can grow their own knowledge, develop more high skills, independent students, and increase self-confidence [15]. Jaisook said that PBL is effectively used in mathematics learning and can improve students' understanding and ability to apply mathematical concepts in everyday life. With the existence of PBL students can be free to develop their creativity and problem solving ability [16].

4. Conclusions

Based on the result of this research and the discussion, it could be concluded that contextual fable module charged with character which met the criteria valid, practical, and effective to improve concept understanding and mathematical motivation. Characteristics of student modules developed in this study are: 1) learning activities designed so students can construct mathematical concepts independently, 2) contain character education values for student character development, 3) consist of several guided questions, 4) consist of real problems and

close to students' daily lives, 5) there is room for students to write down the results of their reflections on the learning that has taken place. The characteristics of the teacher book are: 1) facilitating the teacher in the learning process in class, because it contains clear learning steps and adapted to the student's book, 2) contains notes related to the way the teacher attempts to develop student character according to the implementation of values value of character education, 3) contains alternative actions and equipped with alternative answers so as to facilitate the teacher in directing students to the expected answers.

Based on the conclusions above, the researchers recommend that (1) Modules with contextual fable modul can be considered by teachers as alternative teaching materials in schools; (2) Problem-based learning models can be considered by teachers to help students understand concepts; (3) Further research examining the effect of contextual fable media modules on various aspects of the material is also more diverse.

5. References

- [1] W Ellissi and A M Aroran "The Analysis Of Student Thinking In Mathematical Understanding Of 7th Grade Of Bopkri I Junior High" 278–286.
- [2] R. Sahrida 2010 "Upaya Meningkatkan Pemahaman Konsep Matematis Siswa di Kelas IV SD pada Materi Bangun Datar Melalui Permainan Tradisional"
- [3] M Abrar 2016 "Learning from Fables: Moral Values in Three Selected English Stories," *Din. Ilmu* **16(1)** 47
- [4] R Yildirim and F Pinar Torun 2014 "Exploring the value of animated stories with young English language learners," *Turkish Online J. Educ. Technol* **13(4)** 47–60
- [5] O Zulkifli 2013 "Belajar Bahasa Secara Holistik : Apakah Pandangan Murid?," *J. Pendidik. Bhs. dan Sastra* **13(2)** 102–117
- [6] H D Syafutri and F Hidayati "Dalam Pembelajaran Sastra Anak Fable : an Alternative of Character Educational in the Children ' S Literature Learning" 123–134.
- [7] N Rohmah 2016 "Pengembangan Bahan Ajar Matematika Berbasis Hasil Belajar Tematik Materi Bangun Datar Kelas IV A SD Islam As-Salam Malang," 24
- [8] Z Habsari 2017 "Dongeng Sebagai Pembentuk Karakter Anak," *BIBLIOTIKA J. Kaji. Perpust. dan Inf* **1(1)** 21–29
- [9] A Kaplan and M Öztürk 2015 "The effect of concept cartoons to academic achievement in instruction on the topics of divisibility," *Int. Electron. J. Math. Educ* **10(2)** 67–76
- [10] Y N T B Sinaga, Mukhtar, and E Surya 2017 "Development of Mathemtics Module Based on Metacognitive Strategy in Improving Students' Mathematical Problem Solving Ability at High School," *J. Educ. Dev. Math. Modul. Based Metacognitive Strateg. Improv. Students' Math. Probl. Solving Abil. High Sch. J. Educ* **8(19)** 73-80
- [11] N L Fitriyanti, Y L Sukestiyarno, and N K Dwidayati 2019 "The Development of Module Containing Local Culture with Realistic Approach for Mathematical Literation of Elementary School Students" **10(2)** 181–191
- [12] D B Widjajanti 2011 "Problem-Based Learning dan Implementasinya," *J. Kependidikan* **1** 2–8
- [13] F Khayati, I Sujadi, and D R S Saputro 2016 "Pengembangan Modul Matematika untuk Pembelajaran Berbasis Masalah (Problem Based Learning) Pada Materi Pokok Persamaan Garis Lurus Kelas VIII SMP," *J. Pembelajaran Mat* **4(7)** 608–621
- [14] E. Warti 2018 "Pengaruh Motivasi Belajar Siswa terhadap Hasil Belajar Matematika Siswa di SD Angkasa 10 Halim Perdana Kusuma Jakarta Timur," *Mosharafa J. Pendidik. Mat* **5(2)** 177–185
- [15] Juand. 2018 *Eksplorasi Nilai Fabel sebagai Sarana Alternatif Edukasi Siswa*. Bandung Jurnal Pendidikan Bahasa dan Sastra **18** Universitas Pendidikan Indonesia
- [16] S Jaisook, S Chidmongkol, and S Thongthaw 2013 "the Development of Instructional Model By Integrating Problem-Based Learning and Collaborative Learning Approach To Enhance Mathematical Problem Solving, Communication and Connection Abilities," *7th Int. Technol. Educ. Dev. Conf* **13(2)** 3196–3204
- [17] Foss D H and Kleinsasser R 1996 *Teaching and Leacher Education* **12** 429-442

Development of Geogebra-Based Assessments to Increase Student Motivation and Literacy in Mathematics

Ida ayu Kade Suryani^{1}, I Made Ardana², and I Gusti Putu Suharta²*

^{1,2,3}Ganesha University of Education, Jl.Udayana No.11 Singajara, Bali, Indonesia

Email: Idaayu.kadesuryani24@gmail.com

Abstrak The purpose of this study is to describe the effectiveness and practicality of using GeoGebra in mathematics learning. The method used in this study is a study that is guided by the procedure for developing the Plomp model. Based on the results of the analysis showed quite diverse results in the world of education. The results of the literature study show that (1) The results of the study show that the assessment of two material expert validators in the geogebra-assisted transformation geometry module developed has an average total score of 3.38 with very good criteria, whereas for media expert validators it has an average total score 3.21 with very good criteria. Excellent criteria from the results of the validation of media experts and material experts indicate that the geometry module transformation is assisted by geogebra and is valid for use as teaching material in lectures and there are also other articles that show the results that Improving student learning outcomes by using economic mathematics learning materials based on cycles GeoGebra software-assisted learning is better than students who do not use economic mathematics learning materials based on GeoGebra software-assisted learning cycles. (2) the results of the analysis show that by searching geogebra based development keywords in Scholar. Then found 227 articles. There are 4 articles that contain it, this article is in the tertiary level and high school level.

Keywords: Geogebra, Development, LiteracyIntroduction

1. Introduction

Quality education is a reflection of the progress of a nation. Education plays an important role in preparing human resources who are able to compete in the development of contemporary science and technology. Technology itself has an important role in the learning process in the classroom, especially in learning mathematics. The role of technology in mathematics learning is very helpful in supporting student understanding in building cognitive knowledge. One important thing in learning mathematics is students' understanding of mathematics procedurally and conceptually. But in reality in the field of mathematics learning, most teachers still use traditional learning so it tends to make

students bored participating in learning. Not only that, mathematics learning is more emphasized on the calculation of abstract concepts and memorizing mathematical formulas that cause students to get bored in learning them. This is what makes students' understanding of learning mathematics still lacking so it impacts on the lack of motivation and mathematics literacy in students. Therefore, innovation is needed in the packaging of mathematics learning to make it more interesting for students. One of the things that can be done by combining learning with the use of technology.

Of course, in learning mathematics, software technology such as GeoGebra is needed to support the learning process. In addition, in the face of educational development, the industrial revolution 4.0 has become a challenge for education practitioners and education stakeholders in adjusting the harmony between learning and technology in various developments. The role of GeoGebra in mathematics learning is beneficial for teachers and students. For teachers, the role of Geogebra helps in facilitating the learning process. As for students, GeoGebra's role is to help imagine geometry in a flat form and build more real space, design mathematical models and build cognitive knowledge in combining abstract concepts with virtualization. Development of Geometry Models and Assisted Learning Devices in Open Geogebra Software [2]. The formulation of the problem there are two components that can affect student learning outcomes. First, the students' critical thinking ability demands to be able to understand the material. Second, the need to integrate technology capable of providing visual and dynamic facilities as well as a bridge for students to understand the material. This study aims to develop models and learning tools for Geometry open field assisted Geometrics courses that are expected to improve students' critical thinking skills.

Application of Geogebra-Aided Problem-Based Learning To Improve Motivation and Learning Achievement of Transformational Composition Material. It was concluded that the application of GeoGebra-aided problem-based learning can improve motivation and learning achievement in mathematics in the composition of transformation material [3]. According to the researchers' experience and the results of discussions with colleagues students' learning motivation in learning mathematics material transformation especially in class XII MIPA-6 is low. It was proven when the teacher explained that there were still many students who did not pay attention. Students when asked by teachers tend to be silent, told to ask questions if they encounter difficulties are also silent, only a few students are active in the learning process. While most students do not have the courage to ask questions and express opinions. This results in student achievement. The 2016/2017 odd midterm test results show that out of 38 students only 21.05% were able to achieve the Minimum Mastery Criteria (KKM) specified for mathematics subjects, which was 75. The average student learning outcomes only reached 62.97 with the highest value of 100 and the lowest value of 34. This study aims to improve learning motivation and learning achievement in mathematics. This research is a class action research. The sample of this study was students of class XII MIPA-6 of SMA Negeri 1 Jepara.

2. Method

This type of research is development research. This research development uses descriptive experimental and not hypothesis testing. The research data collection was taken from articles published by online journals. The online journal chosen as the object of analysis in this study is the Education Resource Information Center (ERIC).

From the results of content analysis in research (1) [1]. Development of Mathematics Learning Tools with Geogebra-Aided Scientific Approaches in Efforts to Improve Communication Skills and Mathematical Learning Activities for Class VIII Middle School Students. This type of research is design research conducted through the preliminary research, prototyping stage, and assessment phase. This study involved eighth grade students of SMPN 1 Denpasar as research

subjects. Data were collected using observation sheets of the implementation of learning tools, student response questionnaire, teacher response questionnaire, observation sheet of mathematics learning activities, observation sheet of mathematical communication skills, and written test description. The data obtained were then processed and analyzed descriptively. Development of Geometry Assisted Open Source Geogebra Models and Learning Devices [2]. The learning model developed is a reasoning and problem solving learning model assisted by Geogebra's open software. Learning tools developed include textbooks, instructions / guidelines for using Geogebra software and student worksheets. Model development and learning tools are carried out using the 4 D model from Thiagarajan, Semmel and Semmel. (3) Sugiarto, Application of Problem-Based Learning Based on Geogebra to Improve Motivation and Learning Achievement of Transformation Composition Material [3]. This research is a class action research. The sample of this study was students of class XII MIPA-6 of SMA Negeri 1 Jepara. Data collection through tests and non-tests. Test techniques to determine learning achievement using items while non-test techniques to determine the development of learning motivation using observation sheets.

From exposure to content analysis, they have the same but different interactive media-assisted research methods so that the results of the study refer to the results described above.

3. Results

From the results of content analysis for the results obtained from the following research:

[1] . Development of Mathematics Learning Tools with Geogebra Assisted Scientific Approach in an Effort to Improve Communication Skills and Mathematical Learning Activities for Class VIII Middle School Students. The results showed that the mathematics learning device developed was in the very valid category. Development of Geometry Models and Assisted Learning Devices in Open Geogebra Software [2]. The results showed that the learning model and device developed had fulfilled Nieveen's version of product quality requirements, namely valid, practical, and effective, and could improve students' critical thinking skills . Application of Geogebra-Aided Problem-Based Learning To Improve Motivation and Learning Achievement of Transformational Composition Material [3]. The results showed that students 'learning motivation increased from low to high and the average value of students' mathematics learning achievement rose 31.86% from 62.97 to 83.03 with the level of completeness almost tripled from 21.05% to 81, 58%, so it was concluded the application of GeoGebra-aided problem-based learning can improve motivation and learning achievement of mathematics composition transformation material.

4. Conclusion

From the exposure to the results of the content analysis it can be concluded that the learning tools based on geogebra software have advantages. Where these advantages, can help students understand more deeply not only based on paper and pencil. Not only that, interactive media in the form of Geogebra software can also provide advantages that can motivate students and student literacy in mathematics. Especially in learning the system of linear equations as well, so that students can display directly visually the results of student work. Because of these advantages, GeoGebra learning media is expected to reduce student learning difficulties in learning linear equation systems and be able to increase student motivation.

So from the superiority of the media, it will try to conduct research in developing an authentic Geogebra-based authentic assessment that can guide students in conducting investigations or problem solving activities. Especially in the form of assessment of student performance in learning conducted in class. In learning that is designed to be used in mathematics learning activities that contain material in the Linear Equation System which will be assisted by GeoGebra which involves student literacy towards mathematics, especially in technology literacy, it can understand well. Therefore authentic

geogebra-based assessments are not just scores, but as feedback in learning using interactive media. Learning media can also facilitate understanding of concepts and increase student motivation and literacy in learning Linear Equation Systems. This enables students to become accustomed to drawing graphs, determine intersection points on a graph with more accurate results and determine the Linear Equation System using graphs.

Therefore, the teacher's act of facilitating students is very important and very influential on the learning process. This is very related to an ongoing assessment process. So that what is felt necessary to be done by teachers to be able to overcome these problems is to use learning media designed with Geogebra software. Geogebra is a mathematics education computer software. As the name implies, geogebra can be used for learning (visualization, computing, exploration, and experimentation) and teaching geometry, algebra, and calculus material. From the results of the content analysis that mathematics-aided learning of technology, especially in geogebra software, has a very positive advantage in its use in a variety of purposes.

5. References

- [1] Agus Indrawan, 2014. *Development of Mathematics Learning Tools with a Geogebra-Aided Scientific Approach in an Effort to Improve Communication Skills and Mathematical Learning Activities for Class VIII Middle School Students*. Journal entry. Published: January 2017
- [2] Wisna Ariawan, 2012. *Development of Geometry Models and Assisted Devices in the Field of Open Software Geogebra*. Journal entry. Published: January 2012
- [3] Sugiarto, 2017. *Application of Problem-Based Learning Assisted by Geogebra to Improve Motivation and Learning Achievement of Transformational Composition Material*. Journal entry. Published: January 2017

Development of Problem-Based Physics Learning Module to Improve Students Critical Thinking Ability

Aditya, T. P.¹, Dewi, R. I. L., Sari², N. M. D. M. P³., Suma, K⁴., Gunadi, I. G. A.⁵

Physics Education Departement
Universitas Pendidikan Ganesha
Singaraja, Indonesia

e-mail: teowandaputri@gmail.com, indahraiyasa@gmail.com,
mawarnipermanasari@gmail.com, ketut.suma@undiksha.ac.id,
igagunadi@gmail.com.

Abstract The aim of this study was to produce a physics module based on problem to improve student critical thinking ability in physics learning. The subject of the module concerning sound and light wave. Basic competencies and indicators used in accordance with curriculum 2013 and syllabus that applied at the Negera 1 senior high school. This study was Research and Development based on Santyasa design is called AM3PU3 model. Critical thinking ability test tried for all of the grade XI students consisting of 104 students at Seririt 1 senior high school. The field test tried for 35 students grade XI MIA 6 Negara 1 senior high school. This study used one group pre-post test design. The subject of this study was 2 media expert, 2 content expert, 2 design expert, 10 physics teachers as practitioners, 1 field test physic teacher, student of XI MIA 6 Negara 1 senior high school consisting of 35 students, 9 students of small group test, and 3 students of individual trial test. Data of this study were obtained by using questionnaire and test of critical thinking. The results of this study reveal first, the module is valid due to: a) very good qualified by the media and content experts, b) the average score of design expert is 239 points (very good qualified), c) the practitioners teacher test stated that module is good qualified with an average score of 161,5, d) the individual trial test stated that module is very good qualified with an average score of 164, e). the small group test stated that module is good qualified with an average score of 159,7. Second, the module is stated as practically due to: a) the respond of teachers is good qualified with an average score of 45, b) the respond of students is good qualified with an average score of 70,14, c) the test of module implementation stated that module is good qualified with average score of 44,75. Third, the module is stated effectively by the result of t-test > t-table (t-test of the sound and light wave subject is 33,58, t-table = 2,05), so the H_a is accepted and H_0 is rejected. H_a is stated that there are differences of problem critical thinking of the student after the module is applied. The average score of the post test is 89,01 for the sound and light wave subject, the score are greater than the minimum criteria of mastery learning score for physics subject in Negara 1 senior high school.

Keywords: *Module, PBL, Critical Thinking Ability*

1. Introduction

The hope of education in Indonesia is in accordance with the objectives of education according to Law No. 20 of 2003 concerning the National Education System is developing the potential of students to become human beings who believe and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent and become democratic and responsible citizens. The purpose of education in Indonesia is to form a smart society to shape the independence of a nation [7]

. The formation of intelligent societies is closely related to the quality of education, so the quality of education needs to be built in order to form intelligent students by giving students the opportunity to be actively involved in

building the concepts and theories they learn [6]

The Indonesian government always trying to improve the quality of education by improving the curriculum, developing learning models, learning tools, completing educational facilities and others. One of the ways that the government has done is to improve the curriculum, according to the Tim Pengembang MKDP (2013) the curriculum plays a significant role in education because the curriculum emphasizes plans and arrangements about competencies to achieve goals and how to achieve them according to circumstances, regional capabilities and school. Seeing the magnitude of the influence caused by the curriculum, the government has made improvements to the old curriculum by establishing the 2013 curriculum emphasizing character education possessed by students guided by scientific approach principles in the learning process in the hope of being able to improve students' critical thinking ability (Permendikbud, 2013).

The facts show that students' critical thinking ability in Indonesia are still low. Based on the results of a study by TIMSS (*Trend in the International Mathematics and Science Study*) shows that in 2015 Indonesia was ranked 45th out of 50 countries with a score of 397. This rating shows that students' critical thinking ability in Indonesia are still below the international average score. In addition, the results of research by the OECD (*Organization for Economic Cooperation and Development*) in 2015 using the PISA test (*Program for International Student Assessment*) stated that students' critical thinking ability in Indonesia were ranked 64th out of 72 countries that participated in PISA. This proves that students' critical thinking ability in Indonesia are still relatively low.

Reality in the field, schools that have implemented the 2013 Curriculum have not been able to improve students' critical thinking ability, including schools in the province of Bali. Almost all schools in the province of Bali have applied 2013 Curriculum in the learning process. However, students' critical thinking ability still has not experienced a significant increase. Jembrana is one of the districts in Bali. Negara 1 high school is one of the superior high schools in Jembrana Regency that has implemented the 2013 Curriculum. Based on the initial observations that have been made, students' critical thinking ability are still relatively low, especially in Physics subjects.

The gap between expectations and facts in the application of the 2013 curriculum to improve students' critical thinking ability in physics subject can be caused by many influencing factors, namely student characteristics, teaching method (teachers), school facilities, learning models, and materials teaching that is used during the learning process in class. Based on preliminary observations made at Negara 1 senior high schools, researchers found that scores on Basic Competence-3 related to cognitive students had been quite high, but students still could not work on modification questions linking formulas and concepts in everyday life. In the learning process the teacher still uses a conventional learning model that causes teacher centered learning. In addition, teaching materials used by students during the learning process are still minimal. Student teaching materials are only in the form of worksheets that explain material in a level and contain questions that only relate to mathematical formulas. Based on the results of these observations, it can be concluded that the factors causing students' critical thinking ability in Negara 1 senior high school are still relatively low due to the learning model still using conventional models and minimal teaching materials.

The solution to overcome this gap is to develop teaching materials based on learning models to improve critical thinking ability. Teaching materials that can be developed to improve students' critical thinking ability in the form of learning modules. The learning module is one form of teaching material that is packaged in a complete and systematic manner, in which it contains a set of planned learning experiences and is designed to help students master specific learning goals [10]. In the module contains material in full and complete and adapted to the basic competencies and learning objectives at each meeting. While the learning model can be used so that student-centered learning is a Problem Based Learning model. This model is able to improve student interaction during the learning process in the classroom, both student interaction and student-teacher interaction. According to Awan *et al.* (2017), a student-centered Problem-Based Learning model can increase student activity in the classroom. In addition, [11] also emphasizes that through the application of Problem-Based Learning models can foster interest and train students' critical thinking ability by linking to events that exist in

everyday life. The learning module that will be developed is in accordance with the syntax of the Problem-Based Learning model so that the learning process is better structured. In the module to be compiled, requires students to be able to be able to answer the problems that exist in everyday life by linking with concepts and formulas with relating to answering problems according to concepts and material learned in order to improve students' critical thinking ability. According to [13] the use of problem-based e-modules is quite effective in helping students understand concepts and examples of real-life phenomena and can be an alternative in presenting learning material, so as to improve students' critical thinking ability. The research conducted by [20] also shows that the development of problem-based physics modules can improve students' learning motivation so students' critical thinking abilities. In addition, [1] also emphasizes that Problem-Based Learning modules can improve students' critical thinking ability contextually because the material contained in the module can be studied in a systematic and systematic way.

According to [10], (2016) the learning module is one form of teaching material that is packaged intact and systematically, in it contains a set of planned learning experiences and is designed to help students master specific learning goals. The learning module can make students more quickly master the learning material. [14] state that the module is a unit of teaching programs arranged in a certain form for learning purposes. According to the Indonesian Departement of National Education (in Rahiyanta, 2016), to produce a good module, the preparation must be according to the following characteristics: 1) Self instructional, 2) Self contained, 3) Stand alone, 4) Adaptive, and 5) User friendly.

Student-centered learning has the aim that students have high motivation and the ability to learn independently and are responsible for always enriching and developing knowledge, ability and attitudes. One model student-centered learning is Problem-Based Learning model. Duch (1997) suggests that Problem-Based Learning model is a learning model that presents a real problem relevant to the subject, so that students can experience learning process independently to understand the material from the basic to the complex. [12] asserts that Problem-Based Learning model is designed in a learning procedure that begins with a problem and uses the instructor as a metacognitive (self-reflecting) trainer. According to Barrows and Myers (in[12]) the learning steps with Problem-Based Learning model are starting a new class, starting a new problem, problem follow-up, performance presentation, and after conclusion of problem.

Critical thinking ability according [3] states that critical thinking consists of self-awareness of a series of interrelated critical questions, abilities, and willingness to respond and carry out the question correctly. [19] asserts that critical thinking is a cognitive ability to say something with confidence because it relies on logical reasons and strong empirical evidence. Students can understand and express complete problem solving through critical thinking. This is because the critical thinking process of students is determined by the number of relationships between the objects observed and the scheme they have (Rasiman, 2013).

Problem-based physics learning modules are defined as print-based teaching materials that are intact and systematically designed to include physical material content based on context problems, as well as evaluations that can be used independently by each student to improve critical thinking ability.

yuliono in [2] shows the that effectiveness of physics learning modules compiled based on problems can improve students' critical thinking ability. In addition, [16] shows that Problem-Based Learning models that are student-centered can provide opportunities for students to develop the ability to think critically about a problem. [8] in his research also showed that the products produced in the form of e-modules were able to improve students' critical thinking ability. The results of his research indicate that the module developed is appropriate and has a quality *very good module* so that it can be used as an alternative teaching material for students, especially in improving critical thinking ability.

2. Research Method

This study belongs to Research and Development/R&D. The research design used was the design of AM3PU3 model development research according to Santyasa. The AM3PU3 model consists of several stages including: the first stage (determining module material), the second stage (needs analysis), the third stage (development draft), the fourth stage (preparation draft), and the fifth stage

(expert review) (Santyasa, 2015).

The development trials were carried out through several stages, namely: (1) validation by experts, (2) responses through individual trials, (3) responses through small group trials, (4) trial of practitioner teachers, and (5) responses through field tests. Subjects consisted of 2 content experts, 2 media experts, 2 design experts, 10 physics teachers as practitioners, 1 physics teacher in the field test, XI MIA 6 class students totaling 35 people, 9 students in group trials small, and 3 students in individual trials.

The design of the field test in this study used *one group pretest test post-test design* without a control group [15]. The subjects of the trial in this study were divided into four types of subjects, namely: (a) expert test subjects, (b) individual test subjects and small group trial subjects, (c) practitioner teacher subjects, and (d) field trial subjects. The results obtained from the trial subjects were converted to the level of achievement of scale 5 according to [17] with a range of 90% - 100%.

All data obtained according to its nature can be divided into two groups, namely quantitative data and qualitative data. The collected data are grouped into three parts, namely: (1) the first part includes data on content expert test results, data on expert media content test results, and data from design expert test results; (2) the second part includes data on the results of individual trials, small group trials, and practitioner teachers; and (3) the third part includes data on the results of field trials involving 1 teacher and class XI students of MIA 6 Negara 1 senior high school. The method used to collect data includes questionnaires, observation sheets, and tests of students' critical thinking ability before and after the application of problem-based physics modules.

The instruments used in the study were first tested related to content validity, grain difficulty index, difference power index, and internal consistency of items and tests. The critical thinking ability test consists of one chapter with a total of 22 essay questions. The assessment rubric used is the critical thinking ability test rubric according to [5] which consists of focusing questions, analyzing arguments, answering questions clarification, considering the credibility of a source, observing and considering observations, making deductions and considering the results of deduction, making induction and consider induction, make and consider the value of decisions, define terms, consider definitions, identify assumptions, and decide on an action. T-test done to test the significance of differences in *pre-test* and *post-test* on critical thinking ability test.

3. Results Of Research

The results of this research is a physics-based module product in the material issue of sound and light waves to enhance the critical thinking ability of students in class XI MIA is valid, practical and effective.

The results of the module validity level were obtained from: 1) the results of reviews by content experts and media experts who showed criteria for content validity of 1 with the percentage of questionnaire responses by content experts and media by 100%, so there was no need to revise, 2) the results of expert design reviews showed an average the total score of the two design experts is 239 with very good qualifications so that it does not need to be revised, 3) the results of individual student trials give a total average score of 164 which are very good qualifications and do not need to be revised, 4) small group trials produce an average score of 159 , 67 with very good qualifications, 5) the trial of ten practitioners' teachers produced a mean score of 161.5 that was very well qualified. Based on these five results shows that the problem-based physics learning module fullfill the validity criteria.

The results of the module practicality level were obtained from: 1) the results of the teacher's response questionnaire showed a total score on the application of problem-based physics modules namely 45 with good qualifications so that revisions were needed as needed, 2) the results of student questionnaire responses as module users showed a qualified total score of 70.14 well. Very good response was given by 7 respondents (20% of the total respondents), good responses were given by 25 respondents (71.43% of the total respondents), enough responses were given by 3 respondents (8.57% of the total respondents), 3) results the module implementation questionnaire showed a mean score of 44.75 with good qualifications. Based on the three results, the problem-based physics module fullfill the practicality criteria.

The results of the module effectiveness level are based on the following results: 1) feasibility test that is the average value of the pretest for the sound and light wave material that is 33.58 while the posttest mean value for the sound and light wave material is 89.01. The results of the analysis obtained after testing with SPSS are obtained *thitung* for sound wave and light material is 33.58. In this study using $N = 35$, the degrees of freedom or $db = 35-1$. The significance level used is 5%, meaning the confidence level is 95%. Based on the degree of freedom and significance level used and the list of two-tails, the price of the table obtained is 2.03. Based on the test conditions if $t_{count} > t_{table}$, then the rejection of H_0 gives the meaning that the product of research in the form of problem-based physics learning module is feasible to apply to sound wave material and light. 2) Criteria for the success of the product are determined by comparing the posttest results with minimum criteria of mastery learning score for physics subject. Based on the data obtained that minimum criteria of mastery learning score for physics subject in class XI Negara 1 senior high school with 2013 Curriculum is equal to 70. The acquisition of the average posttest value for sound wave and light material is shown in Table 1.

Table 1. Obtaining the average pre-post test

Materi	Nilai <i>pretest</i>	Nilai <i>Posttest</i>
Gelombang Bunyi dan Cahaya	33,58	89,01

Based on Table 1, the results of the pre-post test showed that the posttest value of sound and light wave material was greater than the minimum score. This gives the meaning that the product developed has met the criteria of success.

Significance testing of differences in pretest and posttest scores was carried out by paired t-test at a significance level of 0.05. The requirement for the t-test is that the distribution of data must be normally distributed, so that before the paired t-test is carried out, the data distribution normality test is carried out first. The results of the data distribution normality test are presented in Table 2.

Table 2. Normality test results distribution of sound and light wave material data

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.130	35	.140	.963	35	.285
Posttest	.122	35	.200*	.983	35	.845

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on Table 2, it can be seen that the significance value of all data is greater than 0.05 so that the data from the pretest and posttest results can be said to be normally distributed. Prerequisite tests have been carried out so that the pairing t-test can be done. The results of paired t-test for all data groups are presented in Table 3.

Table 3. Hasil Uji-t Berpasangan untuk Materi Gelombang Bunyi dan Cahaya									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretes - Postes	-46.88889	8.26134	1.39642	-49.72676	-44.05102	-33.578	34	.000

Based on the results in Table 3, it shows that t_{count} for sound and light wave material is 33.57. The t-test results obtained a significance value below 0.05. In this study using $N = 35$ and $db = 25-1$ and a significance level of 5% (95% confidence level), so that the two-tails t_{table} value obtained was 2.03. Based on this, $t_{\text{count}} > t_{\text{table}}$, so that the value of the pretest and posttest in the sound wave and light material has a significant difference. H_a is hypothesis which states "*there are differences in critical thinking ability of students before and after using problem-based physics modules*" is accepted.

Acceptance H_a means that a problem-based physics learning module is effectively applied in physics learning to improve students' critical thinking ability.

4. Discussion

Hypothesis test results show there are differences in students' critical thinking ability after a problem-based physics learning module is applied in learning. The results of this study are in accordance with theoretical studies and existing empirical studies, where the application of problem-based physics learning modules can improve students' critical thinking ability. The modules developed are certainly influenced by the learning model that is applied at every step.

Awan et al. (2017) in his study showed that students who were treated using the Problem-Based Learning model could improve critical thinking ability and attitudes of students compared to students who used conventional learning models. [18] showed that the effect of the problem-based learning model was effective in improving students' critical thinking ability and learning competencies in the cognitive, affective, and psychomotor domains. Based on his research shows the results that PBL-based learning devices are appropriate to be used to enhance critical thinking ability. The modules developed are also categorized as very good and effective to use.

The excellent qualifications of content experts and media experts are due to several factors, namely products are developed in accordance with the scope of material in the 2013 Curriculum and the problems developed by open ended. In general, the content of the material on the research product includes facts, concepts, principles, and procedures. Learning objectives are clear and in accordance with indicators. In general, the content of the material on the research product includes facts, concepts, principles, and procedures. Improvements to suggestions are also in accordance with one of the attractive requirements of a module according to the Indonesian Departement of National Education, which is if it is user friendly, that is to be friendly with the user.

Qualifications are very good which means that the product is valid in terms of media which is certainly influenced by the accuracy of the media contained in the module. Availability of images, tables, and charts can be used as a medium that helps students understand the products being developed. The product developed is a problem-based physics learning module that meets the characteristics of graphic media. [9] stated that learning assisted with learning media in the form of images, photos or videos can help students understand the concepts or events that occur.

There are several suggestions relating to the media in the form of images, namely the image is less clear and the image is too small, so that repairs are made in the form of replacing with a clearer image and enlarging the image size.

The problem-based physics learning module has the advantage of getting a very good response from students, namely: first because individual students are interested in problem-based physics modules that are usually different from teaching materials, second factor because the questions contained in the module are not only related to physics formula but more related to real events. This is supported by research conducted by [13] states that students' mind set about physics subjects is difficult to overcome through giving problems according to events in everyday life, not only related to the formula.

5. Conclusion

Based on the results of the research and discussion, the following three conclusions can be described: 1) problem-based physics modules are stated to have met valid criteria, 2) problem-based physics modules meet practicality criteria, 3) there are differences in students' critical thinking abilities after a problem-based physics module is applied. This gives the meaning of effective problem-based physics modules to improve students' critical thinking ability.

The results of the practitioner teacher test show that the qualifications are caused by several factors, namely: (1) interesting modules; (2) complete scope of material in accordance with the basic competencies stated in the 2013 Curriculum; (3) problem-based that is able to arouse students' enthusiasm and be active in learning; (4) can be studied independently by students even though the teacher is unable to attend; (5) equipped with practicum; (6) problem-based physics learning modules up to date to be applied; (7) not only train students to apply formulas, but also guide students to think critically and almost all teachers want to apply the module in learning. This is based on the fact that problem-based physics learning modules can increase student motivation and learning outcomes which are demonstrated through improving students' critical thinking ability and scientific processes [20].

The low results of the pretest are caused by students who are not used to answering questions about critical thinking ability. Based on the results of product feasibility and product success criteria, it can be concluded that the problem-based physics learning module is effective to be applied. This result is also in accordance with the results of a study by [13] that through modules based on PBL models that are developed are quite effective in presenting physics learning material so that students' critical thinking ability increase.

Suggestions that can be given from this research are to curriculum developers, especially physics subjects through seminars, MGMP, and physics teacher training and training so that they can apply teaching materials in the form of learning modules prepared by the teacher. The module in this case is a problem-based physics learning module because the problem-based physics learning module can improve critical thinking ability. Suggestions for students who want to develop this product, in order to develop thinking ability indicators that get low scores in posttest.

REFERENCES

- [1] Asmuri., Sarwanto., & Masykuri, M. (2018). Pengembangan modul IPA terpadu SMP/MTS kelas VIII berbasis SETS untuk meningkatkan kemampuan berpikir kritis siswa pada tema makanan dan kesehatan tubuh. *Jurnal Biologi Universitas Jember*, 13(1), 73-80. Retrieved from <https://jurnal.unej.ac.id>.
- [2] Awan, R.N., Hussain, H., & Anwar, N. (2017). Effects of problem based learning on student's critical thinking skills, attitudes towards learning and achievement. *Jurnal of Educational Research*, 20(2), 28-41. Retrieved from <http://admission.iub.edu.pk>.
- [3] Browne, M.N., & Keeley, S.M. (2010). *Asking the right question: A guide to critical thinking*. New Jersey: Pearson Education.
- [4] Duch, B.J. (1997). *Problem-based learning in physics: Making connections with the real world*. Retrieved from <https://aip.scitation.org/>.

- [5] Ennis, R.H. (1993). *Critical thinking assessment*. Retrieved from <https://www.tandfonline.com/doi/abs/>.
- [6] Erawanto, U., & Santoso, E. (2016). Pengembangan modul pembelajaran berbasis masalah untuk membantu meningkatkan berpikir kreatif mahasiswa. *Jurnal Inovasi Pembelajaran*, 2(2), 427-436. Retrieved from www.e-journal.umm.ac.id.
- [7] Mulyasa, E. (2017). *Manajemen berbasis sekolah*. Bandung: Remaja Rosdakarya.
- [8] Nikita, P. M., Leksmono, A.D., & Harijanto, A. (2018). Pengembangan e-modul materi fluida dinamis untuk meningkatkan kemampuan berpikir kritis siswa SMA kelas XI. *Jurnal Pembelajaran Fisika Universitas Jember*, 7(2), 175-180. Retrieved from <https://jurnal.unej.ac.id>.
- [9] Putranta, H. & Kuswanto, H. (2018). Improving student's critical thinking ability using problem based learning (PBL) learning model based on PhET simulation. *Journal of Association for Information Communication Technology, Education and Science*, 1(3), 77-87. Retrieved from <https://www.sarjournal.com>.
- [10] Rahdiyanta, D. (2016). *Teknik penyusunan modul*. Retrieved from <http://staff.uny.ac.id>.
- [11] Rokhim, A.R., Suparmi., & Prayitno, B.A. (2018). Pengembangan modul IPA berbasis problem based learning pada materi kalor dan perpindahan untuk meningkatkan kemampuan berpikir kritis siswa SMP kelas VII. *Jurnal Inkuiri*, 7(1), 143-150. Retrieved from <https://jurnal.uns.ac.id>.
- [12] Sadia, I W. (2014). *Model-model pembelajaran sains konstruktivistik*. Yogyakarta: Graha Ilmu.
- [13] Serevina, V., Sunaryo., Raihanati, Astra, I M., & Sari, I.J. (2018). Development of e-module based on problem based learning (PBL) on heat and temperature to improve student's science process skill. *The Turkish Online Journal of Education Technology*, 17(3), 26-36. Retrieved from <https://www.tojet.net>.
- [14] Sudjana, N., & Rivai, A. (2003). *Teknologi pengajaran*. Bandung: Sinar Baru Algesindo.
- [15] Sugiyono. (2009). *Metode penelitian kuantitatif dan R&D*. Bandung: Alfabeta.
- [16] Sulisworo, D., & Syarif, F. (2018). The utilization of open educational resources in the collaborative learning environment to enhance the critical thinking skill. *International Journal of Learning and Development*, 8(1), 73-83. Retrieved from <http://ijld.macrothink.org>.
- [17] Tegeh, I M., Jampel, I N., & Pudjawan, K. (2014). *Model penelitian pengembangan*. Yogyakarta: Graha Ilmu.
- [18] Yanto, E.A. & Yerizon. (2018). Effect of problem based learning model towards students' critical thinking and learning competences in grade VIII in SMPN 21 Padang. *International Journal of Sciences and High Technologies*, 9(2), 199-205. Retrieved from <http://ijpsat.ijshjournals.org>.
- [19] Yaumi, M. (2012). *Pembelajaran berbasis multiple intelligences*. Jakarta: Dian Rakyat.
- [20] Yuliono, S. N., Sarwanto., & Cari. (2018). Physics-based scientific learning module to improve students motivation and results. *Journal of Education and Learning (EduLearn)*, 2(1), 137-142. Retrieved from <http://journal.uad.ac.id>.

Development of STEM-Based PhET Simulation Students Worksheet To Improve Creative Thinking Skills of Class XI in High School

I Made Astra^{1*}, Hannah Yessi Pricilia^{2*}

¹Prodi Pendidikan Fisika, FMIPA, Universitas Negeri Jakarta, Jl. Rawamangun Muka No 1, Pulo Gadung, Kota Jakarta Timur 13220, Indonesia

²Prodi Pendidikan Fisika, FMIPA, Universitas Negeri Jakarta, Jl. Rawamangun Muka No 1, Pulo Gadung, Kota Jakarta Timur 13220, Indonesia

^{*}imadeastra@gmail.com , hannahyessy@gmail.com

Abstract. The development of this research aims to produce STEM (*science, technology, engineering, and mathematics*) -based PhET Simulation Student Worksheets to Improve Creative Thinking Skills of High School XI Students. One learning approach used to practice creative thinking skills is the STEM learning approach. This development is based on learning objectives that are in accordance with the principles of the Indonesian Curriculum 2013, students can learn anytime and anywhere with a guide to student worksheets and the PhET Simulation application. The preparation of this student worksheet uses the syntax of the STEM learning approach, that are: observe, new idea, innovation, creativity, society. The research method used is Research and Development (R&D) with ADDIE development models, that are: Analysis, Design, Development, Implementation, and Evaluation. Validation tests have been carried out consisting of material, media, and learning expert tests as well as field tests by physics teachers and students stating that the product is suitable for use as a learning medium. Gain test results through pre-test and post-test gained 0.4 in interpretation which means that the STEM-based PhET Simulation students worksheet is effective in improving students' creative thinking skills.

1. Introduction

Learning is one of the most important aspects in the world of education. Permendikbud No. 65 of 2013 concerning Basic and Secondary Education Standards has signaled the need for a learning process that is combined with the principles of a scientific / scientific approach. Learning activities in schools that aim to improve the process skills and social skills of students that are fun and explore creativity to produce graduates who have the ability according to graduate competency standards, it is necessary to develop learning for each competency systematically, integratedly and thoroughly [1].

In this life, both in education, work and other professions, need resources that have high-level skills that require individuals and society to have the habit to always learn, reason, think creatively, make decisions, and solve problems [2]. Creativity is often described as the ability to think differently, be sensitive to problems, the ability to solve problems, and look for unusual solutions to those problems [3]. Chua (2010) describes that creative thinking has characteristics such as: generating unique ideas; generate ideas not normally thought of; imaginative; able to produce ideas in a fixed time; the tendency to see problems directly from various perspectives [4]. According to Guilford in Alghafri and Nizam (2014) there are four main components of creative thinking skills which include: fluency (flexibility), flexibility (originality) and originality (elaboration) [5].

In Indonesia, it uses an integrative approach in seeking graduates who have the ability to associate the knowledge gained with real life. The integrative approach is a learning approach that is carried out using several disciplines. One of the disciplines that is expected to improve the creative thinking skills and science process of students is STEM (science, technology, engineering and mathematic). The purpose of STEM education (STEM education) for all students is to apply and

practice the basic content of STEM in situations they face or find in life, belonging to STEM (STEM literacy) [6]. The STEM curriculum involves "4C" of 21st century skills which include creativity, critical thinking, collaboration, and communication [7]. The application of this STEM requires teachers to be more creative and innovative in learning so that teaching materials are needed that can influence the skills of students

One of the processes used to train basic skills is through scientific experiments which are carried out and improved through practicum activities in the laboratory [8]. The purpose of practicum in the laboratory is to train students to work according to scientific procedures in order to acquire scientific skills, knowledge and values [9]. According to BSNP, one way to achieve competence in learning is to use LKPD that has been adapted to the characteristics of students in subjects, namely by applying learning that includes processes of exploration, elaboration, and confirmation [10]. LKPD is a worksheet containing tasks done by students, containing instructions, steps to complete a task in the form of theory or practice. Student worksheets can be used to improve students' creative thinking skills which involve activities by hand such as inquiry and thinking activities such as analyzing the results of inquiry.

Based on the results of observations made at SMA N 77 Jakarta in the odd semester of the 2018/2019 school year XI MIA 3 class shows that students are classified as active in participating in the learning process both in class and in the laboratory and the use of technology. According to the results of discussions with physics teachers at the school, it was found that students were still weak in mastering the science process skills, namely formulating problems, proposing hypotheses, interpreting data and analyzing hooks in daily life.

The results of the discussion and the needs questionnaire distributed to students about practicum at school obtained information that not all material was developed by conducting experiments in the laboratory or using technology due to several obstacles, even though students were very interactive to conduct experiments in the laboratory. In addition, it is known that teachers have not used laboratory support learning tools such as student worksheets or effective guidebooks and the methods used are still conventional so that students have not gotten good learning skills especially creative thinking skills. Complete practicum tools and technology provided by schools already exist that are not yet utilized to the maximum in supporting students' creative thinking skills.

Based on the conditions and information obtained, the writer tries to provide an alternative by making a Student Worksheet (LKPD) that is used as a tool that makes it easy for students and teachers in the learning process [11]. This LKPD was developed with the STEM approach and PhET Simulation tools which can later be used wherever and whenever to improve creative thinking skills on Dynamic Fluid material.

2. Method

2.1. Research methods

This development research was conducted at SMAN 77 Jakarta in class XI MIA 3. The research method used was development (Research and Development) to develop teaching media in the form of student worksheets (LKPD). Research and Development (RnD) is a research process used to produce certain products and test the effectiveness of products made [12]. In terms of using the ADDIE model which has 4 stages, namely: the analysis phase (Analyze), the design stage (Design), the development stage (Develop), the implementation phase (Implementation), the evaluation stage (Evaluate) [13].

In the needs analysis phase, an analysis of physics learning materials for class XI high school, learning media used, learning media in practicum and the impact of technological development. At the design stage is carried out to determine the content specifications of the developed media and assessment strategies. At the product development stage, the process consists of making worksheets for STEM-based PHET simulation students, validation tests, field tests and product revisions. The validation test aims to determine the feasibility of a phet simulation student worksheet with the developed STEM learning model. The validation test is carried out by material experts, learning experts and media experts. During the implementation phase, a product field trial was conducted on physics teachers and class XI high school students. At the evaluation stage, it is assumed that the formative evaluation form is in the development stage, which means that the actual

evaluation phase can be carried out from the previous four stages. The final results of this evaluation will be used to make decisions about the product being developed.

2.2. Product Description Developed

The product produced from this development research is a learning media in the form of STEM-based pheth learners simulation worksheets on the dynamic fluid material of class XI SMA. With the learning media in the form of LKPD, it is hoped that enthusiastic students will learn physics directly in virtual laboratories by utilizing technology, so that students can more easily understand physics material and its relationship with daily life.

The STEM-based LKPD PhET Simulation component in high school dynamic XI fluid material consists of:

1. Cover
LKPD skin consists of a front cover that explains the title, author's name, material drawings, supervisors and column names for students and LKPD back cover contains the origin of the agency.
2. Page II
This section explains the instructions for use, understanding the model used (STEM) and the application of the PhET simulation.
3. Page III
This section contains a concept map of the material that is the subject of LKPD and a brief theory of the subject.
4. ill in LKPD
The contents of the developed LKPD consist of five stages which are divided into seven steps. The steps are arranged based on a learning model that has been integrated with a scientific approach, namely STEM (Science, Technology, Engineering and Mathematics). In this developed LKPD there are STEM characteristics such as Science as a process, Technology as an application, Engineering as an engineering science, and Mathematics as a tool. The preparation of LKPD steps refers to the syntax of STEM, namely: observe, new idea, innovation, creativity, and society (value). The syntax is divided into three stages, namely:
 - Preliminary
At this stage contains basic competencies, illustration of the application of material and a brief theory related to the material. In the next section the students determine the hypotheses related to the illustrations and material discussed then write down the variables after watching the video illustration of the PhET practicum.
 - Practice
At this stage students do practicum according to information obtained from the steps of the work, then write down the results of the data obtained in the observation table. After writing down the data, students analyze by answering the questions and summarizing the results of the practicum.
 - Pacsa Practicum
Students are presented pictures and illustrations of the application of the material. Students are asked to connect concepts with the problems found and provide examples of other applications in everyday life.
This student worksheet will be printed using A4 size paper with a portrait display and intended for high school class XI students.

The following is the syntax of STEM (science, technology, engineering and mathematics) that guides the preparation to woorksheet :



Figure 2.1 Worksheet

3. Results And Discussion

The results of this development are in the form of STEM-based phet simulation learners to improve the creative thinking skills of high school class XI students on the subject of dynamic fluid. The developed LKPD aims to improve students' creative thinking skills. After the product is finished being developed, the product is then validated by a material, media and learning expert who is a physics lecturer at the Faculty of Mathematics and Natural Sciences UNJ by using a validation test instrument which is interpreted using a Likert scale. The results of the material feasibility test consist of 2 aspects, namely the appropriateness of the contents / content of the material and the feasibility of the language obtained by an average percentage of all aspects showing that the learning media developed by LKPD included in the interpretation is very feasible. The results are obtained from conformity with basic competencies and learning objectives as well as learning material relating to applications in daily life especially those related to science, technology, engineering and mathematics.

Learning feasibility test results consist of 3 aspects, namely the steps of the learning model (STEM), LKPD assessment and the feasibility of the language used to obtain a category that is very feasible to be developed as a learning medium. This is obtained from the suitability of the contents with the STEM syntax, the presentation contains illustrations of the application of STEM and content according to dynamic fluid material. The third test is the feasibility test of the media which consists of 2 aspects, namely graphics and linguistics which obtain a very appropriate category as a learning medium. This is obtained through improvements related to the suitability of softer color compositions so that students are directed to the writing / contents of LKPD, a composition of images and writing that are coherent so that students can understand the contents of LKPD and are given concrete explanations related to the application of dynamic fluid material.

Based on the results of the validation by the material, media and learning experts, the worksheet products of these students are fit to be used as learning media. The following are the average values of the results of the validation test by material, media and learning experts:

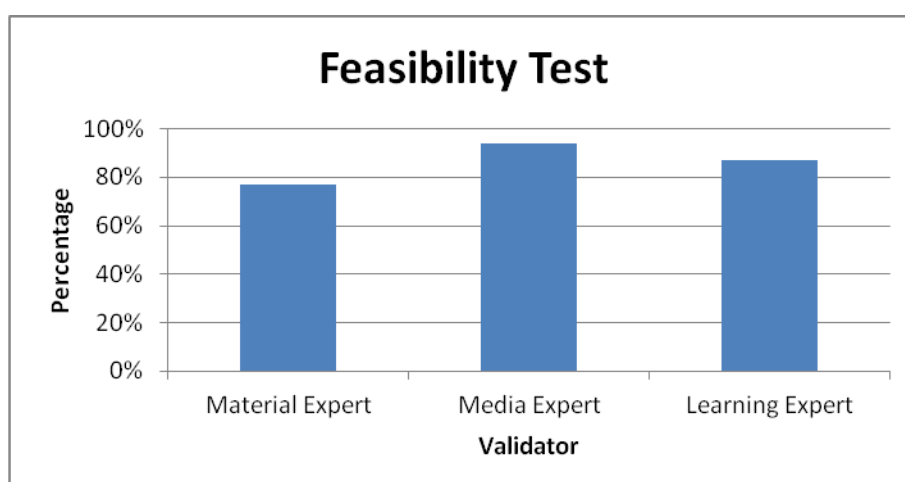


Figure 3.1 Graph of Feasibility Test

Next is the trial of product use in class XI MIA 3 SMAN 77 Jakarta. The trial results of using the product obtained from the pre-test and post-test scores to see the effectiveness of STEM-Based LKET PhET Simulation to improve students' creative thinking skills is the value of the Gain test. From the results of the pre-test and post-test conducted by 33 students, the Gain test value was obtained with moderate classification.

Tabel 3.1 The Result of Gain Value

No	Bentuk Tes	Nilai Rata-rata	Nilai Gain	Interpretasi
1	<i>Pre- test</i>	36.67	0.4	Sedang
2	<i>Post – test</i>	62.50		

This shows that STEM Based LKPD is feasible and effective in improving students' creative thinking skills on dynamic fluid material. This is in line with the research of Pertiwi et al, (2017) which states that STEM-based LKPD (science, technology, engineering and mathematics) is effective in training students' thinking skills on each indicator. Students are taught to look for data through problem solving activities as well as through detailed and systematic steps so that students are able to answer various questions in a varied manner and all indicators of creative thinking are achieved. In addition, based on the effectiveness test, it is also in line with research conducted by Rissanen (2014) which states that the incubation stage which is a phase of the unconscious mind in the creative process contributes to creative thinking skills, while each individual has different abilities in reaching the stage the. But overall the results obtained state that STEM-based learning is quite good in improving students' creative thinking skills in understanding learning material.

4.Conclusion

Based on the results of the feasibility test by experts, field trials by physics teachers and high school students as well as pre-test and post-test can be concluded that the learning media of STEM-Based PhET Simulation Students Worksheet To Enhance Creative Thinking Skills of XI High School Students the criteria are fit to be used as learning media and effectively improve students' creative thinking skills on dynamic fluid material.

References

- [1] Ministry of National Education (2008). Guidelines for Development of Teaching Materials. Jakarta: Ministry of National Education. Directorate General of Primary and Secondary Education Management. Directorate of High School Development
- [2] Pusfarini, Abdurrahman, and Jalmo, Tri. (2016). The Effectiveness of LKPD Science Oriented Problem Based Learning Models in Growing Creative Thinking Skills. Journal of Progressive Education, Vol. 6 (1), 86-96
- [3] Bacanli, H., Dombayci, M. A., Demir, M., & Tarhan, S. (2011). Quadruple thinking; Creative thinking. Procedia-Social and Behavioral Sciences, 12, 536-544.
- [4] Chua, Y. P. (2010). Building a test to assess creative and critical thinking simultaneously. Procedia Social and Behavioral Science 2. 551-559.
- [5] Alghafri, A. S. R., & Ismail, H. N. B. (2014). The Effects of Integrating Creative and Critical Thinking on Students Thinking Schools. International Journal of Social Science and Humanity, 4 (6), 518.
- [6] Borg and Gall. (1983). Educational Research, An Intriductionun. New York and London: Longman Inc., 772

- [7] Beers, S. (2011). 21st Century Skills: Preparing Students For Their Future. Accessed from http://www.yinghuaacademy.org/wp-content/uploads/2019/07/11st_century_skills.pdf
- [8] Subagyo, Y. Wiyanto and Marwoto. (2008). Learning with the Science Process Skill Approach to Enhance Mastery of the Concept of Temperature and Expansion. *Indonesian Journal of Physical Education*. Vol. 5 (1).
- [9] Ministry of National Education. (2004). General Guidelines for Developing High School Teaching Materials. Ministry of National Education, Directorate of General Secondary Education.
- [10] BSNP. (2007). Regulation of the Minister of National Education of the Republic of Indonesia Number 41 of 2007 concerning Process Standards for Primary and Secondary Education Units. Jakarta: Ministry of National Education Education Research and Development Agency.
- [11] Bybee, R. (2013). The case for STEM education: Challenges and Opportunity, NSTA press; Arlington, Virginia.
- [12] Tegeh, I. M., Jampel, I. N., & Pudjawan, K.,. (2014). Development Research Model. Yogyakarta: Graha Science.
- [13] Pertiwi, S., Abdurahman, and Rosidin, UU. 2017. Effectiveness of STEM LKS to Train Students' Creative Thinking Skills. *Journal of Physics Learning*, Vol.5 (2), 11-19.
- [14] Rissanen, A. (2014). Active and Peer Learning in STEM Education Strategy. *Science Education International*, Vol. 25 (1), 1-7.

The Ability of insulation Sound In Partition Room (Case study in Undiksha physics department 's room)

Dewi Oktofa Rachmawati¹, Gede Aris Gunadi², Ni Ketut Rapi³

^{1,2,3}Departement of Physics Education Universitas Pendidikan Ganesha

Email: dewioktofa.r@undiksha.ac.id

Abstract. Noise is unexpected noise and can disturb the comfort of the listener. Noise can come from the compartment room partition. In the Department of Physics FMIPA, there are several compartment rooms with various partitions. The partition used has not been able to insulate sound optimally. Disorders of loss of cosmetics are often felt and have an impact on lecturer performance. The combination of materials in a partition determines the ability of the partition to sound insulation. This study analyzed the sound insulation level of compartment room partitions in the lecturer room, the laboratory coordinator room and the room study program coordinator room for the Physics Department. Data were analyzed by SRI and STC techniques. The lecturer room partition is a combination of double plywood doors, double-sided plaster brick walls, glass walls, and wood vents. Laboratory coordinator room partitions are a combination of double-sided plaster brick walls, glass walls, and wooden vents. And the partition of the study program coordinator room is composed of double plywood. The total area of partitions in each room is 7.68 m², 10.50 m² and 12.00 m². Noise levels that can be muted by the partition in the lecturer room, laboratory coordinator room and study program coordinator room are shown by SRI values of 20.83 dB, 20.27 dB, and 26.90 dB, respectively. The effectiveness of sound insulation in the lecturer room partition is shown by the STC value of 25.75 dB. The STC in the laboratory coordinator room is 26.07 db, and the laboratory coordinator room is 27.29 dB

1. Introduction

Noise is unwanted sound and its presence can disturb comfort and endanger human health. The impact of noise in the form of disorders kosentarsi, emotional, hearing, other psychological disorders, and decreased work productivity. Noise is heard after sound through the transmission media. Therefore noise control is needed in the room so that according to the fulfillment of the function of space based on the Decree of the Minister of Environment No. 48 of 1996 concerning Noise Level Standards.

Compartment space is a contiguous space separated by a partition (partition). This space is often found in buildings such as hospitals, schools, offices and settlements. The compartment room is inseparable from noise. Noise control in the compartment room must be the center of attention. Noise control in the compartment room can be done by selecting or using an appropriate partition or barrier. Usually, the use of artificial barriers such as coatings with sound absorbent materials can be an option when noise reduction does not provide maximum reduction. This use is considered to be more effective at reducing sound compared to adjusting the distance between the receiver and the noise source, the influence of wind, and air absorption.

The lecturer room, laboratory coordinator room and study program coordinator room in the Faculty of Mathematics and Natural Sciences-Undiksha have compartment room designs. Partitions that separate space have different characteristics. Composed of materials with different absorption coefficients. The combination of compartment space compartment material has not yet considered the concept of noise control. The ability to reduce sound partitioning is not in accordance with the allotment of space, causing noise in the next room. The combination of these constituent compartments is interesting to study in its ability to reduce noise and its ability as a sound insulator. Sound waves that hit the partition, some of the energy will be reflected from the surface, some absorbed and other parts are transmitted. If the surface of the partition is more massive, the higher the sound energy portion is reflected. Consequently the sound energy that is absorbed and transmitted

becomes smaller. Sound absorption occurs when sound energy is lost when it hits the surface of an area of space.

Sound transmission can be generated from sound transmission through structure-borne and airborne (Mediastiaka, Christine E., 2005). Airborne sound propagation is sound propagation in the open air. Airborne sound propagation generated in a room by a sound source can be transformed into the sound of a borne structure when sound waves hit the boundary wall of a room. A measure of how much sound energy is reduced due to the transmission process is called transmission loss. This magnitude represents the performance of the material in transmitting sound. The greater the loss of sound transmission the greater the ability of the partition or object to reduce sound. Sound transmission (TL) loss can be calculated using the equation:

$$TL(f) = L_1(f) - L_2(f) + 10\log S - 10\log A_2$$

$L_1(f)$ = sound pressure level in the source chamber (dB)
 $L_2(f)$ = sound pressure level in the receiver chamber (dB)
 S = Area of room (m^2).
 A_2 = total of absorption of Room (m^2)

His value depends only on the construction of the partition, it changes with the sound frequency and does not depend on the acoustic properties of the two spaces separated by the partition. Partition construction with a porous soft surface structure very much absorbs sound vibrations. This partition construction is able to block the sound energy or vibration when propagating and does not produce resonance. Conversely, the construction of partitions with hard surface structure is reflected sound energy.

Sound waves that pass through the partition weaken the vibration of sound energy. This vibration produces sound pressure lower than the sound pressure before propagation. Reducing the sound pressure level (L_1) in the room where the sound source is with the sound pressure level in the receiving room (L_2) is called Noise Reduction. (NR) or sound reduction (Reynold, Douglas D., 1981). Sound reduction is a quantity which indicates the insulation power of the material. Mathematically given with the equation: $NR = L_1(f) - L_2(f)$ in units of dB or

$$NR = TL - 10 \log \left(\frac{1}{4} + \frac{S_w}{R_2} \right)$$

with S_w = Area of Partition, (m^2)
 R_2 = Constata of room (m^2)

The surface characteristics of the material making up the space are illustrated by the reverberation time value (RT). Sound absorption by the surface of the material is getting bigger, the RT value is getting shorter. The size of the RT value depends on the volume of space and the coefficient of absorption of surface material. Space with a small volume, RT value does not depend on frequency. The everberation time can affect the atmosphere created in a space. RT values that are too short cause space to feel dead, while long RTs give a more lively atmosphere to the space (Satwiko, 2009: 91). The RT calculation formula under normal conditions is as follows:

$$RT = 0.161V / A$$

where RT = Reverberation Time (seconds)
 V = space volume (m^3)
 A = total absorption surface area (m^2)
 $= \sum s.a = \sum \text{surface area} \times \text{absorption coefficient}$

The absorption coefficient describes the ability of the material to absorb sound. Material that is able to eliminate or minimize sound transmission is a good sound insulation material. The criteria used to measure the ability of a partition as a sound insulator is the Sound Reduction Index (SRI). SRI value indicates the level of noise that can be muted by the object. The SRI of an object can be determined

by the equation:

$$SRI = -10 \log \tau \text{ (dB)}$$

where τ = transmission coefficient

The average transmission coefficient value can be determined by the equation:

$$\tau = \sum_{i=1}^n \frac{\tau_i S_i}{S_i}$$

with:

τ = average transmission coefficient

S = area of partition between spaces, m²

Sound Transmission Class, STC or sound transmission class is a term that was introduced by the American Society for Testing Materials (ASTM) to provide a certain rating number that states the ability of building materials or building structures, walls, doors, windows etc. insulate sound. The sound transmission class of the partition can be determined by comparing the TL curve at 16 frequencies with the standard reference contour.

Table 1. **Value of** referensi *transmission loss*
pada *air-borne sound*

Frekuensi (Hz)	Nilai Referensi (dB)
100	33
125	36
160	39
200	42
250	45
315	48
400	51
500	52
630	53
800	54
1000	55
1250	56
1600	56
2000	56
2500	56
3150	56

(Smith,B.J, R.J.Peter, Stephanie Owen,1996)

The STC value of a partition is determined by comparing the TL (f) curve with the STC contour. The STC contour is shifted vertically relative to the TL (f) curve until some TL (f) value is below the TL STC contour satisfies the following conditions. 1. deviations under the contour do not exceed 32 dB (an average of 2 dB for each 1 frequency. 2. maximum deviations at each single trial frequency do not exceed 8 dB. The determination of the STC value is the TL (f) value at the intersection with the contour with coordinates 500 Hz.

Based on the Decree of the Minister of Environment of 1996 No. 48 concerning the noise level standard, the noise level in the office area is 65 dB and 55 dB education with a tolerance of 3 dB. The research of Indrajadja Makainas, et al (2011) shows that the boundary wall of the ½ pair of plastered bricks on both sides is sufficient to withstand the transmission of sound with a standard character construction of STC values of 42 dB to 45 dB. The effectiveness of objects or partitions in

compartment space in sound isolation refers to the STC value. This value measures the ability of a partition as a sound insulator. This study focuses on the analysis of Sound Transmission Loss (TL) compartment space partitions and the effectiveness of compartment space reducing sound. The compartment room partition studied is a composite wall that has a glass window, ventilation door.

2. Methods

The subject of this research is the compartment room partition in the lecturer room, study program coordinator room and laboratory coordinator room of the Physics Education Study Program. The room was chosen because it has different partitioning characteristics from one another. The partition in the lecturer room is a combination of 16 cm thick double-sided plastered brick walls, 3 cm double plywood doors, 2 ml glass, and wooden vents. The lecturer room is adjacent to the laboratory room. Partition in the study program coordinator room combination of double plywood walls 8 cm. The study program coordinator room is adjacent to the study room coordinator room. Room coordinator room laoratorium combination of two-sided plastered brick walls 16 cm thick, 2 ml glass, and plastic-enclosed wooden vents. The laoratorium coordinator room is adjacent to the laboratory room.

This research method is an experiment that is the measurement of the sound pressure level in the source room and receiver room simultaneously. Measurements were made at one point, namely at a distance of 1.2 m from the partition. Considering the size of the room is very small. The sound source uses the digital function generator-amplifier PI 9586. Measurements are carried out for 1 minute. (60 seconds) at the sound frequencies of 250Hz, 500Hz, 800Hz and 1000Hz. Data were analyzed with SRI and STC. The SRI value is based on the absorption coefficient of each material as a component making up the partition. The STC value is based on the intersection of the TL value with the STC contour.

3. Result

Material characteristics of the arrangement of the partition and lecturer room are double-sided plaster brick walls, with an area of 3.18 m², 1.53 m² wide plastic covered wood vents, double plywood doors with an area of 1.8 m², 3 ml thick glass of 1.53 m² in area. Partition compilation material in the lab coordinator room. is a double-sided plaster brick wall with an area of 5.61 m², plastic vents covered in wood with an area of 1.65 m², 3 ml thick glass with an area of 3.30 m². The study program coordinator room partition is only composed of double plywood with an area of 12 m². The partition area in the lecturer room, laboratory coordinator room, and study room room are respectively 7.68 m², 10.5 m² and 12.0 m².

Table 2. Property room

Partisi	Komponen Penyusun	Ukuran (lbr x tinggi x tebal)	Volume Ruang
Lectures's Room	2-sided plaster brick wall	240 cm x 70 cm x 14.5 cm	$V_{\text{receiver}} = 2.5 \text{ m} \times 3.5 \text{ m} \times 3.0 \text{ m}$ $= 26.25 \text{ m}^3$
	Wood vents covered in plastic	240 cm x 50 cm	
	Glass	150 cm x 102 cm x 3 ml	
	Double plywood door	90 cm x 200 cm x 3 cm	
	2-sided plaster brick wall	150 cm x 100 cm x 16 cm	
Head of Laboratorium 's Room	2-sided plaster brick wall	330 cm x 70 cm x 16 cm	$V_{\text{receiver}} = 3.5 \text{ m} \times 4.0 \text{ m} \times 3.0 \text{ m}$ $= 42.0 \text{ m}^3$
	Wood vents covered in plastic	330 cm x 50 cm	
	Glass	330 cm x 100 cm x 3 ml	
	2-sided plaster brick wall	330 cm x 120 cm x 16 cm	
Head of Physics Departement	2-sided plywood wall	4 m x 3 m x 8.5 cm	$V_{\text{receiver}} = 4 \text{ m} \times 3 \text{ m} \times 3 \text{ m}$ $= 36.0 \text{ m}^3$

Measurement of sound pressure level in the receiving room is 1.2 m from the partition. The sound source is placed at a distance of 1.2 m from the partition. While the measurement of sound pressure level in the laboratory coordinator room is 2.1 m from the partition. Sound wave signals in the source room and reception room in the lecturer room, laboratory coordinator, and study program coordinator at a frequency of 500 Hz are respectively presented in Figure 1.

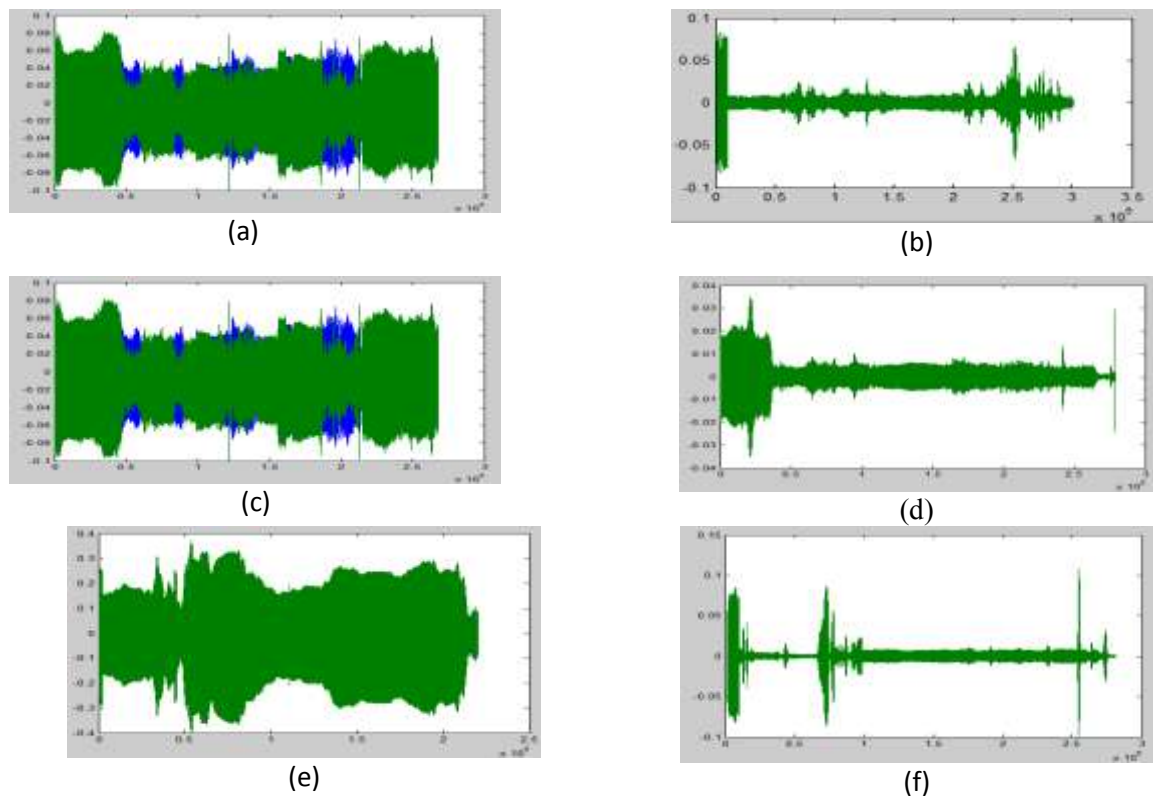


Fig 1 sound wave characteristics ; (a) Sound wave Source Chamber in lecturer's room ; (b) Sound wave in receiver Chamber in lecturer's room , (c) Sound wave Source Chamber in Head of Laboratory's room ; (d) Sound wave in receiver Chamber in Head of Laboratory 's room , (e) Sound wave Source Chamber in Head of Departement 's room ; (f) Sound wave in receiver Chamber in Head of Departement 's room

The number of waves in the receiving chamber in the 3rd chamber for 1 minute in order 106. The amplitude of the waves after going through the partition has decreased which varies per receiver chamber. indicates sound wave absorption after going through a partition. Partition area data, NR, at a frequency of 250 Hz-1000 Hz and SRI values, and STC are presented in Table 3.

Table 23 Value of SRI and STC .

Frekuensi (Hz)	Luas Partisi (m ²)	NR (dB)	SRI (dB)	STC (dB)
250	7.68	21.4	20.83	25.75
500		24.1		
800		23.9		
1000		25.7		
250	10.5	23.8	20.27	26.07
500		25.1		
800		24.2		
1000		24.7		
250	12.0	23.5	26.90	27.29
500		24.1		

800	25.2
1000	25.3

Based on table 3, the partition value in the study program coordinator room has the highest SRI value. The total area of absorption of lecturer rooms which has a volume of 26.25 m^3 in the laboratory coordinator room with a volume of 42.0 m^3 is at intervals of 5.60 - 8.40 sabin / m^2 . And the total area of absorption in lecture rooms with a volume of 127.5 m^3 is at intervals of 18.54 - 25.50 sabin / m^2 at a frequency of 250 Hz - 1000 Hz. Based on the SRI method, the objects making up the partition with an area of 7.68 m^2 have an SRI value of 20.68 dB meaning that the partition is able to reduce the sound by 20.68 dB. Partitions that are able to reduce the greatest sound, 36.47 dB is a partition with two-sided plaster brick wall components, 15 cm thick and 21.9 m^2 wide, double plywood double doors 3.5 cm thick and 2.4 m^2 wide. Based on the measured value of the loss of sound transmission, partition performance with an area of 7.68 m^2 in transmit sound has a different interval TL value than the SRI value. The same results for other partitions are shown in table 2.

The reduced sound energy due to the transmission process through each partition increases with increasing frequency. Value of loss of sound transmission in the compartment room partition in the lecturer room, lecture hall, korlab room. and corproductive space increases with increasing frequency. Partition in the lecture room has the ability to reduce sound or loss of sound transmission is high. The relationship between TL and frequency can be stated in the form of Fig1
The ability of each partition to reduce sound increases with increasing frequency.

4. Discussion

Water-borne sound transmission in compartment space partitions is determined by the surface of the boundary plane (partition). The results obtained by the lecturer room partition adjacent to the laboratory room consisting of doors, glass windows and ventilation and double-sided plaster brick walls with a total area of 7.68 m^2 as a whole gave a SRI calculation value of 20.83 dB. This value indicates the composite diding partition is able to isolate noise by 20.83 dB. This value is smaller than the measurement TL value at a frequency of 500 Hz. Measurement of sound transmission loss in the receiver chamber does not take into account the presence of cavities that prevent sound resonance. The STC value of this partition is 25.75 dB. This value <30 dB, this means the partition will not function to hold the sound produced by the sound source of the next room. This has an impact on the comfort of lecturer activities in his office. The lecture room partition adjacent to the departmental computer room consisting of double-sided plaster brick walls and double plywood doors with a partition area of 22.5 m^2 has an SRI value of 36.47. This value is greater than the value of the loss of measured sound transmission. Noise background from the door gap, as well as the source room ceiling causes flanking to enter the reception room. The STC value on this partition is 31.70 dB Noise below 31.70 dB cannot be heard by the recipient in the next room because it is inhibited by the ability of this partition. This means that the partition wall is effective in reducing noise below 31.70 dB. This STC value <40 dB indicates that the partition cannot hold the sound that the receiver is trying to hear in the next room. The SRI value is calculated for the laboratory coordinator room partitions adjacent to the laboratory room and the study room coordinator room partitions adjacent to the other study program coordinator rooms, respectively 20.7 dB and 26.9 dB. This value is smaller than the loss value of the measurement sound transmission at a frequency of 500 Hz. These two partitions are only able to reduce noise up to 26.07 dB and 27.29 dB. These two partitions are not effective at holding sounds with a strength of > 30 dB. Conversations from the next room can be heard. This has an impact on the disruption of work concentration for recipients in the laboratory coordinator and study program coordinators.

5. Conclusion

Based on the description of the results of the study it can be concluded:

1. (a) composite partition wall consisting of doors, glass and ventilation windows and double-sided plaster brick walls with a partition area of 7.68 m² capable of inhibiting the sound of 25.75 dB with an insulation level of 20.83 dB.
 - (b) partition with double-sided plaster brick walls and double plywood doors, partition area of 22.5 m² is able to reduce the sound of 31.70 dB with an SRI value of 36.47 dB.
 - (c) composite partition walls consisting of glass windows and vents and double-sided plaster brick walls with a partition area of 10.5 m² capable of inhibiting noise by 26.07 dB with an insulation level of 20.27 dB.,
 - (d) partitioning with double plywood material capable of reducing sound 27.29 dB with an SRI value 26.9 dB.
2. a) The partition wall with a partition area of 7.68 m² is ineffective as a sound barrier (STC = 25.75 dB),
 - b) a partition wall with an area of 22.5 m² effective as a sound barrier under 31.70 dB
 - c) a partition wall with an area of 10.5 m² is not effective as a barrier sound (STC = 26.07 dB),
 - d) the partition wall with an area of 12.0 m² is not effective as a sound barrier (STC = 26.9 dB)

References

- [1] Benny Adi Nugraha, dkk. 2013. Peningkatan Insulasi Akustik Dinding Luar Kamar Hotel Studi Kasus Di Dalam Bandar Udara. JURNAL TEKNIK POMITS Vol. 2, No. 2, 2013).Online download.portalgaruda.org/article.php?article=89200&val=4186. Diakses tgl. 27 Nopember 2017.
- [2] Cox, T.J. and D'Antonio, P. 2009. Acoustics Absorbers and Diffuses : Teory, Design and Application 2nd Edition. Taylor and Frances. London.
- [3] Indradjaja Makainas, dkk. 2011. Kompartemen Akustik Ruang. Jurnal Sabua Vol.3, No.2: 15-25, Agustus 2011. Online <http://download.portalgaruda.org/article.php?article=16086&val=1034&title=KOMPARTEMEN%20AKUSTIK%20RUANG>. Diakses tgl. 27 Nopember 2017.
- [4] Mashuri. 2007. Penggunaan Akustika Luar-Ruangan Dalam Menanggulangi Kebisingan Pada Bangunan. Jurnal SMARTek, Vol. 5, No. 3, Agustus 2007: 196 – 206. Online <http://download.portalgaruda.org/article.php?article=10673&val=750>. diakses tgl. 27 Nopember 2017
- [5] Mediastika, Christina E. 2005. Akustika Bangunan: Prinsip-prinsip dan Penerapannya di Indonesia. Jakarta: Erlangga.
- [6] Rettinger, Michael. 1973. Acoustic Design and Noise Control. New York. Chemical Publishing Co. Inc.
- [7] Reynolds, Douglas D. 1981. Engineering Principles of Acoustics Noise and Vibration Control. Massachusetts: Allyn and Bascon. Inc.
- [8] Smith, B.J., Peters R.J., Owen, S. 1982. Acoustics and Noise Control. Second Edition. UK: Addison Wesley Longman.

The Effect of Chitosan Immersion to Physical and Breaking Strength of Pineapple Leaves Rope for Fishing Gear

Muth Mainnah^{1*}, Diniah², Budi Hascaryo², Made Mahendra Jaya¹

¹ Lecturer of Marine and Fisheries Polytechnic of Jembrana

² Lecturer of IPB University

*Corresponding author: muthmainnah215@gmail.com

Abstract. We need some natural materials for fishing gear in order to reduce the use of synthetic materials in the manufacture of fishing gear. It needs preservatives to gain its breaking strength like chitosan in this research. There are differences of chitosan usage to fibre physical of pineapple leaves, such as the colour, diameter, touch impression, water content, specific weight and also breaking strength. Pineapple leaves rope has a brown color, the touch impression are coarse and stiff and the presentation of the difference in diameter size before and after soaking chitosan is 0,06%. The average value of pineapple leaves water content with chitosan is greater 56,7% than the water content of pineapple leaves rope without chitosan. Chitosan is able to increase the breaking strength of pineapple leaves rope, as seen from the results of breaking strength of the pineapple leaves rope (172,0734 kgf / cm²) is greater than the breaking strength of pineapple leaves rope without chitosan (153,4089 kgf / cm²).

Keywords: natural fibre, pineapple leaves rope, breaking strength, chitosan, fishing gear material

1. Introduction

Some example of fibre that made from synthetic materials for fishing gear that used by many fishermen such as polyamide, polyethylene and polyvinyl chloride. The synthetic fibre is derived from non-renewable materials, so it is not good for our environment. From this thing, we need some natural material for fishing gear in order to reduce the use of syntetic materials in the manufacture of fishing gear. Therefore it needs to develop technology for natural fibers specifically in fishing gear materials.

One of the best natural fibers that has many advantages in many sectors is pineapple leaves fibre. There are no specific research on pineapple leaves fiber that can be used for fishing gear material. Other materials from natural plant fibers that can be used as fishing gear include *Boehmeria nivea* [1], *Fimbristylis sp.* [2], and the results of recent research, namely *Scirpus grossus* [3].

One of deficiencies of natural fiber is easy to absorb water and susceptible to decay. Because of that, it needs fiber coating material, including chitosan to inhibit the growth of bacteria that cause spoilage. Chitosan was chosen because of its ability to suppress bacterial growth, chitosan has positively charged polycation which is able to inhibit the growth of bacteria and mold [4]. Chitosan is easily degraded biologically, non-toxic, insoluble in water and soluble only by dilute inorganic acids [5]. Chitosan comes from fisheries waste that is easily to get [6], such as from shrimp shell waste [7]; [8]; [9], crab shell waste [10]; [11]; [12]; [13], as well as shellfish waste [14].

Based on environmental problems caused by synthetic materials from fishermen's fishing tools, especially in the rigging section, this study aims to resolve that problem. The solution of this problem is to use rigging material from natural materials of pineapple leaves

fibers that physically contain such as moisture content, specific gravity, color, touch impression, diameter size that will be related to the strength of fiber breaking will be examined in this study. In addition, this study will also provide information about the effect of the use of chitosan preservatives on the physical properties and breaking strength of pineapple leaves rope.

2. Method

Research Procedures

The research duration is two months among January – February 2016. Sample of this research is pineapple plant from Subang Regency, West Java. This research used laboratory experiment method to get the breaking strength data of twisted pineapple leaf fibers. Materials used were pineapple leaves fibre (*Ananas comosus*), aquadest liquid, sea water and liquid combination of chitosan acetate 1 % concentration as a preservatives. Tools research used plastic container, plastic wrap, beaker glass, digital microscope, camera, ruler, cutter, digital scale, electric oven, desiccator, *Universal Testing Machine* (UTM) to measuring breaking strength fibers.

The research was done in Wood Building Engineering and Design Laboratory, Forest Product Engineering Department, Forestry Faculty, IPB University. This research aims to testing breaking strength fibers. The procedure among others:

Preparation.

Preparing plastic wrap that had been sterilized used aquades liquid; and

1. Immersion of the pineapple leaves fibre test sample into chitosan liquid.

Chitosan liquid 1% concentration poured out into plastic container. The immersion of pineapple leaves fibre into chitosan for 45 minutes (Figure 1.a). Experimental design listed in the Table 1.

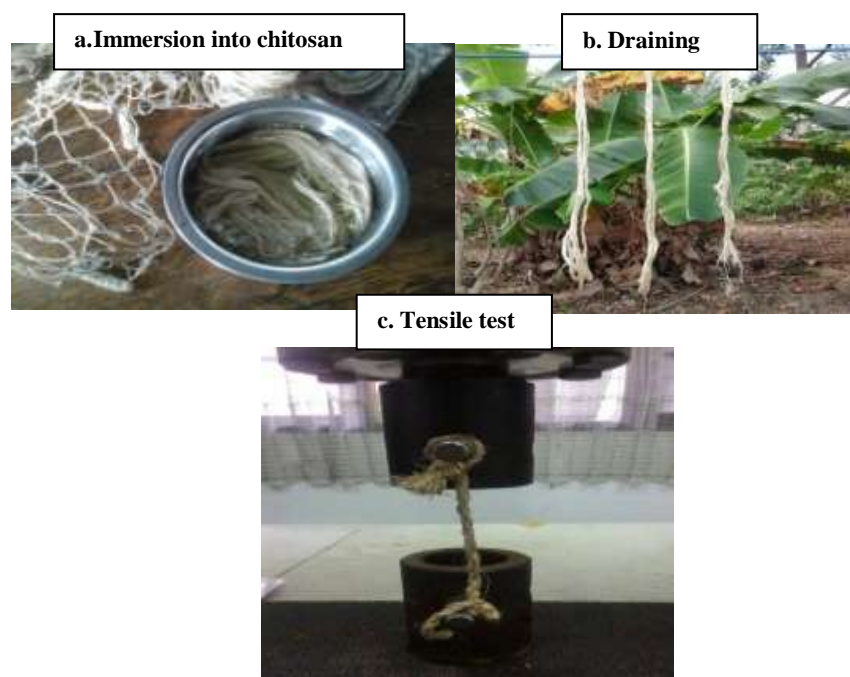


Figure 1. Immersion of the pineapple leaves fiber test sample into chitosan liquid and tensile test

Table 1. Experimental design of pineapple leaves rope immersion into chitosan liquid

Repetition	σ (kgf/cm ²) (<i>i</i>)	
	Without chitosan	Chitosan
1	X.1	X.1
2	X.2	X.2
3	X.3	X.3
...
10	X.10	X.10

where:

$$i = 1, 2, 3, \dots, 10 = \text{kgf/cm}^2$$

1. Draining

Fibers draining is done by hanging it on the clothesline under sunshine for around two hours (Figure 1.b);

2. The twisting of pineapple leaves fibre with chitosan

Twisting pineapple leaves fibre for 60 strands of fibre in 1 twisted. Twisted yarn of pineapple leaves fibre prepared trough the length of 70 – 80 cm, diameter 0,04 - 0,05 cm. After twisted, the diameter becomes 0,50–0,55 cm and length per each ropes 25 cm. Pineapple leaves fibre twisted manually where S twisting direction.

3. Water content and specific weight determination (Figure 2)

Sample test water content counted by formula [15]:

$$WC = \frac{FW - ODW}{ODW} \times 100\%$$

where:

WC = water content (%);

FW = first weight (g); and

ODW = oven dry weight of material (g).

Specific weight of test sample is counted by formula [15]:

$$Sw = \frac{ODW/V}{\rho_w}$$

where:

Sw = specific weight;

ODW = oven-dry weight of material (g);

V = volume of material (cm³); and

ρ_w = density of water (1 g/cm³).

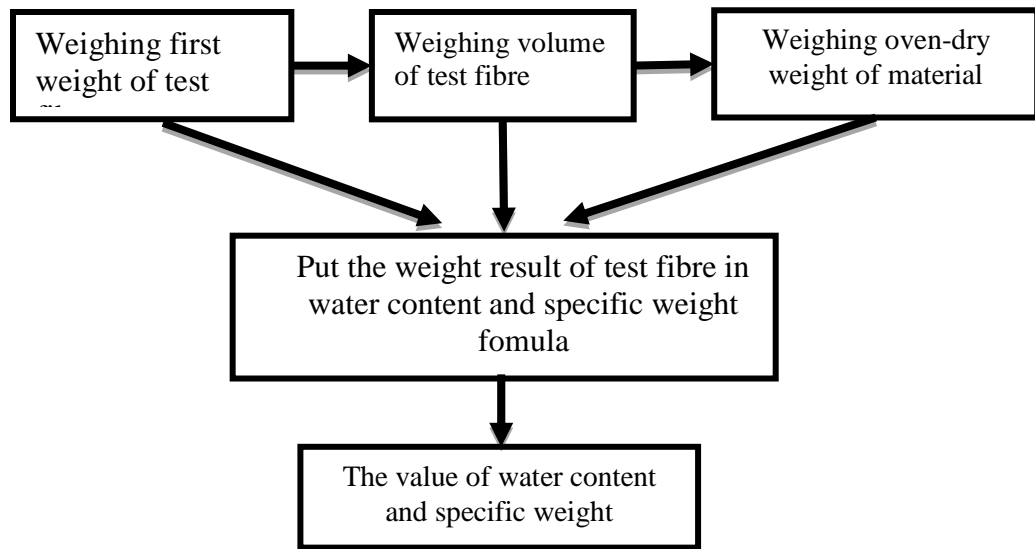


Figure 2. Process of water content and specific weight of test fibre

3. Breaking strength process (Figure 1.d).

- a. To preparing breaking strength tester and its monitor;
- b. Tie up the both ends of the test sample in each top and bottom grib. The space between *grib* was settet 25 cm, according to breaking strength fibre test standard in Indonesian National Standard (SNI);
- c. To connencting the bottom grib in tester machine to voltage sensor by joint; and
- d. To recording the data of sample test breaking strength. Test was done by 10 times of repetition.

4. To counting the breaking strength of pineapple leaves rope based on the data obtained by using this formula [16] :

$$\sigma = \frac{P}{A}$$

where:

σ = breaking strength (kgf/cm²);

P = strain (kgf); and

A = area (cm²).

2. Results And Discussion

The length of pineapple leaves fiber before and after chitosan additional is stable, while the average diameter value is difference 0,05 μm be measured by using digital microscope. It is bigger than pineapple leaves fiber without one. Physical of its look visually is the color and fineness of fibers. The fibers that is dipped into chitosan has more coarse texture of fiber but not stiff, while its color turns brown (Table 5).

Table 2. Physical of test pineapple leaves rope

Parameter	Without chitosan	Chitosan
Colour	bright brown	dark brown
Touch impression	stiff and coarse	coarse and not stiff
Diameter (μm)	80-90	80,05 – 90

Water Content of Pineapple Leaves Rope

Water content of pineapple leaves rope around 6,0606 – 36,0000% and its average 14,9149 % and pineapple leaves rope without chitosan 4,5455 - 13,7931 % and its average 9,5154 %. The difference of average value of water content for pineapple leaves rope with and without chitosan is 0,0461 %. Generally, the water content value of pineapple leaves rope with chitosan is higher than it without one. Distribution of it for water content value among pineapple leaves rope with and without chitosan can be seen in Table 3.

Table 3. Water content of pineapple leaves rope with and without chitosan

Repitition	Water content (%)	
	Without chitosan	Chitosan
1	11,4286	36,0000
2	4,5455	19,2308
3	11,1111	6,0606
4	4,7619	20,8333
5	9,5238	13,3333
6	9,5238	10,3448
7	6,4516	8,1081
8	11,1111	8,5714
9	12,9032	16,6667
10	13,7931	10,0000
Average	9,5154	14,9149

The water content is affected to stickiness of preservative that is used in material. According to [17], the effect of it depends on inherent ability among it and preserved fibers. The inherent ability to fiber depends on water content of it. Chemical reaction such as oxidation is affected by water content number in a material. Based on morphological analysis research by [18] used surface morphological analysis by Scanning Electrone Microscope (SEM) method, can be seen the content, composition and compactness of pineapple leaf structure as listed in Table 3.

Water content of pineapple leaves fiber is very high till 81,6 %. The extraction result of it is 5% [19]. Its number is less than water content number of this research, it is 9,5154 %. It can be caused by difference of pineapple plant type, its planting location and method to extracting the pineapple leaves become fiber, sun intensity, rainfall and also difference of

environmental humidity in India and Indonesia where its difference will affect to pineapple plant condition, include its water content.

Beside that, they used extraction method cause water content in fibre become very dry, so it is less than test fiber water content in this research that do not use extraction one [19]. Chitosan additional to pineapple leaves rope actually can increase water content of it. It is guessed the reason why it happened is affected by immersion duration of pineapple leaves rope into chitosan and also the concentration usage in this research. To knowing it for sure, needs an experiment connecting research.

Specific Weight of Pineapple Leaves Rope

Specific weight of pineapple leaves rope with chitosan around $0,8182 - 0,9211 \text{ g/cm}^3$ where its average $0,8822 \text{ g/cm}^3$ and for pineapple leaves rope without chitosan $0,8750 - 1,0000 \text{ g/cm}^3$ where its average $0,9178 \text{ g/cm}^3$. The difference of specific weight average value among it with and without chitosan is $0,0356 \text{ g/cm}^3$. Specific weight value of it with chitosan is lower than without one. It shows that chitosan additional to pineapple leaves rope is not very influential to specific weight value. Distribution of it can be seen in Table 4.

Table 4. Specific weight of pineapple leaves rope with and without chitosan

Repitition	Specific weight (g/cm^3)	
	Without chitosan	Chitosan
1	0,8750	0,8929
2	0,9167	0,8667
3	0,9000	0,9167
4	0,9545	0,8276
5	0,9545	0,8824
6	0,8750	0,9063
7	0,9118	0,8810
8	1,0000	0,9211
9	0,9118	0,8182
10	0,8788	0,9091
Average	0,9178	0,8822

Morphology of pineapple leaves fibre becomes important to know because has relation to specific weight of fibre. It is determined between as by cell wall thickness and how small cell cavities is that pores-formed [20]. Average of cell wall thickness of pineapple leaves fibre is $8,3 \mu\text{m}$, placed between sisal fibre ($12,8 \mu\text{m}$) and banana trunk fibre ($1,2 \mu\text{m}$) [21].

Breaking Strength

The average breaking strength value of a stringed test rope ($172,0734 \text{ kgf / cm}^2$) is greater than the test rope without chitosan ($153,4089 \text{ kgf / cm}^2$). The results show that chitosan can increase the breaking strength value of pineapple leaves in Table 5.

One of the factors that influence the breaking strength value of a material is its stiffness [17]. Chitosan not only able to increase the breaking strength of pineapple leaves ropes, but also can reduce the stiffness of the test ropes. Based on the value of breaking

strength, pineapple leaves rope without chitosan is able to withstand a load of 153,4089 kgf per area of 1 cm², while a pineapple leaves rope with chitosan is able to withstand an even greater load of 172,0734 kgf per 1 cm² area. This shows that the pineapple leaves rope is classified as strong. Chitosan used as a preservative a polysaccharide that can be absorbed and isolated in pineapple leaves fibers. This is supported by the results of research through the Scanning Electron Microscope (SEM) image which states that the pineapple leaves fiber structure is multicellular with a hollow surface and has a dense tissue structure, capable of absorbing and isolating the liquid very well (Figure 8) [23]. This makes the pineapple leaves fiber stiffness decrease and the breaking strength increases, where it has a positive impact. The positive charge of chitosan is known to be able to interact with the bacterial cell surface which is negatively charged, so it can interfere with the growth of bacteria that cause damage [24].

Table 5. Pineapple leaves breaking strength value with chitosan and without chitosan

Repitition	σ (g/cm ³)	
	Without chitosan	Chitosan
1	170,4968	161,2804
2	159,2357	115,3312
3	146,2446	165,2659
4	140,4944	164,3033
5	152,8753	104,1693
6	189,4013	277,9618
7	119,3074	148,2588
8	100,1783	228,3033
9	200,5993	171,8105
10	189,1606	140,1449
Average	153,4089	172,0734

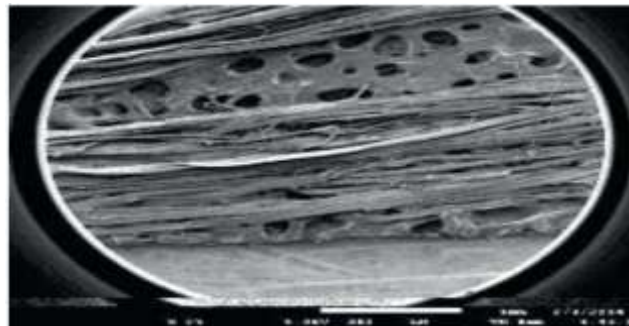


Figure 8. Pineapple leaves fiber structure through SEM image [22]

The mechanism of anti-microbial substances in general is to break the main structures of microbial cells such as cell walls, cytoplasm, ribosomes and cytoplasmic membranes. The presence of chitosan preservative anti-microbial substances, will cause denaturation of proteins. This situation will cause enzyme interactions, so that the metabolic system is disrupted or become broke and ultimately there is no activity from microbial cell [25].

3. Conclusion

The conclusion of this research are:

1. Pineapple leaves rope has a brown color, the touch impression are coarse and stiff and the presentation of the difference in diameter size before and after chitosan immersion is 0,06%. The average value of pineapple leaves water content with chitosan is greater 56,7% than the water content of pineapple leaves rope without chitosan;
2. Chitosan is able to increase the breaking strength of pineapple leaves rope, as seen from the results of breaking strength of the pineapple leaves rope (172,0734 kgf / cm²) is greater than the breaking strength of pineapple leaves rope without chitosan (153,4089 kgf / cm²);
3. Pineapple leaves rope is potential to use for fishing gear based on its physical form and breaking strength number. How strong it is when used on fishing gear will be known by an experiment connecting research in the field.

5. Acknowledgment

Our special thanks to IPB University, especially to the Head of Wood Building Engineering and Design Laboratory, Forest Product Engineering Department, Forestry Faculty, for all facilities that had given to us so this research can be finished and collect all data we need.

6. References

- [1]. Lenkosmanerri. 1998. Break Resistance and thread stretching of poly amide (pa), soaked cotton and hemp in extra cassava bark (adinandar acuminate korth). Faculty of Fisheries and marine science Riau University Pekanbaru. 50p (not published)
- [2]. Nofrizal, Ahmad M, Syofyan I, Habibie I. 2011. Puzzle Grass (*Fimbristylis* sp), linggi (*Penicum* sp) and cyanic (*Carex* sp) as a natural fiber for fishing gaer. Riau (ID):Riau University. *Jurnal Natur Indonesia*. 14(1):100-106.
- [3]. Zuldry A, Syofyan I, Nofrizal. 2015. Study on bundung grass (*Scirpus Grossus* L.) as the natural fibre for fishing gear material with the sinking speed and absorption test. Riau (ID): University of Riau. *Jurnal Natur Indonesia*. 14(1):120-126.
- [4]. Wardaniati RA, Setyaningsih S. 2009. Chitosan making from shrimp shell and its application for meatball preservation. Semarang (ID): Diponegoro University.
- [5]. Kurita, K. 2001. Controlled functionalization of the polysaccharide chitin. *Journal of Polimer Science*. 26, 1921–71.
- [6]. Younes I, Rinaudo M. 2015. Chitin and Chitosan Preparation from Marine Sources. Structure, Properties and Applications. *Journal of Marine Drugs*. 13(10):1133-1174.
- [7]. Hargono, Abdullah, Sumantri I. 2008. Making Chitosan from Shrimp Shell Waste and Its Application for Reducing Goat Fat Cholesterol. *Jurnal Reaktor*. 12(1): 53-57.
- [8]. Purwanti A. 2014. Evaluation of Shrimp Skin Waste Treatment Process To Improve Quality of Chitosan Produced. *Jurnal Teknologi*. 7(1):83-90.
- [9]. Hossain MS, Iqbal A. 2014. Production and Characterization of Chitosan from Shrimp Waste. *Journal Bangladesh Agricultural University*. 12(1):153–160.

- [10]. Trisnawati E, Andesti D, Saleh A. 2013. Making chitosan from crab shell waste as duku fruit preservatives with variation of preservation time. *Jurnal Teknik Kimia*. 2(19): 17-26.
- [11]. Lesbani A, Yusuf S, Meiviana RAM. 2011. Characteristics of chitin and chitosan from mangrove crab shells (*Scylla serrata*). *Jurnal Penelitian Sains*. 14(3):32-36.
- [12]. Sakthivel D, Vijaykumar N, Anandan V. 2015. Extraction of Chitin and Chitosan from Mangrove Crab *Sesarma indicum* from Thengaithittu Estuary Pondicherry Southeast Coast of India. *Human Journals*. 4(1):12-24.
- [13]. Arbia W, Adour L, Arbia L, Amrane A. 2013. Chitin Extraction from Crustacean Shells Using Biological Methods – A Review. *Journal of Biotechnology*. 51(1):12–25.
- [14]. Wahyuni S, Asnani, Nur I. 2008. Analysis of deprotenation and demineralization waste analysis on the making of chitosan from local abalone shellfish (*Haliotis asinaria*) Lokal. *Jurnal Warta-Wiptek*. 16(2):123-127.
- [15]. Diniah. 2010. Mechanical of betung bamboo for fishing gear material. Bogor: IPB University.
- [16]. Mardikanto TR, Karlinasari L, Bahtiar ET. 2011. *Mechanical of Wood*. Bogor: IPB Press.
- [17]. Klust. 1987. *Netting Material for Fishing Equipment II. Team Translation BPPI*. Semarang : Fishing News Book Ltd.
- [18]. Daud Z, Hatta MZ, Kassim ASM, Awang H, Aripin AM. 2014. Exploring of agro waste (pineapple leaf, corn stalk, and napier grass) by chemical composition and morphology study. *Journal of BioResources*. 9(1):872-880.
- [19]. Dey SK, Satapathy KK. 2011. A Combined Technology Package for Extraction of Pineapple Leaf Fibre-An Agrowaste, Utilization of biomass and for application in Textiles. National Institute of Research on Jute and Allied Fibre Technology Indian Council of Agricultural Research 1-9.
- [20]. Dumanauw JF. 2001. *Getting to know wood*. Semarang: Kanisisus publisher.
- [21]. Hidayat P. 2008. The utilizing pineapple leaf fiber technology as an alternative textile raw material. Yogyakarta. *Jurnal Teknoin*. 13(2):31-35. ISSN: 0853-697.
- [22]. Yusof Y, Yahya SA, Adam A. 2015. Novel technology for sustainable pineapple leaf fibers productions. *Science Direct*. 26:756-750.
- [23]. Dhanabalan V, Laga S, Rashmi J. 2015. Pineapple fibers: properties and uses. [internet]. Downloaded 2016 Juni 24] on www.slideshare.com.
- [24]. Fitriawati N. 2012. The effectiveness of four types of plants and chitosan againts *Xanthomonas campestris* pv. *Campestris* causes black rot in cabbage [tesis]. Bogor: IPB University.
- [25]. Volk WA, Wheeler MF. 1990. Basic of *Microbiology*, volume 2. 5th edition. Jakarta: Erlangga publisher.

The Implementation of 7E Learning Cycle Model in Improving the Social Attitude And Physics Learning Achievement of the XI MIPA 3 Class Students of in the Academic Year of 2018/2019

I Made Tri Pramana Putra, I Wayan Suastra., A. A. I. Agung Rai Sudiatmika.

Universitas Pendidikan Ganesha, Indonesia, Jalan Udayana 11 Singaraja Bali
81116 Indonesia

Tripramana100@gmail.com, i-wayansuastra@yahoo.com, r_sudiatmika@yahoo.com

Abstract. This study aimed at improving social attitude and physics learning achievement of the students of XI MIPA 3 class of SMAN 3 Singaraja through the implementation of 7E learning cycle model. The type of this research was Classroom Action Research. The research subjects were 33 students of XI MIPA 3 class. The object of this research was the 7E learning cycle model, social attitude, learning achievement, and students' responses. The research instruments were social attitude observation sheets, social attitude questionnaires, learning achievement tests, and students' responses questionnaires. The data was analyzed descriptively quantitatively. The results of the study showed that (1) There was an increase in social attitude based on observation (in the first cycle, the obtained score was 57.59, while in the second cycle the obtained score was 62.28). There was an increase in social attitude based on the questionnaire (in the first cycle, the obtained score was 112.64, while in the second cycle the obtained score was 120.67). (2) In the first cycle, the students' learning achievement had not reached the research success criteria ($\bar{X} = 72.88$, $SD = 9.44$, $KK = 54.55\%$), while in the second cycle it reached the research success criteria ($\bar{X} = 82.42$, $SD = 7.815$, $KK = 87.88\%$). (3) Students' responses toward the learning cycle model were highly positive ($\bar{X} = 80.76$). The conclusion of this study showed that the implementation of 7E learning cycle model was able to improve students' social attitude and physics learning achievement in XI MIPA 3 class of SMAN 3 Singaraja.

1. Introduction

Education is an important aspect in the life of the country and the nation. The government holds vital role in nation's efforts in conducting the expected education. The implementation of 2013 curriculum is one of such efforts that the government does to improve the quality of the graduates in accordance to the educational objective. The implementation of 2013 curriculum is expected to be able to improve the attitude, knowledge and skill competences. Based on the research done by Gusviani (2016), social attitude arises more in the 2013 curriculum. This is in accordance to the essence of 2013 curriculum that states that the learning process is designed into three areas, namely attitude, knowledge and skills. Students' social attitude in the classroom learning process can affect their learning achievements. This is in accordance to the research done by Zahara et al. (2017), who state that there was a significant influence of students' social attitude towards their learning outcome. In fact, based on the observation data in XI MIPA 3 class of SMA N 3 Singaraja, students' social attitude and their physics learning achievement were still low. This statement was supported by the data of their daily test scores as seen on Table 1.

Table 1. Daily Test Scores of the Students of XI MIPA 3 Class of SMA N 3 Singaraja

Aspect	XI MIPA 1	XI MIPA 2	XI MIPA 3
The Number of Students	35	33	32
The Number of Passing Students	5	2	1
Average	54.6	43.9	31.8
Passing Ratio	14,3%	6,06%	3,03%
Highest Score	81	78	76
Lowest Score	36	18	3

Based on the observation result done at di SMA N 3 Singaraja through interview with the physics teacher in XI MIPA 3 class, direct observation in XI MIPA 3 class, and interview with 3 students of XI MIPA 3 class, several causes of the low physics learning achievement and students' low social attitude in XI MIPA 3 class were revealed. Among others were: (1) 60% of the learning process conducted by the teacher implemented lecturing method; (2) there were only 2-3 students out of 33 students who participated during the learning process; (3) there were students who were not honest in doing daily tests; (4) the teacher had not delivered the learning objectives that would be accomplished, so that the students did not have any preexisting perception on the learning process that was conducted on that day; (5) the learning process was still dominated by the teacher; (6) discussion, question-and-answer and expressing opinion activities were not done frequently; (7) according to the students, physics was difficult because there were many formulas that should be memorized; (8) students tended to be bored when learning physics due to the teaching technique of the teacher was less interesting according to the students.

The problem of low social attitude commonly happened to the students. Bachtiar, S., Siti Z., Aloysius D. C., & Sri E. I. (2018) state that the learning process conducted at school does not facilitate students' social attitude development. This may cause the students to be less honest in doing their tasks, they may cheat on their friends' work, they may not be discipline, less polite to their friends, and may cause little practical activities.

This also happens to their learning achievement. The low learning achievement has been a global problem. The research of Trends in Mathematics and Science Study (TIMSS) of 2015, showed that in the field of science, Indonesia is ranked low, i.e. 45 out of 47 countries. This is in line with the problem disclosed by Naade et al. (2018) who state that students' physics learning achievement was still low. Many students found difficulties in learning physics because it needed strong concept comprehension. Sulastrri et al. (2018), state that most of the students were still unable to achieve the competence in physics subject.

Based on several identified problems, most of them were due to the not-optimal learning process. The teachers were yet to be able to implement innovative learning models which can evoke students to be active in the classroom learning process (teacher centered learning). The use of learning model can affect the learning in processing the obtained information (Sarac, 2018). The classroom learning process familiarizes the students to always receive knowledge from the teacher without knowing its application in daily life. This is in accordance to the argument of Sulastrri et al. (2018), who state that physics learning process tends to place physic as a number of information that should be delivered and memorized. During the learning process, the students only were only listening and being less involved in investigating new matters such as conducting several experiments. Such activities cause students to be not active in the learning activities. Based on such problem, an appropriate solution is required to improve students' social attitude and learning achievement. Such solution is in the form of the implementation of an innovative learning model.

Such problem can be overcome by implementing an innovative learning model. According to Santyasa (2005), an innovative learning is a type of learning that provides opportunities for the students to reconstruct knowledge independently (self-directed) and is mediated by their peers (peer-mediated instruction). This is because in the innovative learning model, the learning process is centered on the students. One of the innovative learnings is constructivism-based learning.

In the constructivism learning, individuals form their own concept and adjust it with the new situation by utilizing their preexisting knowledge (Yaman & Karasah, 2018). Such knowledge can be the basis of receiving the next information. One of the learning models that adheres to the constructivism view is 7E learning cycle.

7E learning cycle model provides affects the teaching material development process, interest in the lesson, skills and attitude (Sarac & Tarhan, 2017). According to Eisenkraft (2003), the use of 7E model assures the disclosure of students' preexisting knowledge. 7E learning cycle emphasize on the importance of preexisting knowledge and on expanding or transferring scientific concepts and principles of a subject.

The selection of 7E learning cycle model to improve students' social attitude and learning achievement was supported by several researches. According to Naade et al. (2018), 7E learning cycle model affects positively towards the students' learning achievement. The interactive nature of the use of 7E learning cycle model could motivate students, so that it evoked their interest and improved deeper and broader concept comprehension. This is in line with Sulastrri et al. (2018), who state that 7E learning cycle model provided positive result on students' physics learning achievement. This was because the 7E learning cycle model could ease the students in understanding concepts, because the students directly interact with the learning objects. Students' interaction with the learning objects indicated enthusiast attitude of the students in receiving the lesson.

7E learning cycle model was believed to be able to improve social attitude and learning achievement. Social attitude is a positive or negative reaction of a person towards particular object in the social environment. Kerlinger (1972) states that social attitude is a part of the attitude domain that has a reference of various general social relevance with many people in terms of religion, economy, politic, education, ethnicity, and other social aspects. Furthermore, Gerungan (2004) states that social attitude is ways of behavior which are repeatedly expressed towards particular social subjects and is usually not just by a person, but also other persons who are in the same group or community. According to Ahmadi (2007), social attitude is individual's awareness that determines real, repeated actions towards social objects. Social attitude is not only expressed by a person, but is also noticed by the people in his/her community. Generally, social attitude is an individual's ability in understanding other people's feelings accompanied by the tendency to behave/act related to the social activities experienced by such individual. In this research, the used dimensions of social attitude were criticality, diligence, honesty, caution, curiosity, responsibility, cooperation, and openness.

Learning achievement can be defined as an educational evaluation regarding students' progress in all the things that they have learned at school relating to knowledge and skill that is expressed after the evaluation result. According to Djamarah (1994), learning achievement consists of two words, namely "achievement" and "learning". Achievement is the result of a particular activity that has been done, created, both individually and in groups. Meanwhile, learning is an activity that is done consciously to gain a number of impression from the learned material. Learning itself can be interpreted as an activity that processes and is a highly fundamental element in the administration of any type and level of education (Syah, 2007). This shows that, the success or failure of the educational objective accomplishment depends on the learning process experienced by the students both at school and in their living environment. In this research, the used dimension on the learning achievement was the cognitive dimension, which comprised remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6).

There were 7 phases in the learning activity in 7E learning cycle model, namely eliciting, engaging, exploring, explaining, elaborating, evaluating, and extending. In the eliciting phase, the students would be invited to recognize the given initial problem, the developed social attitude was critical, while the targeted learning achievement dimension was remembering. In the engaging phase, the students would be motivated by the teacher by giving phenomena so that the students would be more active and more curious, the developed social attitude was curiosity, while the targeted learning achievement dimension was analyzing. In the exploring phase, the students would be invited to find concepts on the learning materials through experiments, the developed social attitude was criticality, dilligence, curiosity, cooperation, and caution, while the targeted learning achievement dimension was understanding and analyzing. In the explaining phase, the students communicate their concept findings; the developed social attitude was openness and criticality, while the targeted learning achievement dimension was understanding. In the elaborating phase, students' concept findings were applied on the given problem by the teacher, the developed social attitude was responsibility, while the targeted learning achievement dimension was applying. In the evaluating phase, feed backing was conducted on the obtained concept, the developed social attitude was honesty, while the targeted learning achievement dimension was evaluating. In the extending phase, students developed their conceived concepts into the more complex daily life problem; the developed social attitude was diligence and criticality, while the targeted learning achievement dimension was creating.

Based on the above arguments, then it was deemed necessary for the learning process improvement by implementing 7E learning cycle model to improve the social attitude and physics learning achievement of the XI MIPA 3 class students of SMA N 3 Singaraja in the academic year of 2018/2019. According to such problem, then the writer proposed a classroom action research with the title of "The Implementation of 7E Learning Cycle Model to Improve the Social Attitude and Physics Learning Achievement of the XI MIPA 3 Class Students of SMA N 3 Singaraja in the Academic Year of 2018/2019".

2. Method

This research utilized classroom-action-research method. This research aimed at improving social students and physics learning achievement of the XI MIPA 3 class students of SMA N 3 Singaraja in the academic year of 2018/2019 by implementing 7E learning cycle model. This research was conducted in two cycles. Each cycle consisted of four main stages, namely action planning, action implementation, observation/evaluation, and reflection.

The subject of this research was the students of XI MIPA 3 class with the total number of 33 students. The object of this research was 7E learning cycle model, social attitude, learning achievement, and students' responses. The data of social attitude was obtained from the observation result and questionnaire. The observation was conducted in each meeting, meanwhile the questionnaire was given at the end of cycle I and cycle II. The data of the learning achievement was obtained from the learning achievement test at the end of cycle I and cycle II. The data of students' responses was obtained from the students' responses questionnaire that was given at the end of cycle II. The obtained data was then analyzed by using descriptive quantitative analysis technique.

3. Result and Discussion

Based on the observation, during the first meeting of cycle I, the number of students who obtained the score of social attitude on highly positive category was 7 students, on positive category was 19 students, and on adequate category was 3 students. In the second meeting, the number of students who gained social attitude score on highly positive category was 8 students and on positive category was 23 students. In the third meeting, the number of students who gained social attitude score on highly positive category was 11 students and on positive category was 17 students.

The result of data analysis of the three meetings in cycle I showed that the average score of the students' social attitude in cycle I was 57.97 with the standard deviation of 4.09. Based on the categorization criteria of the students' social attitude, the average score of the social attitude of the XI MIPA 3 class students of SMA N 3 Singaraja in the academic year of 2018/2019 in cycle I was on the

positive category. This accomplishment had met the research success criteria, which had been set previously.

In the first meeting of cycle II, the number of students who obtained the score of social attitude on highly positive category was 14 students and on positive category was 16 students. In the second meeting, the number of students who gained social attitude score on highly positive category was 18 orang and on positive category was 13 students. In the third meeting, the number of students who gained social attitude score on highly positive category was 22 students and on positive category was 10 students.

The result of data analysis of the three meetings in cycle II showed that the average score of the students' social attitude in cycle II was 62.28 with the standard deviation of 3.49. Based on the categorization criteria of the students' social attitude, the average score of the social attitude of the XI MIPA 3 class students of SMA N 3 Singaraja in the academic year of 2018/2019 in cycle II was on the highly positive category. This accomplishment had met the research success criteria that had been set previously.

Based on the result of the observation, students' social attitude in every meeting had experienced improvement from cycle I until cycle II. The improvement of the social attitude is provided in Figure 1

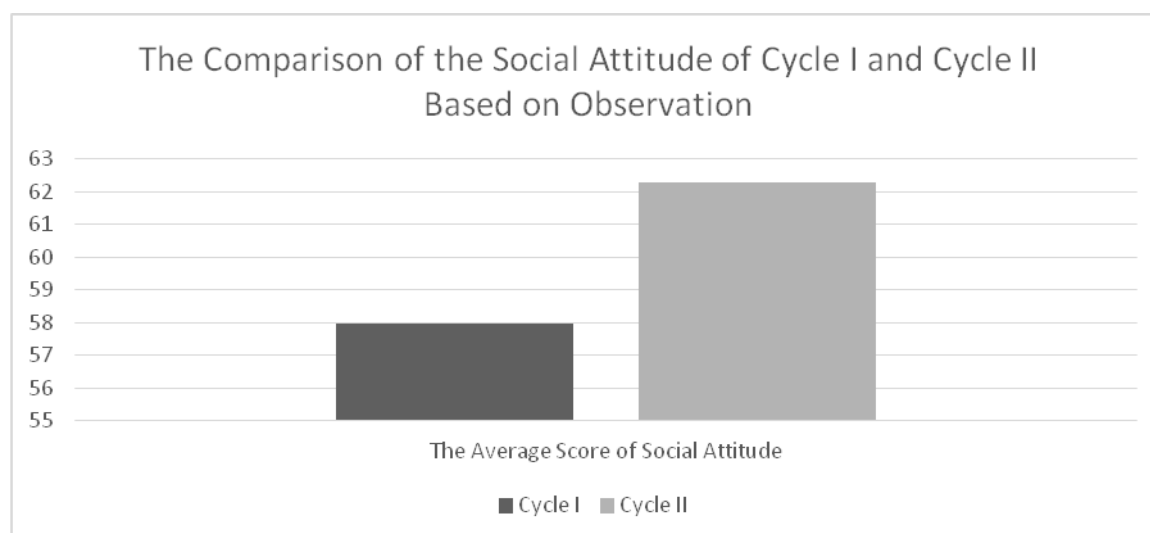


Figure 1. The Comparison of Social Attitude Score of Cycle I and Cycle II Graph Based on Observation

Based on the questionnaire evaluation, in cycle I, the number of students who gained highly positive category on their social attitude score was 10 students, who gained positive category was 21 students, and who gained adequate category was 2 students. In cycle II, the number of students who gained highly positive category on their social attitude score was 21 students, and the ones who gained positive category was 12 students.

Based on the analysis, the average score of students' social attitude in XI MIPA 3 class in cycle I had met the success criteria. The gained average score was 112.64 and was on the positive category. Meanwhile, in cycle II, the average score of students' social attitude in XI MIPA 3 class was 120.76, which was on the highly positive category. This result showed that there was an improvement in the social attitude score from cycle I to cycle II. The improvement of students' social attitude score in XI MIPA 3 class based on the questionnaire is provided on Figure 2.

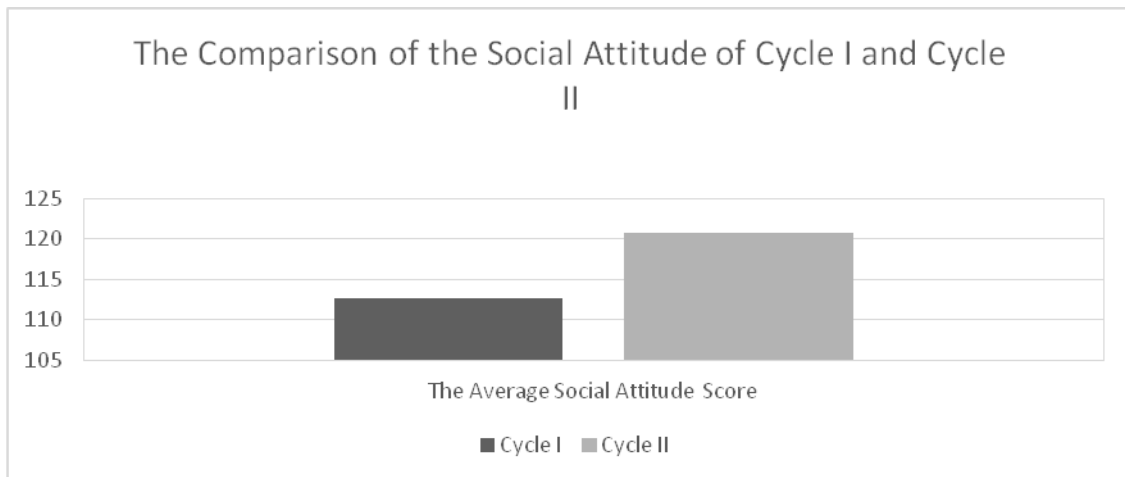


Figure 2. The Comparison of Social Attitude Score of Cycle I and Cycle II Graph Based on Questionnaire

The physics learning achievement data of the students was obtained through physics learning achievement test that was conducted at the end of each cycles. In cycle I, the obtained average score

(\bar{X}) was 72.88, with classical passing of 54.55%. the percentage of the obtained classical passing in cycle I had not met the research success criteria set previously. In cycle II, the obtained average score

(\bar{X}) was 82.42 with the classical passing of 87.88%. the percentage of the obtained classical passing in cycle II had met the research success criteria set previously. The improvement of students' physics learning achievement is shown on Figure 3.

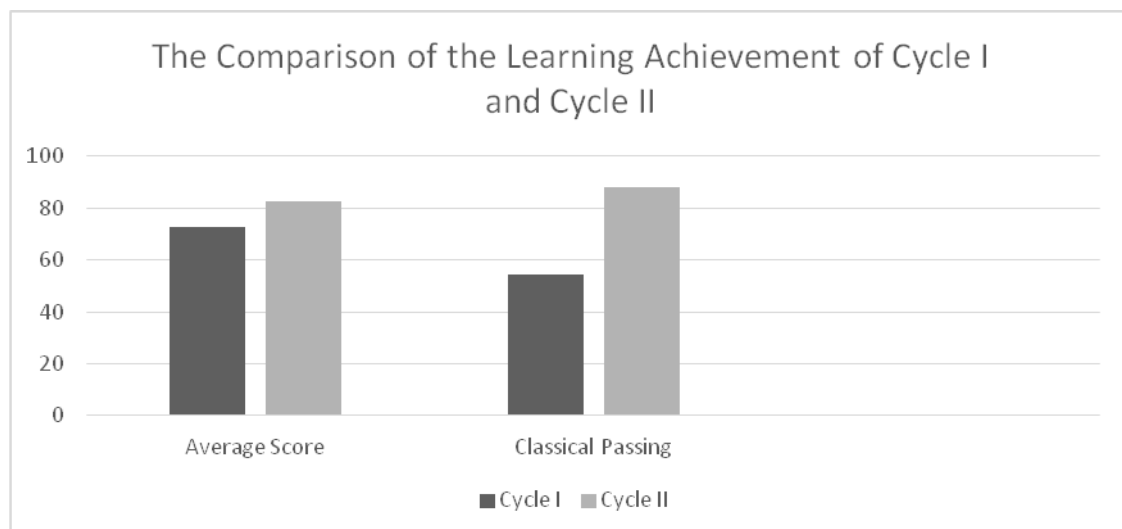


Figure 3. The Comparison of Learning Achievement Graph in Cycle I and Cycle II

Based on the data analysis, students' classical passing in cycle II experienced an improvement from cycle I. In cycle I the classical passing was 54.55%, while in cycle II the classical passing was 87.88%.

Based on the categorization guideline of the students' responses, the average score of students' responses towards the implementation of 7E learning cycle model was on the highly positive category. This showed that the students could take on the implementation of the 7E learning cycle model that had been done. The number of students' responses score, which were on the highly positive category, was 15 students and on the positive category was 18 students.

The research is pronounced to be successful should the implementation of the implementation of 7E learning cycle model be able to improve the social attitude as minimum as on the positive

category. Based on the result of the data analysis, the implementation of the 7E learning cycle model was able to improve students' social attitude with positive category in cycle I and highly positive category in cycle II. Such result showed that this research had been successful at improving students' social attitude.

Based on the learning process that had been conducted in cycle I, there were several obstacles in the cycle implementation. The said obstacles, among others were: (1) the students were not accustomed to do the Student Worksheet for practices and the investigation that consisted of hypothesis, problem formulation, objectives, and conclusion. (2) From the conducted learning activities, the activities that experienced obstacles was the exploring stage. The students were not willing to read on the steps prior to conducting the practices. (3) From the evaluation conducted by the researcher, many students were still having low social attitude, mainly in the criticality, curiosity, openness, and cooperation, (4) in cycle I, many students still had not met the passing grade, namely as many as 15 students with the classical passing of 54.55%. This result had not yet met the research success criteria that had been set previously. Based on such obstacles, thus learning improvement should be arranged and conducted in the following meetings. The efforts on learning improvement for the following meetings were: (1) the teacher provided information regarding the correct way of processing hypothesis, problem formulation, learning objectives, and conclusion during the learning process, (2) the teacher facilitated the students by providing Student Worksheet before the meeting so that the students gained more opportunities to learn the Student Worksheet which would be discussed in the following meeting, (3) The researcher optimized the learning process in the engaging stage, i.e. by providing motivation, providing appreciation for the active students, re-emphasizing the learning benefits and objectives, and providing group or individual counseling, (4) the researcher provided emphasis on the learning concept and materials, as well as provided more exercises in the evaluating stage and discussed them directly during the learning process.

Based on the learning improvement process in cycle I, the learning process in cycle II experienced improvement which could be seen from the students' attitude and learning achievement. The reflection on the conducted learning activities in cycle II were (1) the students had begun to get accustomed to the 7E learning cycle model through practices and investigations, (2) based on the observation and questionnaire evaluation, students' social attitude experienced improvement from cycle I to cycle II; based on the observation, in cycle I the average score of students' social attitude of XI MIPA 3 class was on the positive category, meanwhile in cycle II it was on the highly positive category. Based on the questionnaire filling, in cycle I the average score of students' social attitude in XI MIPA 3 class was on the positive category, meanwhile in cycle II it was on the highly positive category, (3) students' learning achievement experienced improvement from cycle I. Besides that, the class classical passing of XI MIPA 3 class also experienced improvement from 54.55% in cycle I to 87.88% in cycle II, (4) students gave highly positive responses towards the implementation of 7E learning cycle model in the physics lesson.

Theoretically, the result of the research regarding the social attitude was supported by Bustami, et al. (2017), who state that cooperative learning could improve students' attitude. Cooperative learning provides positive impacts on students' social attitude and when implemented in a particular class which consists of various natures of individuals it could construct good relationship among the students.

Empirically, the researches on the implementation of 7E learning cycle model was effective in improving social attitude. In this research, the used social attitude dimensions were honesty, criticality, curiosity, caution, cooperation, diligence, responsibility, and openness. The steps of the 7E learning cycle model provided opportunities for the students to improve their social attitude. In the eliciting stage, students' preexisting knowledge regarding particular concepts was tested. The social attitude that could be developed were criticality, i.e. the students were critical at responding the initial problems provided by the teacher. After finding out their preexisting knowledge, the students would be focused on the teacher by giving motivation, i.e. in the engaging stage. In the engaging stage, the developed social attitude was curiosity. In the exploring stage, the students did practices or investigations, whereby this stage demanded the students to be able to cooperate within groups, to think critically, to be cautious and diligence during the practices or investigations. These four aspects were important to support the success of the group in completing the practices or investigations. In the explaining stage, the students in groups presented the result of their discussion in front of the class;

meanwhile the other students expressed their questions to the presenting group regarding the discussed material. The developed social attitude in this stage was criticality and openness. In the elaborating stage, the students applied their obtained concept on the new problems. The developed social attitude was responsibility and diligence in solving the newly presented problems. The evaluating stage also provided opportunities for the students to be able to improve their social attitude, namely the honesty aspect. The students who had not understood the presented material could ask questions to the teacher to be discussed with the class. However, should the students not be honest in expressing the gained knowledge, it would affect the said students in the future. The last stage was extending stage. The students developed their owned knowledge on the more complex problems. In this stage, the social attitude that could be developed was criticality. Through the possessed concept, the students were more critical in responding the presented problems.

The result of the data analysis of the students' physics learning achievement showed that there was improvement in the physics learning achievement through the implementation of the 7E learning cycle model. In cycle I, the classical passing was 54.55%. This result had not met the success criteria. This was because in cycle I, the students were constrained by mathematical calculations in working on the problems. Besides that, in cycle I there were students who were not willing to follow teacher's instruction to do the exercises. In cycle II, the classical passing improved to 87.88%. This was because the students had been willing to do the exercises given by the teacher, so that the students gained more understanding and were more prepared to do the learning achievement test.

The research success criteria of the learning achievement aspect should at least meet the classical passing of 75%. The result of the research in cycle II had met the research success criteria. Such improvement of the classical passing indicated the success of the implementation of 7E learning cycle model in improving the students' physics learning achievement.

Theoretically, this research was supported by Eisenkraft (2003), who states that the implementation of 7E learning cycle model could generate students' preexisting knowledge. By using the 7E learning cycle model, the teacher would evoke the students' preexisting knowledge (elicit) and focus the students on the teacher (engage). Meanwhile, the students would apply the concepts on other problems (elaborate) and develop them (extend). According to Balta and Sarac (2016), the implementation of 7E learning cycle model in science education could improve students' academic achievement and conceptual because this model provides opportunities for the students to dig knowledge through experiments and investigations. Besides that, according to Colburn and Clough (1997), learning cycle model is a learning technic in which the teacher can estimate and change students' concept regarding scientific principles, whilst simultaneously, the students will gain direct practice experiences as a part of the science.

Empirically, this research was supported by similar researches that had been previously conducted. The research conducted by Naade et al. (2018) showed that 7E learning cycle model with constructivism approach can improve students' physics learning achievement. Furthermore, the research of Sulastri et al. (2018) showed that there was positive impact of 7E learning cycle model towards physics learning achievement. The experimental class that used 7E learning cycle model showed greater improvement on learning achievement compared to the control class that used conventional model. The result of this research was also in accordance to the meta-analysis research of Sarac (2018), which showed that the learning cycle model affected positively on the students' learning achievement.

Based on the result of the questionnaire analysis of the students' responses, the average score of the students' responses towards the implementation of 7E learning cycle model was 80.76 with highly positive category. The research is pronounced to be successful should the students' responses be at least on the positive category. The result of this research showed that the students accepted the implementation of the 7E learning cycle model that was given in the physics lesson well.

Based on the reflection that was conducted at the end of the cycles, it was revealed that several obstacles were experienced during the implementation of the 7E learning cycle model in XI MIPA 3 class of SMA N 3 Singaraja. The obstacles that were experienced during the learning process of cycle I among others were: (1) the students had not been accustomed to do the Student Worksheet for practices and investigations that consisted of hypothesis, problems formulation, objectives, and conclusion. (2) In the exploring stage, the students were not willing to read on the steps before conducting the practices. (3) Many students still had low social attitude, mainly criticality, curiosity,

openness and cooperation. (4) 15 students gained scores below the passing grade, with the classical passing of 54.55%. This result had not met the research success criteria that was set previously. The applied solution to overcome such problems among others were: (1) the teacher provided information regarding the correct way of doing hypothesis, problems formulation, learning objectives, and conclusion during the learning process. (2) The teacher facilitated the students by giving Student Worksheet before the meeting so that the students gained more opportunities to learn the Student Worksheet that would be discussed during the following meeting. (3) The researcher optimized the learning in the engaging stage, namely by providing motivation, providing appreciation for the active students, re-emphasizing on the learning benefits and objectives, and providing counselling both in groups and individually. (4) The researcher provided emphasis on the learning concept and material, as well as providing more exercises in the evaluating stage.

The reflection of the conducted learning activities in cycle II among others were: (1) the students had begun to be accustomed to the 7E learning cycle model through practices and investigations. The practice and investigation reports of the students were better than in cycle I. (2) based on the observation and questionnaire evaluation, students social attitude experienced improvement from cycle I to cycle II. (3) The students' learning achievement experienced improvement from cycle I. Besides that, the classical passing of XI MIPA 3 class also experienced improvement from 54.55% in cycle I to 87.88% in cycle II.

4. Conclusion and Suggestion

Based on the result of the research and the discussion, then it can be concluded the followings.

1. The implementation of 7E learning cycle model could improve students' social attitude of the XI MIPA 3 class SMA N 3 Singaraja in the academic year of 2018/2019. Based on the observation, students' average social attitude score in cycle I was 57.95 on the positive category, meanwhile in cycle II it was 62.28 on the highly positive category. Based on the questionnaire evaluation, students' average social attitude score in cycle I was 112.64 on the positive category, meanwhile in cycle II it was 120.76 on the highly positive category.
2. The implementation of 7E learning cycle model was able to improve the students' physics learning achievement of the XI MIPA 3 class of SMA N 3 Singaraja in the academic year of 2018/2019. The average learning achievement score obtained in cycle I was 72.88 with the classical passing of 54.55%, while in cycle II it improved into 82.42 with the classical passing of 87.88%.
3. The students' responses towards the implementation of 7E learning cycle model in the physics lesson in XI MIPA 3 class of SMA N 3 Singaraja in the academic year of 2018/2019 obtained the average score of 80.76 on the highly positive category.

Based on the findings, discussion, and conclusion, several suggestions that could be proposed were drawn as follows.

1. In implementing the 7E learning cycle model the teacher should be able to dig students' preexisting knowledge.
2. The teacher is suggested to form heterogeneous groups, so that there would not be any social jealousy among the students.
3. The teacher can adjust the time allocation as good as possible for each step of the prepared 7E learning cycle model, so that the learning activities can be conducted effectively.

References

- [1] Ahmadi H A 2007 Jakarta: PT Rineka Cipta
- [2] Bachtiar S, Siti Z, Aloysius D C, & Sri E I 2018 *Issues in Educational Research* 28 2 254-270
- [3] Balta N & Hakan S 2016 *European J. of Educational Research* 5 2 61-72
- [4] Djamarah B S 1994 Surabaya: Usaha Nasional
- [5] Eisenkraft B S 2003 *The Science Teacher J.* 70 6 56-71

- [6] Gerungan W A 2004 Bandung: PT Refika Aditama
- [7] Kerlinger F N 1972 *Educational and Physicological Measurement* 32 3 613-630
- [8] Naade N B, Alamina J I, & Okwelle P c 2018 *J. of Education, Society and Behavioural Science* 24 3 1-9
- [9] Santyasa I W 2005 papers presented in upgrading middle, high school and vocational school teachers on June-July 2005, at Jembrana
- [10] Sarac H 2018 *International J. of Educational Methodology* 4 1 1-18
- [11] Sarac h & Tarha D 2017 *European J. of Eduactional Research* 6 3 299-311
- [12] Sulastri E H & I W G 2018 *J. Pendidikan Fisika dan Teknologi* 4 1 56-65
- [13] Syah M 2007 Bandung: PT Remaja Rosdakarya
- [14] Yaman S & Karasah S 2018 *J. of Baltic Science Education* 17 1 65-83

The Effect Of Problem Based Learning Model toward Formal Reasoning Ability And Science Process Skills Of Junior High School

Pratiwi Ni Luh Gede Sri¹, Suastra I W², Siti Maryam³

Postgraduate Program of Science Education, Mathematics and Science Faculty
Ganesha University Of Education, Bali-Indonesia, 81116

Email : ¹niluhgedesripratiwi@gmail.com, ²iwsuastra @undiksha.ac.id ,
³siti.maryam@undiksha.ac.id ,

Abstract. This research is aimed to analyze the differences: (1) Formal Reasoning Ability and Science Process Skills, (2) Formal Reasoning Ability, and (3) Science Process Skills between the students learning with Problem Based Learning and Direct Instruction. The focus of this research problem is the effect of problem based learning to the formal reasoning ability and science process skills. This research was quasi experiment with Posttest Only Control Group Design. The number of the population was 288 students. The sample in this research is class VIIIB and VIIC selected by random sampling. Data obtained, then analyzed with descriptive statistics and MANOVA. This research discovered that (1) there are significant difference of formal reasoning ability and science process skills between student learning by using problem based learning model with students learning by direct instruction ($F=45,390$, $p<0.05$), (2) there is significant difference of reasoning ability between students who are learning by using problem based learning model with students who learn by direct instruction, ($F=37,796$, $p<0.05$), and (3) there is a significant difference of science process skills between students who learn with problem based learning model with students who learn by direct intruction (MPL) ($F=54,494$, $p<0.05$). The group of student learning with problem based learning model got better formal reasoning ability and science process skills than those learning with direct intruction.

Key words: *Problem Based Learning, Reasoning Ability, Science Process Skills*

1. Introduction

The quality of a nation is not supported by the only its natural resources but also the excellence of human resources that able to face the globalization era. Education is the key of all the advances and the development of the better nation because humans who get good education can consummate potential in themselves as both a person and the citizen, (Amri & Ahmadi, 2010). It also a process for changing the attitude and behavior of humans in an efforts to maturing people in the learning steps. The educational process will lead to the formation of attitudes also in evolve of both intellectual and skills so what is the aim of it can be reached. In this time, the priority off the education just focused on developing 21st century skills such as technology of information and communication skills, problem solving skills, critical thinking skills and the ability to cooperate. each other as humans. Nowadays, the improvement and the development in education intensively carried out by the government to form better human resources.

School is the place where we can get the knowledge, one of the most popular is about science. Science contributes to the goals of the national education progress greatly. Science focused to give the real experience for the students to make they are able to exploring and understand about the nature scientifically. Carin (1993) states that science directed to help students to “find out” and “acts” for gain a deeper understanding about nature around them. Science as a systematic and well organized knowledge is generally accepted and formed by the data that collected with the observations and

experiments. The learning process became meaningful when the students can get it lesson by connecting the materials in daily which is using scientific methods, (Wilhelm, in Hendrik 2017). Referring to the competencies above, besides knowledge, learning science also has to developing aspect of process for the students among others science process skills and the formal reasoning abilities. Harlen, 1992 states that science process skills are physical and mental skills related to the fundamental abilities that are owned, mastered and applied in the scientific activities, therefore scientists are able to find something new. The science process skills are the skills of thinking used by scientist to construct knowledge for solve the problems and formulate the results, (Ozgelen 2012). According to Tawil, Physics as the one part of science is always deals with the symbols in its. The concept which is added symbols of Physics could help the students to manipulate the rules that used in Physics, (2005). The learning process will run well if the students could connect the new information to the relevant concepts in its cognitive structure, (Dahar, 2006) The capability to associate new information is related to the ability of formal reasoning. The enhancement of students reasoning abilities during the learning process are highly necessary to determine it is success.

Piaget (in Hergenhahn, 2008) states that students could develop their thinking skills in regular phases. At some phase a certain scheme where the success of it depends on the previous phases. Junior high school is the transition step where the childhood is change to adolescence, also the way they think will be different from the concrete to the abstract. Base on Pigaet's development level, junior high school student with the range of age 11-15 years old are the level of the evolve of formal operation. In this step, they start to realize the limitations of themselves and begin to wrestle with the concepts outside from their experiences. The reality shows, that many students are knows just about the theory and hard to practice it in real life. Supposedly, learning science in this case Physics the students are accustomed to using the ability of reasoning, especially formal reasoning skills or analytical logical thinking. It will make the students are not just memorize the theories and they can apply it in real situations so that the learning process will become meaningful. The poor quality of science learning process is the impact in using inappropriate learning model. The learning model which is used now is the direct learning model (MPL) that emphasizes only the product and it does not involve the students in a whole practice also lack of emphasis in competence and attitude. The effects of direct learning models during the learning process are demeaning their scientific skills and formal reasoning abilities because the learning processes just focus for transferring knowledge from the teacher to the student. The often things happen this time is lack of practical activities because of deficient of time in study and less of the adequate facilities.

Starting to the gap that described above, then we need to improve the process and the models of learning that innovative in order to develop students' abilities in their study of science. To make it real, we could use one of learning process that is Problem Based Learning, it will be not only empower science as a product but also as a process and attitude especially for the improvement of formal reasoning abilities and science process skills. There are some characteristics of problem based learning (1) *student-centered* used in learning process. (2) Form the small groups in study section (4) teachers as adviser and as who give some facilities (5) through self-direct learning students can get a new information and the last (6) Problems can be the way to hone problem solving skills. The use of problem based learning is expected can increase student abilities in formal reasoning and science process skills.

This study aims to analyze differences such as (1) Formal reasoning skills and science process skills abilities. (2) To find out the comparison between the students use direct learning model with the student use problem based learning in school.

2. Methods

The types of research

This research was made to compare between two different kinds of learning models. These two models have an impact on the two dependent variables that is formal reasoning skills and science process skills. This research is a quasi-experimental because its variables and the conditions of the experiment are not regulated tightly.

Research Design

Posttest control only group design used in this research. It is aim to probe differences in formal reasoning abilities and students' science process skills between the control group and experiment group where the students are different.

The Population and the Samples of the research

The population of this study is the second grade student from Junior high school at Gerokgak Buleleng, Bali in first semester on 2019/2020. There are 288 students follow this research which is spread in nine classes. *Simple random sampling* is the way how to choose the sample as the class control and experiment class (Sugiyono, 2014). Before being as a research sample, classes have to test for equality to make sure that the classes used as a sample are equivalent to one and another. To know it has equivalence, we can see it from the result of their science exam in second semester in 2018/2019 school year. The next step is to analyze it using the t-test for an independent sample.

Variable of Research

There are two variables in this research, one of them is Independent variable and the other one is Dependent variable. We use (X) for Independent Variable, then for both formal reasoning skills (Y1) and science process skills (Y2) that is Dependent Variables.

Technique of Data Collection

The techniques that used in this study are non-test technique and test technique. We choose exam with multiple choice to know about formal reasoning skills of the students, these exam held a few minutes before class have done (*Posttest*). And for science process skills the test that given to the students are analysis test for testing technique and observation sheet for non-testing technique. Instrument of this research are Lesson Plan, Students Work Sheet and an Essay of science process skills, Observation sheet and test with multiple choice of formal reasoning skills.

3. Research and Discussion

The result of this data research is a students' posttest score that taken a few minutes before the learning process end. The score of each formal reasoning and science process skills among experiment group and control group analyzed with parametric test as known as MANOVA test. This test used to determine significant differences among control group and experiment group. The first test that we have to do before conducting the MANOVA test is to test it with prerequisite tests there are the test for normality, homogeneity and co-linearity test. The average comparison of the value for formal reasoning abilities and science process skills in both students who studied with the problem based learning and the students who studied with the direct learning model can be seen on the Fig 1.

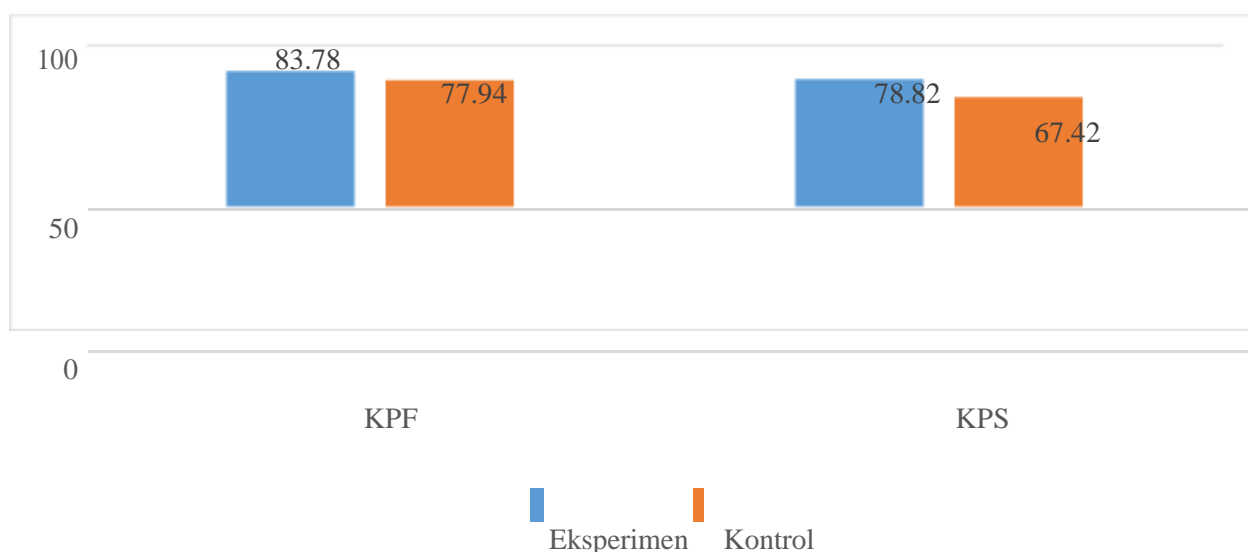


Fig.1 a comparison of average posttest result of the formal reasoning abilities and science process skills.

The average value for formal reasoning abilities with problem based learning is 83,78 which is in the high category. And the value for formal reasoning abilities that studied use direct learning process is 77,94, it can be describe that the score for formal reasoning abilities use problem based learning is higher than direct learning process. The description of the posttest data from process science skills that use study of problem based learning model have the average value in 78,82 that's in high category. And the average value of the process science skills data posttest where the learning model is direct learning get the score 67,42 it is in enough category. Hypothesis test result of the effect of problem based learning on formal reasoning abilities and science process skills are presented in table 1.

Table 1 . Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Signifikansi
Intercept	Pillai's Trace	0,998	1,614 x 10 ^{4a}	2	61	0,001
	Wilks' Lambda	0,002	1,614 x 10 ^{4a}	2	61	0,001
	Hotelling's Trace	529,307	1,614 x 10 ^{4a}	2	61	0,001
	Roy's Largest Root	529,307	1,614 x 10 ^{4a}	2	61	0,001
Learning	Pillai's Trace	0,598	45,390 ^a	2	61	0,001
	Wilks' Lambda	0,402	45,390 ^a	2	61	0,001
	Hotelling's Trace	1,488	45,390 ^a	2	61	0,001
	Roy's Largest Root	1,488	45,390 ^a	2	61	0,001
	Root					

a. Exact statistic

b. Design: Intercept + Learning

Based on the table number 1 is obtained the statistic value *Pillai's Trace*, *Wilks' Lambda*, *Hotelling's Trace*, dan *Roy's Largest Root* each $F=45,3900$ and have significance 0,000 less than 0,05 with the result that is rejected. So, this result explain that the students' formal reasoning skills and process science skills which is studied in problem based learning model is have differences with both of them studied in directly learning models. The result of analyze second hypothesis are done by looking at the table test of between subject effect at the outcome of MANOVA test. It is presented in the following table 2 below.

From the table 2, we get the value F at the variable formal reasoning in the amount of 37,796 with *Tests of Between-Subjects Effects*

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Significances
Corrected Model	Formal Reasoning	95,063 ^a	1	95,063	37,796	0,001
	Science_process_skills	333,063 ^b	1	333,063	54,494	0,001
Intercept	Formal Reasoning	60025,000	1	60025,000	2,38 x10 ⁴	0,001
	Science_process_skills	54756,000	1	54756,000	8,959x10 ³	0,001
Pembelajaran	Formal Reasoning	95,062	1	95,062	37,796	0,001
	Science_process_skills	333,062	1	333,062	54,494	0,001
Error	Formal Reasoning	155,938	62	2,515		
	Science_process_Skills	378,938	62	6,112		
Total	Formal Reasoning	60276,000	64			
	Science_process_skills	55468,000	64			
Corrected Total	Formal Reasoning	251,000	63			
	Science_process_skills	712,000	63			

a. *R Squared* = 0,379 (*Adjusted R Squared* = 0,369)

b. *R Squared* = 0,468 (*Adjusted R Squared* = 0,459)

the significance score 0,000. If it compared to 5% of significance level, its significance value is smaller, it can be decided to refuse . Therefore, can be conclude that there are differences between formal reasoning skills of the students who studied with the problem based learning model and they who studied use directly learning model.

The result of the analysis of the third hypothesis in table test of *between subject effects* at the output of MANOVA test. It will be in table 3.

Table 3. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected Model	Formal Reasoning	95,063 ^a	1	95,063	37,796	0,001
	Science_process_skills	333,063 ^b	1	333,063	54,494	0,001
Intercept	Formal Reasoning	60025,000	1	60025,000	2,38 x10 ⁴	0,001
	Science_process_skills	54756,000	1	54756,000	8,959x10 ₃	0,001
Pembelajaran	Formal Reasoning	95,062	1	95,062	37,796	0,001
	Science_process_skills	333,062	1	333,062	54,494	0,001
Error	Formal Reasoning	155,938	62	2,515		
	Science_process_Skills	378,938	62	6,112		
Total	Formal Reasoning	60276,000	64			
	Science_process_skills	55468,000	64			
Corrected Total	Formal Reasoning	251,000	63			
	Science_process_skills	712,000	63			

a. *R Squared* = 0,379 (*Adjusted R Squared* = 0,369)

b. *R Squared* = 0,468 (*Adjusted R Squared* = 0,459)

In table 3 obtained the F value on the variable science process skills is about 54,494 with the significance value 0,000. If it compared to 5% significance level then the significance value that found is smaller. It is mean refused. Therefore, can be conclude that there are differences between formal reasoning skills of the students who studied with the problem based learning model and they who studied use Directly Learning Model.

The analysis data researched of the *Problem Based Learning* model have a significant effect to the formal reasoning skills and science process skills of the students. It can be found in the differences of the average result that the problem based learning better than *Directly Learning Model*.

Based on the MANOVA test the student that studied with the Problem Based Learning have a better value of formal reasoning skills and science process skills than the students that studied with the Directly Learning Model.

It can be seen from the analysis of *Pillai's Trace*, *Wilks' Lambda*, *Hotelling's Trace*, dan *Roy's Largest Root* that indicate $F_{count} = 45,390$ and $p(0,000) < 0,05$ so that H_0 refused and H_1 received, which is means there is significant differences in Formal Reasoning Skills and Science Process Skills that have studied with Problem Based learning Model and Directly Learning Model.

4. Conclusion

The result of the research about the effect of Problem Based Learning Model to Formal Reasoning Skills and Science Process Skill are there are significant differences between both of the learning models that the students who studied in Problem Based Learning model are have the better value and they can increase their skills higher than the students who use Directly Learning Model.

References

- [1] Amri, S. & Ahmadi, I.K. 2010. *Proses pembelajaran kreatif dan inovatif dalam kelas*. Jakarta: PT.Prestasi Pustakarya.
- [2] Carin, Arthur. A. 1993. *Teaching modern science*. New York: Macmillan Publishing Company.
- [3]Dahar, R W. 2006. *Teori Belajar dan Pembelajaran*. Jakarta: Erlangga.
- [4] Harlen, W. 1992. *Teahing of science*. London: David Fulton Publisher.
- [5] Hergenhahn. 2008. *Theories of lernaning*. Edisi Ketujuh. Jakarta: Kencana Pranada.
- [6]Ozgelen, S. (2012). Students science process skills within a cognitive domain framework. *Eurasia Journal of Mathematics Science & Technology Education*. 8(4). 238-292.
- [7] Sadia, I. W. 2014. *Model-model pembelajaran sains konstruktivistik*. Yogyakarta: Graha Ilmu.
- [8] Sugiyono. 2014. *Metode penelitian kuantitatif, kualitatif, dan r&d*. Bandung: Alfabeta.
- [9] Tawil, M. 2005. Pengaruh Kemampuan Penalaran Formal Terhadap Hasil Belajar Fisika Siswa Kelas II SLTP Negeri 1 Sungguminasa Kabupaten Goa. *Skripsi*. Makasar: FMIPA UMN.

Fish Abundance in The Estuary of Cianjur, West Java Based on Temporal of Lunar Cycles and Spatial Differences

E Paujiah*¹, A Mas'ud¹, Wilman Taupik Ardiansyah¹

¹Department of Biology Education, Faculty of Tarbiyah and Teacher Training, UIN Sunan Gunung Djati, Bandung, Jl. AH. Nasution, No. 105, Cibiru, Bandung

Corresponding author: epapaujiah@uinsgd.ac.id

Abstract. Information on the abundance of resources in time and space is a prerequisite for the success of any fishing operation. The present study is an attempt to evaluate the effect of the lunar cycle and spatial differences on the abundance of fish. Catch rates recorded at different place and time (29.5-d lunar cycles) and was caught using line gear with mesh size of 0,5", 1" and 2". Observations made on new moon, full moon and during both quarters revealed variations in total catch as well as individual species catch in gillnetters. The results of the present study indicated that there is a significant effect of the lunar cycle on the catch rate of fish community occurring in the estuaries in Cianjur Regency, West Java. In trawl catches, *Mystus gulio* and *Terapon jarbua* were caught in all lunar phase. There are 10 species can found in one of lunar phase. Based on spatial differences, *Glossogobius circumspectus*, *Gerres filamentosus*, *Mystus gulio*, *Liza tade* and *Terapon jarbua* can found at all location. Results suggest that lunar cycles influence catch rates for some of the estuaries fish species examined. In addition, this habitat plays an important role in the maintenance of the ecological functioning of the estuarine-coastal ecosystem.

1. Introduction

The Estuary ecosystem with its characteristics that have a high habitat complexity becomes an interesting study in studying the structure of animal communities, especially fish as residents of the aquatic environment. The existence of environmental changes caused by natural and artificial processes can have an effect on the presence of organisms in it such as fish [1] [2]. Fish communities in estuarine habitats have different dynamic patterns based on time as well as the moon phase [3] and location [4]. Based on time, this month's phase can affect fishing performance, capture time and survival of fish [5]. Whereas based on location, the characteristics of different habitats can determine differences in fish species that inhabit it [6].

The estuary of Cianjur Regency, West Java, Indonesia is an estuary whose waters originate from a combination of several large river basins with each different river characteristics. This estuary has water conditions where the process of mixing sea water and river does not always take place. Another characteristics in this estuary is the existence of environmental degradation [7] such as over-use of sand which can disrupt the presence of animal species in it [8] if not managed properly. This is an interesting thing to study considering the complexity of habitat and time into an appropriate combination in determining the existence of a species.

The study of the structure of fish communities, especially those related to different times and places at the river mouth, has not been reported. As for [9], only studied the fish community in one of the estuaries, the Cisadea River. Not only additional about information of fish biodiversity, but this information can used for decision of catching fish time. As the first step for conservation about existence of animal water especially fish community. The objective of the present paper is to measure the effect of lunar phase, spatial differences and their interactions on the abundance of fish assemblages in the estuarine environments.

2. Methods

The sampling survey was undertaken at the mouth of estuaries in Cianjur, West Java, Indonesia. This area features two tidal cycles per day, with a higher difference between high and low waters, ranging from 30-150 cm (based on preliminary research in dry season). Sampling areas were distributed as

follows: the Cidamar river mouth (CD), Cipandak river mouth (CP) and Ciujung river mouth (CU) (Fig. 1).

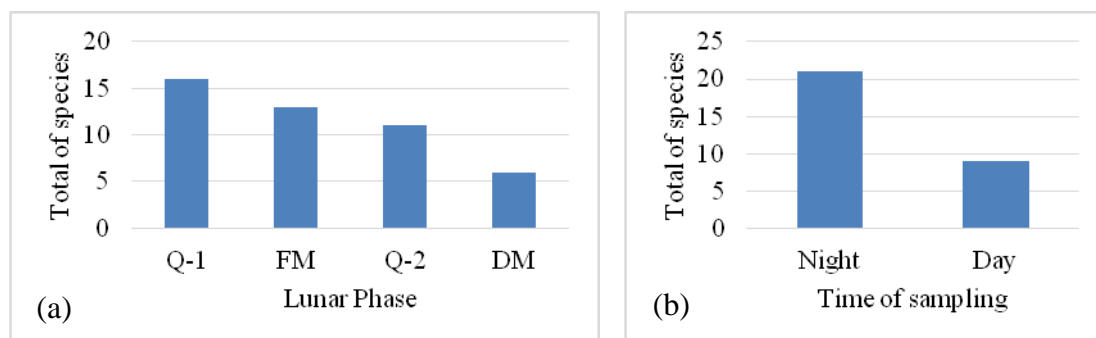


Figure 1. Sampling points at the estuarine habitats of the Cidamar river (6), Cipandak river (5) and Ciujung river (4).

Sample collections were made during Juny-July (dry seaseon) of 2019, using line gear with mesh size of 0,5", 1", and 2". This tool was attached along day (morning-6am-10am and evening-2pm-5pm) and night (6pm-5am) with chacked the present of sample every two hours. The lunar phase was used at this research consist of Quarter one phase (Q-1), Full moon phase (FM), quarter two phase (Q-2) and the last phase is dark moon phase (DM). Moreover, we were made at a fixed depth of 50 cm. Samples were preserved in a 4% formaldehyde solution. All ichthyofauna from net samples were separated and counted, and then measured of wight and lenght of fish using scales with accuracy of 0,01 and calipers. All fish were identified to the lowest taxonomi level (species) using the identification keys of [10], [11] and [12]. For data analysis of fish abundance, we counting of sample (total of sspecies) was cought from field based on different of location, time (night and day) and lunar phase differences and then the data was tabulated in microsoft excell.

3. Results and Discussion

There are 283 individu, 22 species, 13 famili at has colected from three location. The species of *Mystus gulio* and *Terapon jarbua* to be species with wide distribution based on time and place differences. Based on time of lunar phase, there are three species (*Mystus gulio*, *Terapon jarbua*, and *Caranx ignobilis*) were caught in all lunar phase. There are 10 species can found in one of lunar phase and individual number were dominant during new moon (Q-1) for all species (Fig. 2-a-b). Based on spatial differences, *Glossogobius circumspectus*, *Gerres filamentosus*, *Mystus gulio*, *Liza tade* and *Terapon jarbua* was found at all location (Fig. 2-c).



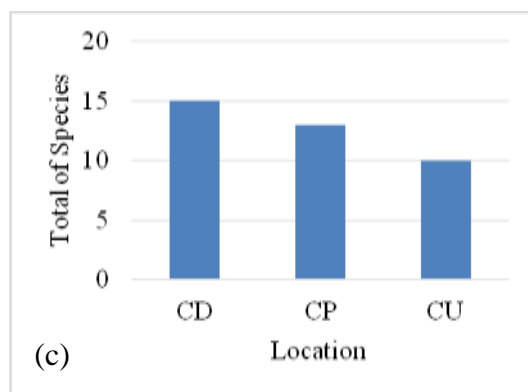


Figure 2. Abundance of fish estuarin from Cianjur, West Java Indonesia, based on time (a) (b), and location (c). CD-Cidamar, CP-Cpandak, CU-Ciujung

The difference in species composition in each moon phase can be influenced by several factors such as differences in the use of moonlight for its physiological processes such as reproduction [13] [14], and distribution and predator-prey activity [15] [16]. On the physiological process, the moonlight relate with a light-inducible clock gene (*rfPer2*) in the body of animal and that its expression is affected by daylight and moonlight. In addition, since the *rfPer2* expression level during the full moon period was higher than that during the new moon period [17].

Based on location, the characteristics of aquatic habitat can be a determinant of the type of fish that inhabit the estuary. For the species of *Mystus gulio* which occupies a lot of Cidamar estuary waters with rocky substrate characteristics. This species is group of catfish that inhabit of estuary. Reported by [18], *M. gulio* was found at India and Bangladesh. This fish primarily inhabits brackish water and also enters and lives in freshwater. Generally, the adults occur in rivers and streams with type of substrates is mud or clay, and live at smaller streams, rarely [19].

4. Conclusion

There are 283 sample has collected from 22 species, 13 famili. *Mystus gulio* and *Terapon jarbua* to be species with wide distribution based on time and place differences. The reason is that the using of parameter such as the distance of time and place can great toleranced by *M. gulio* and *T. Jarbua*. Based on lunar phase, the phase of Quarter-1 (Q-1) is phase with high abundance. Based on time, the total species in the night more abundance than the day. And based on the location, Cidamar river have more abundance of fish than other river (Ciujung and Cipandak). The knowledge of the fish fauna in the Cianjur estuary is still not much reported, and this investigation can contribute to support data base of fish fauna.

Acknowledgement

We thanks those who helped us carry out the sampling: Aris, and fishermen who helped sampling with the sampling survey: Aju and Andi. Thanks to integrity laboratory at UIN Sunan Gunung Djati Bandung for provide the place to sample analysis. This project was financed by BOPTAN.

References

- [1] Kotrschal, A., & Taborsky, B. (2010). Environmental change enhances cognitive abilities in fish. *PLoS biology*, 8(4), e1000351.
- [2] Izzo, C., Doubleday, Z. A., Grammer, G. L., Gilmore, K. L., Alleway, H. K., Barnes, T. C., ... & Gillanders, B. M. (2016). Fish as proxies of ecological and environmental change. *Reviews*

- in Fish Biology and Fisheries*, 26(3), 265-286.
- [3] Lacerda, C. H. F., Barletta, M., & Dantas, D. V. (2014). Temporal patterns in the intertidal faunal community at the mouth of a tropical estuary. *Journal of fish biology*, 85(5), 1571-1602.
 - [4] Robinson, T. P., Wint, G. W., Conchedda, G., Van Boeckel, T. P., Ercoli, V., Palamara, E., ... & Gilbert, M. (2014). Mapping the global distribution of livestock. *PloS one*, 9(5), e96084.
 - [5] Poisson, F., Gaertner, J. C., Taquet, M., Durbec, J. P., & Bigelow, K. (2010). Effects of lunar cycle and fishing operations on longline-caught pelagic fish: fishing performance, capture time, and survival of fish. *Fishery Bulletin*, 108(3), 268-281.
 - [6] Pittman, S. J., & Brown, K. A. (2011). Multi-scale approach for predicting fish species distributions across coral reef seascapes. *PloS one*, 6(5), e20583.
 - [7] Rosyadi, R. (2014). Sistem pengetahuan lokal masyarakat Cidaun–Cianjur Selatan sebagai wujud adaptasi budaya. *Patanjala: Jurnal Penelitian Sejarah dan Budaya*, 6(3), 431-446.
 - [8] Furlan, N., Esteves, K. E., & Quinágua, G. A. (2013). Environmental factors associated with fish distribution in an urban neotropical river (Upper Tietê River Basin, São Paulo, Brazil). *Environmental biology of fishes*, 96(1), 77-92.
 - [9] Paujiah, E., Solihin, D. D., & Affandi, R. (2017). Struktur trofik komunitas ikan di Sungai Cisadea Kabupaten Cianjur, Jawa Barat [Trophic structure of fish community in Cisadea River, Cianjur, Jawa Barat]. *Jurnal Iktiologi Indonesia*, 13(2), 133-143.
 - [10] Kottelat M, Whitten AJ, Kartikasari SN, Wirjoatodjo S. (1993). *Freshwater fishes of Western Indonesia and Sulawesi*. Hongkong: Periplus Editions. 291 p.
 - [11] Lim KKP, Ng PKL. (2000). *A Guide to The Freshwater Fishes of Singapore*. Singapore: Singapore Science Centre. 160 p.
 - [12] Rachmatika I. (2003). *Fish Fauna of The Gunung Halimun National Park, West Java*. Jakarta: Biodiversity Conservation Project LIPI-JICA-PHKA. 126 p.
 - [13][14] Ikegami, T., Takeuchi, Y., Hur, S. P., & Takemura, A. (2014). Impacts of moonlight on fish reproduction. *Marine genomics*, 14, 59-66.
 - [15] Takemura, A., Susilo, E. S., Rahman, M. S., & Morita, M. (2004). Perception and possible utilization of moonlight intensity for reproductive activities in a lunar- synchronized spawner, the golden rabbitfish. *Journal of Experimental Zoology Part A: Comparative Experimental Biology*, 301(10), 844-851.
 - [16] Kronfeld-Schor, N., Dominoni, D., de la Iglesia, H., Levy, O., Herzog, E. D., Dayan, T., & Helfrich-Forster, C. (2013). Chronobiology by moonlight. *Proceedings of the Royal Society B: Biological Sciences*, 280(1765), 20123088.
 - [17] Griffin, P. C., Griffin, S. C., Waroquiers, C., & Mills, L. S. (2005). Mortality by moonlight: predation risk and the snowshoe hare. *Behavioral Ecology*, 16(5), 938-944.
 - [18] Sugama, N., Park, J. G., Park, Y. J., Takeuchi, Y., Kim, S. J., & Takemura, A. (2008). Moonlight affects nocturnal Period2 transcript levels in the pineal gland of the reef fish *Siganus guttatus*. *Journal of Pineal Research*, 45(2), 133-141.
 - [19] Alam, M. J., Begum, M., Islam, M. A., & Pal, H. K. (2006). Spawning behaviour and induced breeding of an estuarine catfish, *Mystus gulio* (Ham.). *Bangladesh Journal of Fisheries Research*, 10(2), 101-109.
 - [20] Talwar P.K., Jhingran A.G. (1991). Inland fishes of India and adjacent countries. Vol-1 and Vol-2. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Bombay and Calcutta. 1063 p.

Water Quality Management for Surface Water Resources: System Dynamics (SD) Approach

Hendra Andiananta Pradana¹, Elida Novita^{2}, Bambang Herry Purnomo², Amelia Ika Puspitasari¹*

¹Agricultural of Water Resources Management, Postgraduate University of Jember, Jember, Indonesia

²Faculty of Agricultural Technology, University of Jember, Jember, Indonesia

*E-mail: elida_novita.ftp@unej.ac.id

Abstract. Water resources pollution is one of the crucial problems in the world. The dynamics of watersheds affect water pollution in the river. The approach to water quality management in the river must be holistic or comprehensive and sustainable. System Dynamics (SD) as an approach for described water quality management in watershed such us social, economic, and environmental aspects. The simulation represented positive and negative feedback of the overall aspect in SD as input for water quality management. The focus of the research was described the construction of a dynamic system model of pollution load flow as a basis for sustainable Bedadung River water management efforts based on social, economic, and environmental components. Input aspect in causal loop diagram (CLD) was social (domestics wastewater), economic (agricultural, livestock, hospital, and industry), and environmental (carrying capacity of the watershed). The CLD of SD simulation described positive and negative feedback mutual aspects for the water quality of the river. Negative feedback in SD was wastewater runoff from domestic, agricultural, livestock, and industrial. Positive feedback in SD was a total maximum daily load (TMDL). The water quality management in watershed used SD model as consideration to decision making support of sustainable river condition by stakeholder and government.

Keywords: system dynamics (SD), pollution load, bedadung watershed, sustainable

1. Introduction

The environment is dynamically changing from time to time. Living beings must adapt to survive in the environment. One of the environmental adaptation is water resource management. Water resource management is related to watersheds [1]. The management must consider the condition of quality and quantity of water resources which fluctuates frequently.

The watershed has an important role as a provider of surface water sources. However, several studies state that some of the Big Rivers in Indonesia have bad water quality [2]. The results of the 2016 Asian Development Bank report explained that several rivers in Indonesia are polluted [3]. The phenomenon of river water pollution is caused by the changing of natural processes and anthropogenic activities. This phenomenon occurs in several major rivers in East Java [4]. Some of the major rivers in East Java that have been hit by pollutants are Brantas River, Surabaya River, and Bedadung River. The study conducted by Suwari et al. (2011) on the status of Surabaya River water quality show in heavily polluted conditions[5]. In line with these conditions, Bedadung River has a Water Quality Index value in 2016 of 50.75 which belongs to the lowest parameters of BOD, COD, TSS and Total Coli [6]. Another study stated that urban activities in Jember Regency make Bedadung River becomes heavily polluted. Some districts that belong to Bedadung River is in Patrang, Sumbersari, Kaliwates and Mangli Districts [7]. The consequence of this decreased water quality is to

reduce the using of Bedadung River water as a source of raw water and irrigation water. The phenomenon of decreased water quality will be influenced by the volume fluctuation. The fluctuation is influenced by the distribution of rainfall and climate change [8][9].

Climate change that occurred in the last 10 years has also affected the fluctuations in rainfall and water volume in Bedadung River. The reduced rainfall and river volume during the dry season and the increasing length of the dry season, decreased water quality in the dry season, increased frequency and intensity of floods, and increased rainfall intensity in the wet season can be seen from the four phenomena of climate change that mainly occur in Jember Regency [10]. The deterioration in Bedadung River water volume directly affects the availability of water for irrigation as well as people's daily needs. Besides, changes in land use in a certain area in the upstream part of Bedadung River affect the volume peak by 32.4% [11]. The volume fluctuation will affect the concentration of pollution that occurs in Bedadung River. Water quality management can be done based on the total maximum daily load based on its calculations by using Streeter Phelps [12]. This changing is not comprehensive when we use static modeling as an approach. The dynamic modeling that can comprehensively consider the social, economic and environmental aspects is a dynamic system. A dynamic system is an approach that is predicted to be able to interpret the dynamics of the Bedadung River watershed. It is in the form of pollutants concentration and water volume. There are some dynamic applications in pollution control of the surface water sources involving social, economic, institutional, and environmental aspects carried out by Suwari et al. (2011); Irianto et al. (2011); Xiang et al. (2013); Liu et al. (2015) [5][13]. Water quality management will certainly be related to the role of stakeholders as managers and users of Bedadung River water in a sustainable manner [14]. This dynamic system model can be used as consideration for decision making in the management of sustainable river water quality by the government and stakeholders. The focus of the research was described the construction of a dynamic system model of pollution load flow as a basis for sustainable Bedadung River water management efforts based on social, economic, and environmental components.

2. Method

This study used descriptive qualitative method and some literature studied [15]. The composition or the structure of the dynamic system model was compiled in Powershim 5.0 software. The identification of dynamic system components was done based on social, economic, institutional and environmental aspects. The phenomena and dynamics of water quality management were illustrated in the input and output diagrams. The amount of literature i.e book, article, dan journal reviewed to support this study which was related to surface water quality management and dynamic systems. There were some stages in doing this research, i.e identifying the components, preparing input-output diagrams, describing the framework of the model, analyzing dynamic systems, and analyzing policies.

2.1 Model Components

Watersheds systems as approach determined the flow of pollution loads and efforts of water quality management [16][17][35]. Some of these components were the nature or environmental components and anthropogenic activities. The environmental components were carrying capacity of watershed i.e carrying capacity of land and the total maximum daily load of the river. This component was assumed as an indicator of environmental quality. It was used as a consideration of the model objectives achievement. The component of anthropogenic activity was divided into social and economic activities. Both of these activities were assumed to be contributors to the pollution sources.

2.2 Constructed of Input-Output Diagram

Dynamic systems were arranged based on the reciprocal relationship of both positive and negative dynamic system components. The pollution load flow is closely related to the hydrological component, human activities and river conditions [18]. This stage become of the considerations of model limitations and the preparation of algorithms or equations in dynamic systems. This diagram was used as a measurement of the model dynamics refer to its logic in the actual system. The input and output diagrams can be seen in Figure 1. Current regulations were used as a controller of the pollution load in river water.

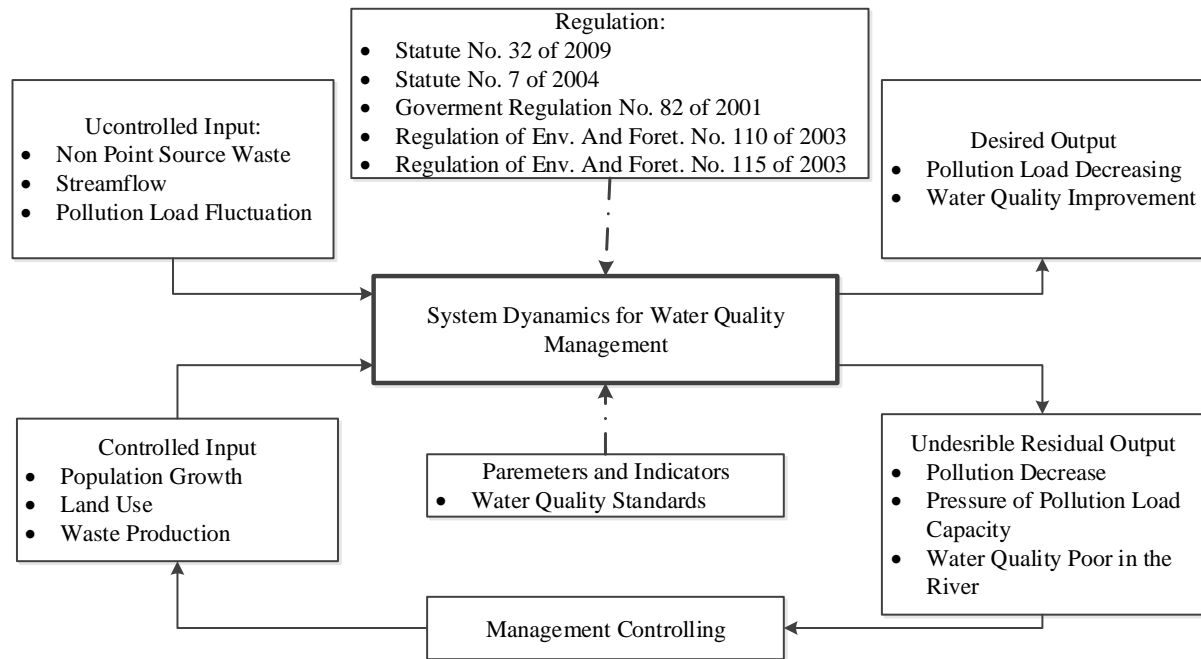


Figure 1. Diagram input and output system dynamics

2.3 The framework of System Dynamics Model

The stages of arranging cause and effect relationships in the dynamic system of water quality management can be seen in Figure 2.

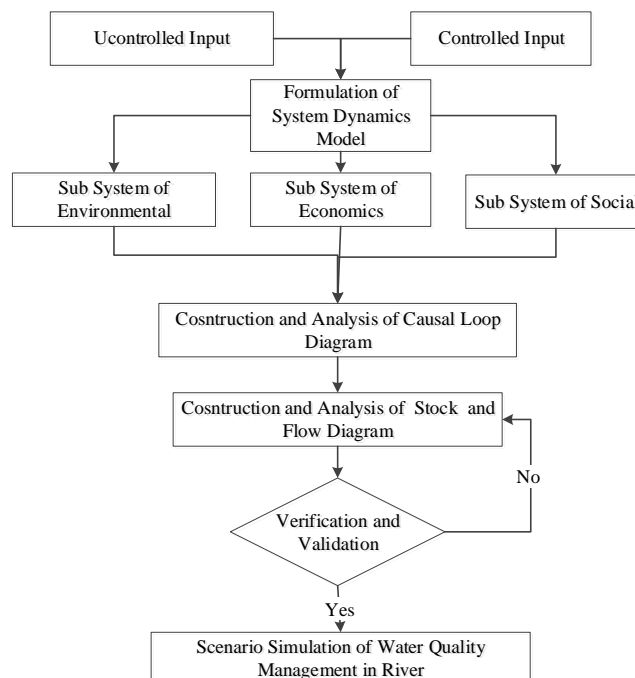


Figure 2. Constructed of the system dynamics model

2.4 Analysis of System Dynamics Model and Policy

The following was an analysis and simulation of a policy scenario for a dynamic system model for river water quality management using the powershim 5.0 program package. Some software that is used in dynamic system applications is generator, stella, powershim, and vensim [35].

- a. The model design was done with a top-down approach, which means the main model was built first then later will be broken down into sub-models to determine the causal relationship between components, variables, and parameters of the model.
- b. Causal Loop Diagrams were used in the inventory of data. The data from initial observations were then identified to obtain some patterns of interaction between variables and parameters in the real system of river water quality management. This diagram represented the interactions between some components of both positive and negative model. The variables in the causal loop diagram were still intact general variables which will then be broken down according to the requirements in the Stock and Flow Diagram (SFD) in the form of Bedadung River water quality conditions, land use, domestic activities, and economic activities in the Bedadung River Watershed in Jember Regency.
- c. The next step is to insert the formulation into the dynamic system model and continue the process with testing [19]. This test consists of system verification and validation. Verification is used to compare the structure of the model and its behavior with the structure and behavior of the system in actual conditions so that the model can represent the real system and can be simulated in the SFD [20][21].
- d. The policy analysis was carried out based on scenarios created after the results of the SFD output are simulated. This scenario considered some expectations of the likelihood of occurrence or expectations of the possibility of anticipatory policies due to the adoption of land use policies on river water quality in Bedadung River watershed based on their allotment [22][23].
- e. The decision was made based on the results of policy analysis. The policy analysis refers to a simulation of the total dynamic potential of the pollution load. Then it was associated with the total maximum daily load (TDML) as an environmental indicator. This comparison was used as an alternative strategy for river water quality management based on the achievement timing of river quality standards according to their allocations.

3. Result dan Discussion

3.1 Model Conceptualization

The dynamic system approach simplifies the actual phenomenon of pollution loads flow of the river in the form of simple simulations in the 5.0 powershim program. The results of the conceptualization of pollution loads flow of the river can be seen in Figure 3. The concept of river water quality management must consider the sustainable component in the form of social, economic, and environmental aspects [24]. There is a reference to the development and application of dynamic system models in Indonesia related to surface water quality management which was carried out by Suwari et al. (2011) and Irianto et al. (2011). The results of the study in the Surabaya River show that the pollution dynamics and community participation can be described by a dynamic system [5]. In line with this research, the dynamic system can represent the dynamics of effluent nutrients N and P to the Jatiluhur Reservoir from anthropogenic activity [13]. These components were then inputted to some variables and parameters of surface water quality management, specifically rivers.

The results of the conceptualization of the pollution load as a consideration of sustainable water quality management are described in the component relationships in the causal loop diagram (CLD). The explanation is obtained founded on a break down of some relations between variables and parameters qualitatively [19]. The following was a component description in the dynamic system sub-models.

a. Sub System of Environmental

The dynamics or environmental behavior described in the CLD i.e the carrying capacity of land and the total maximum daily load of the river. The indicator of environmental quality was approached as the carrying capacity of a watershed. The factors that influence pollution load were the concentration of pollutants and river water discharge. The dynamics or discharge fluctuations are influenced by rainfall and hydrological conditions of a certain area [9]. The prediction of discharge is influenced by rainfall values [25]. This condition was able to reflect the influence of climate-changing on the pollution loads dynamics. The relationship between discharge and pollution load is positive

feedback. However, the correlation of pollution loads with water quality is negative feedback. High pollution load value has the potential to deteriorate the river water quality. The key parameters of water quality aspects are Total Solid Suspended (TSS), Chemical Oxygen Demand (COD), and Biochemical Oxygen Demand (BOD). This parameter becomes one of the reference parameters in the management of river water quality based on physical and chemical parameters of pollutants [2], [26]. These three key parameters are used as a basis for determining Total maximum daily load. The results of the study by Musemic et al. (2015), the BOD auto purification comparison can be modeled with a dynamic system [27]. Thus, indicators of the achievement of model objectives based on water quality parameters are under their allotment.

The dynamics of the land capacity in Bedadung watershed depend on the proportion of land use for industries, settlements, hospitals, agriculture, and stockbreeding. The total land area is the capacity of available land. It is used as sub variable input. If the total land was not able to meet the manifestations of land use. The assumption of land-use change can be applied to this sub-model. Agricultural land contributes directly to the pollution load in rivers. Therefore, the dynamic changes in agricultural land will affect the potential pollution load in the agricultural sector [28], [29].

b. Sub System of Social

The social sub-model as input for the environmental sub-model is the domestic activity. These activities will produce wastewater and solid waste (garbage) and will be a contributor to the pollution load in the river [5],[30]. The factors that influence the accumulation of pollution load from domestic activities were delivery load (DL), the effluent factor of each parameter, and the equivalent ratio. Solid waste or rubbish also contributes to the river pollution load, especially organic waste [31]. The relationship between organic waste and pollution load were BOD, COD, and TSS emission factors. It was influenced by the amount of unprocessed waste. The relationship between inorganic waste and river pollution load was indirect. However, the consequences of exposure to inorganic waste in rivers caused the river looks worse. It also reduced the oxygen supply in water which causes anaerobic waters. It can cause the flood to happen. The dominant factor influencing the dynamics of potential domestic pollution loads was the population growth.

c. Sub System of Economics

The industrial, livestock and agricultural activities were identified as contributors to the pollution load in the sub-economic model. Industrial activities will affect the Gross Domestic Product (GDP) and waste production [17][19][32]. Industrial and hospital sub-models (services) as contributors to pollution load have the same pattern and structure. The pollution load which is generated from the two sectors is the multiplication of the concentrations of COD, BOD, TSS and the amount of waste generated each day. The number of industries and hospitals influences the dynamics of the production of potential pollution load. Meanwhile, the sub-model of the agricultural sector which includes stockbreeding and cultivation of agricultural plants has a different structure.

Farming and agricultural sub-models will be influenced by several components of emission or effluent factors in generating pollution loads [29]. Livestock pollution load was influenced by the emissions value of the COD and BOD parameters and the number of livestock. Both components are directly proportional to the potential pollution load from the livestock activities. The potential pollution load from the activities of agricultural crop cultivation are agricultural land area, delivery load, and effluent factors. The dynamics of the potential pollution load from the livestock and agriculture sub-models in the sequence was the number of livestock, agricultural land area, and delivery load.

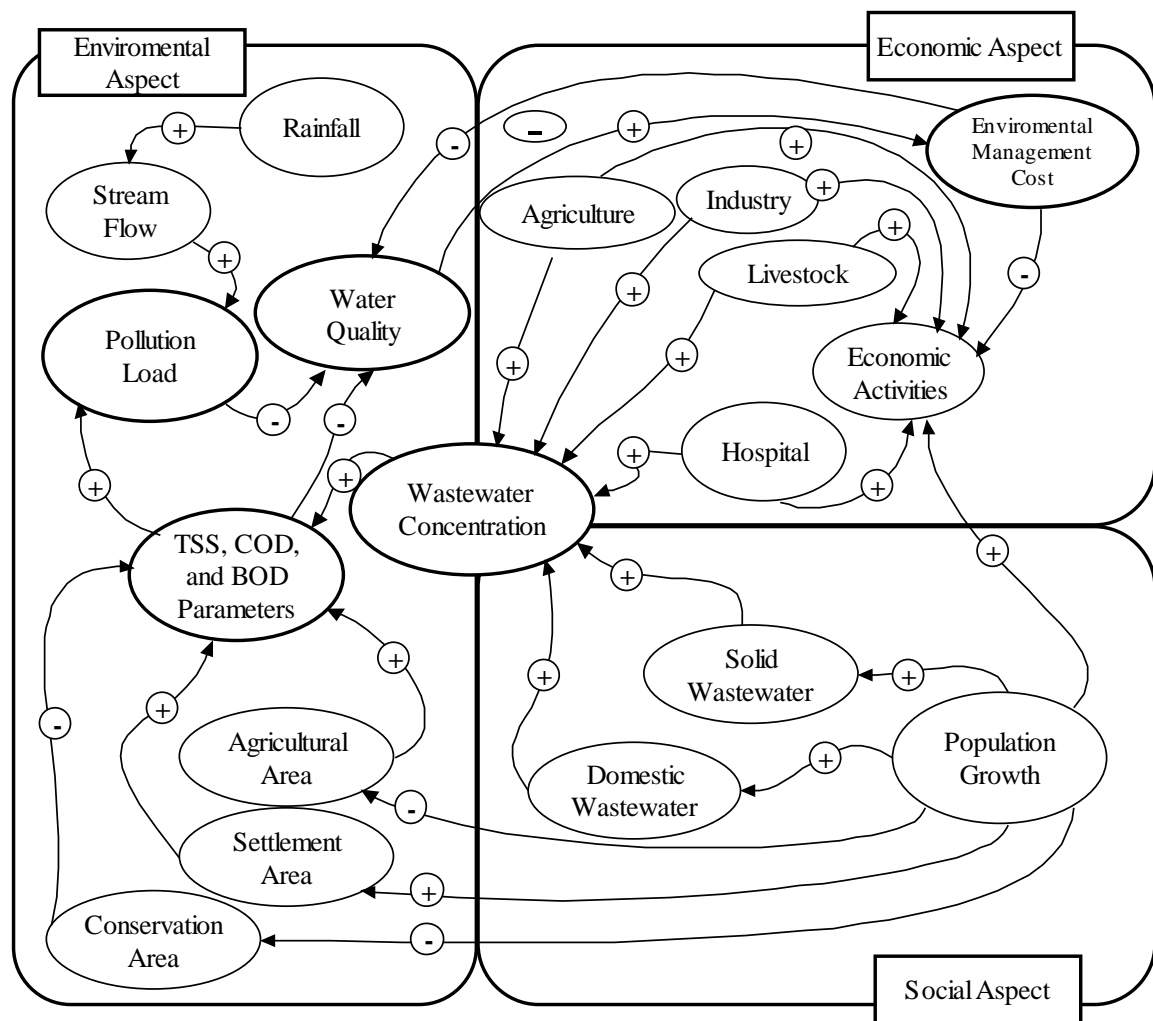


Figure 3. Causal loop diagram for water quality management

The conceptualization of the water quality management model would be used as the basis for the construction of a stock and flow diagram (SFD). Stock as a component of the model used a fixed variable input or level. These stages will include algorithms and equations. This variable and component simulation is done based on dynamic system equations and algorithms. It will quantitatively describe the dynamics of the pollution load and the capacity of the river pollution load. The feasibility of this dynamic system application was gained based on the results of testing the structure of the model and the consistency of the output model. Moreover, to examine the level of confidence in this model, the model testing needs to be done.

Model testing was categorized into two methods, i.e the verification and validation of dynamic system models. Model verification consists of the model structure that describes the actual or logical condition, the consistency of the unit, and the behavior of the model. This comparison is done by comparing real behavior (quantitative comparison behavior). Model validation is in the form of theoretical validation and output validation with an absolute mean error or means absolute percentage error [19],[33],[34]. This test is used as a basis for the feasibility of a dynamic system model for river water quality management in policy-making based on scenarios according to the expectations or objectives of the model. The test is utilized to assess the effectiveness of scenarios which carried out with a sensitivity test.

4. Conclusion

Watershed (DAS) has a complex mechanism. The phenomenon of river pollution is influenced by the dynamics of the watershed. These consequences arise due to hydrological conditions and

anthropogenic activity. The hydrological component is in the form of rainfall and water discharge. The anthropogenic activity as a contributor to the pollution load is in the form of solid and liquid domestic, industrial, and hospital waste. The SD simulation described positive and negative feedback mutual aspects based on causal loop diagram. Negative feedback in SD was wastewater runoff from domestic, agricultural, livestock, and industrial for water quality of the river. Positive feedback in SD was the total maximum daily load for the water quality of the river. The feasibility testing of the model is categorized into two methods, i.e the verification and validation of the dynamic system model. The water quality management in watershed used SD model as consideration to decision making support of sustainable river conditions by stakeholders and government both in terms of Gross Domestic Product (GDP), pollution funding or pricing, and environmental management facilities, and environmental carrying capacity.

5. Acknowledgment

Sending our gratitude to the Ministry of Research, Technology and Higher Education in Grants project of The Master Thesis Research that has been funding the research and we highly appreciate related parties who assisted us to finish this research.

6. References

- [1] R. M. Sánchez-román, M. V. Folegatti, A. M. Guadalupe, O. González, and R. Teixeira, "Dynamics system approach to assess and manage water resources in river basins," *Sci. Agric.*, vol. 66, no. 4, pp. 427–435, 2009.
- [2] R. Y. Tallar and J. Suen, "Identification of waterbody status in Indonesia by using a predictive index assessment tool," *Int. Soil Water Conserv. Res.*, vol. 3, no. 3, pp. 224–238, 2015.
- [3] Asian Development Bank, *Indonesia Country Water Assessment*. Manila, 2016.
- [4] K. K. Vade, J. Wang, L. Cao, T. Yuan, A. J. McCarthy, and R. Sejar, "Assesment of water quality and identification of pollution risk locations in Tiaxi River (Taihu Watershed)," *Water*, vol. 10, no. 183, pp. 1–18, 2018.
- [5] Suwari, E. Riani, B. Pramudya, and I. Djuwita, "A dynamic model for water pollution controlling in the Surabaya River," *J. Bumi Lestari*, vol. 2, no. 11, pp. 234–248, 2011.
- [6] Dinas Lingkungan Hidup Provinsi Jawa Timur, *an Information document on the performance of environmental management in East Java Province in 2016*. 2017.
- [7] U. Nurjanah, "Macro bentoz diversity study as a bioindicator of water quality of Bedadung River Jember," pp. 202–209, 2015.
- [8] P. Rejekiningrum, "Impact of climate change on water resources: identification, simulation, and action plan," *J. Sumber Daya Lahan*, vol. 8, no. 1, pp. 1–15, 2014.
- [9] N. El-jabi, D. Caissie, and N. Turkkan, "Water quality index assessment under climate change," *J. Water Resour. Prot.*, vol. 6, pp. 533–542, 2014.
- [10] H. Ashari, Z. Hanif, and A. Supriyanto, "Study of extreme climate impacts of high rainfall (La-Nina) on Siam Orange (*Citrus Nobilis* var. *Microcarpa*) in Banyuwangi, Jember and Lumajang Regencies," *Planta Trop. J. Agro Sci.*, vol. 2, no. 1, pp. 49–55, 2017.
- [11] R. G. N. Fauzi, D. H. Utomo, and D. Taryana, "The effect of land-use change on peak discharge in Penggung Sub-watershed in Jember Regency," *J. Pendidik. Geogr.*, vol. 23, no. 1, pp. 50–61, 2018.
- [12] Government Regulation of the Republic of Indonesia No.82 of 2001 about Water Quality Management and Pollution Control." Jakarta, pp. 1–32, 2001.
- [13] E. W. Irianto, R. Triweko, and D. Yudianto, "Long-term dynamic estimates of water quality for eutrophication control in the Waduk Jatiluhur," *J. Tek. Hidraul.*, vol. 3, no. 1, pp. 1–16, 2011.
- [14] W. Hatmoko, R. W. Triweko, Radhika, and R. Firmansyah, "Analysis of water resources management policies in river basins with analysis of the main components," *J. Sosek Pekerj. Umum*, vol. 10, no. 1, pp. 1–15, 2018.
- [15] H. A. Pradana, E. Novita, S. Wahyuningsih, and R. Pamungkas, "Analysis of deoxygenation

- and reoxygenation rate in the Indonesia River (a case study: Bedadung River East Java),” in *IOP Conference Series: Earth and Environmental Science*, 2019, vol. 243, no. 1.
- [16] Y. Wang, X. Zhou, and B. Engel, “Water environment carrying capacity in Bosten Lake basin,” *J. Clean. Prod.*, vol. 199, pp. 574–583, 2018.
 - [17] H. Liu, G. Benoit, T. Liu, Y. Liu, and H. Guo, “An integrated system dynamics model developed for managing lake water quality at the watershed scale,” *J. Environ. Manage.*, vol. 155, pp. 11–23, 2015.
 - [18] A. Elshorbagy and L. Ormsbee, “Object-oriented modeling approach to surface water quality management,” *Environ. Model. Softw.*, vol. 21, no. 5, pp. 689–698, 2006.
 - [19] I. Sharawat, R. P. Dahiya, R. Dahiya, and S. Kumari, “System dynamics approach: a novel water resource management tool,” *Int. J. Environ. Research Dev.*, vol. 4, no. 4, pp. 297–302, 2014.
 - [20] E. C. Manfredi *et al.*, “Solid waste and water quality management models for sagarmatha national park and buffer zone, Nepal,” *Mt. Res. Dev.*, vol. 30, no. 2, pp. 127–142, 2010.
 - [21] S. Park, B. J. Kim, and S. Y. Jung, “Simulation methods of a system dynamics model for efficient operations and planning of the capacity expansion of activated-sludge wastewater treatment plants,” *Procedia Eng.*, vol. 70, pp. 1289–1295, 2014.
 - [22] H. A. Pradana, E. Novita, S. Wahyuningsih, and R. Pamungkas, “Analysis of deoxygenation and reoxygenation rate in the Indonesia River (a case study: Bedadung River East Java),” *IOP Conf. Ser. Earth Environ. Sci.*, vol. 243, no. 1, 2019.
 - [23] C. B. Yackulic, “Influence of land use on water quality in a tropical landscape : a multi-scale analysis,” *Landsc. Ecol.*, vol. 26, pp. 1151–1164, 2011.
 - [24] N. Xiang, J. Sha, J. Yan, and F. Xu, “Dynamic modeling and simulation of water environment management with a focus on water recycling,” *Water (Switzerland)*, vol. 6, no. 1, pp. 17–31, 2014.
 - [25] B. Zhang *et al.*, “Quantifying the impact of climate change on streamflow dynamics of two major rivers of the Northern Lake Erie Basin in Canada,” *Sustainability*, vol. 10, pp. 1–23, 2018.
 - [26] N. Pasisingi, N. TM Pratiwi, and M. Krisanti, “Water quality of the Cileungsi River upstream based on physical-chemical conditions,” *Depik*, vol. 3, no. 1, pp. 56–64, 2014.
 - [27] R. Musemic, A. Halac, and M. Alispahic, “Oxygen depletion modeling in polluted river-testing by actual example,” *J. Trends Dev. Mach. Assoc. Technol.*, vol. 19, no. 1, pp. 137–140, 2015.
 - [28] A. Razali, S. Norkhadijah, S. Ismail, S. Awang, and S. M. Praveena, “Land use change in the highland area and its impact on river water quality : a review of case studies in Malaysia,” *Ecol. Process.*, vol. 7, no. 19, pp. 1–17, 2018.
 - [29] J. Mateo-Sagatas, S. M. Zadeh, and H. Turrall, *Water Pollution from Agriculture: A Global Review Executive Summary*. Colombo: Food and Agriculture Organization of the United Nations, 2017.
 - [30] I. Puspita, L. Ibrahim, and D. Hartono, “Influence of the behavior of citizens residing in riverbanks to the decrease of water quality in the river of Karang Anyar Tarakan City,” *J. Mns. dan Lingkung.*, vol. 23, no. 2, pp. 249–258, 2016.
 - [31] W. Yang, M. J. Chen, Y. Liu, and F. Y. Jin, “A system dynamics model for water quality management - waste load allocation,” *Adv. Mater. Res.*, vol. 291–294, pp. 1781–1785, 2011.
 - [32] S. P. Saraswati, M. V. Ardion, Y. H. Widodo, and S. Hadisusanto, “Water quality index performance for river pollution control based on better ecological point of view (a case study in Code, Winongo, Gadjah Wong streams),” *J. Civ. Eng. Forum*, vol. 5, no. 1, p. 47, 2019.
 - [33] Muhammadi, E. Aminullah, and B. Soesilo, *Analisis Sistem Dinamis Lingkungan, Sosial, Ekonomi, dan Manajemen*. Jakarta: UMJ Press, 2001.
 - [34] A. F. Walukow, “Environmental based on policy analysis about the decrease of forest area in Sentani Watershed,” *J. Mns. dan Lingkung.*, vol. 19, no. 1, pp. 74–84, 2012.
 - [35] Ford, A. *Modeling the Environment: An Introduction To System Dynamics Model Of Environmental System*. Wasington D.C: Island Press.1999.

The Development Of Student Worksheet On Science Subject SMK Based On Internet Learning Resources To Improve Learning Outcomes

Made Shita Prajnitya, . I Wayan Subagia, Desak Made Citrawathi

Postgraduate Program of Science Education, Mathematics and Science Faculty
Ganesha University Of Education, Bali-Indonesia, 81116

E-mail: shitaprajnitya@gmail.com, aigabus@yahoo.co.id, dskcitra@undiksha.ac.id

Abstract. This study aims to: (1) describe and explain the characteristics of Student Worksheets (LKS) on Natural Sciences Vocational Schools based on internet learning resources; (2) describe and explain the validity of Student Worksheets (LKS) for Vocational Natural Science subjects based on internet learning resources; (3) describe and explain the practicality of Student Worksheets (LKS) for Natural Sciences Vocational Schools based on internet learning resources; and (4) describe and explain the effectiveness of Student Worksheets (LKS) for vocational science subjects based on internet learning resources. This type of research is research and development. The development model used in this study is the modified Borg and Gall development model. The developed Student Worksheet consists of five topics. Characteristics of student worksheets developed are: (1) there is an introduction to the material from each worksheet; (2) given the problem of a phenomenon and students can identify the problem of the phenomenon then be able to make questions of each problem found; (3) there are several conceptual questions in the worksheet. (4) internet learning resources are available to find answers; (5) there is a column to fill in the summary of learning outcomes. The average score of validation for the content and construction feasibility aspects is within the valid criteria and the average score for the validation of the worksheet for each aspect is in very good criteria and both linguistic aspects. The practicality of student worksheets for the aspects of learning in the learning process are in very practical criteria. The grades obtained by students are above the KKM and achieve 100% completeness. This indicates that the LKS science-based learning resources are effectively developed to improve learning outcomes.

1. Introduction

Education is one important component in improving the quality of human resources. Quality education produces people who have good quality and quantity in terms of knowledge, morals, and character. Through national education can be developed and formed the character and civilization of a dignified nation in order to educate the life of the nation (RI Law number 20 of 2003 concerning the National Education System). Development of Education in Indonesia continues to experience development in a more advanced direction. This can be seen from the implementation of the 2013 curriculum. Learning in the 2013 curriculum requires a student-centered through scientific methods. In accordance with the mandate of the 2013 curriculum, the learning process that takes place in schools must be in accordance with a scientific approach. One of them is a science (science) lesson.

Science is the study of phenomena in the universe, including this earth, so that concepts and principles are formed (Wedyawati, 2010). Science includes knowledge, processes (skills and attitudes), and situations / contexts about nature (OECD, 2012). Science learning implemented by teachers is still monotonous and less varied so that constraints in developing and organizing learning.

This is supported by the results of research conducted by Septiana, et al. (2018), teachers still find it difficult to understand all the material taught because teachers must teach integrated material namely physics, biology, and chemistry while their expertise is still separate and the use of learning media is not optimal because in schools there are learning media available but teachers still have not used it because of lack of knowledge about the use of media, there are also schools that still do not have media that support learning.

Science learning outcomes are also influenced by the media and learning resources used by teachers. According to Widyawati and Wijayanti (2019), that the use of comic-based media obtained an average learning outcome of 86.77, while the control class obtained an average learning outcome of 77.53. Based on this the teacher in designing learning must be creative in creating learning media that is innovative, varied, interesting, contextual and in accordance with the needs of students. Learning media used by teachers today are also less developed so that the learning process is still impressed in one direction. The results of research conducted by Tania and Fadiwati (2015) show that only 25% of teachers have used e-books downloaded from the internet and teachers have never developed e-books and other learning media. However, in this case the learning media referred to is the Student Worksheet. Worksheets are printed teaching materials in the form of sheets of paper containing material, summaries, and instructions for the implementation of learning tasks that must be done by students and refer to the basic competencies that must be achieved (Prastowo, 2011).

Worksheet is one of the media that can be used by teachers to help students to find a concept and at the same time improve student learning outcomes. Hanim et al. (2017) states that the worksheet is able to improve student learning outcomes. Good worksheet in learning will provide the broadest opportunity for students to be able to develop student creativity in finding a concept or in solving a problem. Alfana, et al. (2015) stated that student worksheets had a positive effect on learning outcomes and were able to develop students' creative thinking abilities so that they could be used in learning. Furthermore, Ernawati and Yulia (2014) stated that student worksheets make students more interested and effectively used in learning. The worksheets used by science teachers are still lacking in guiding students to think critically and construct their own knowledge.

The results of observations made on January 10, 2019 at SMK Negeri 1 Singaraja, SMK Negeri 1 Seririt, SMK Negeri 2 Seririt and SMK Negeri 1 Busungbiu show that teachers who teach science subjects only use science textbooks in learning. The book used is the science book of SMK 1MAK Class X in the field of business and management expertise of the 2017 Erlangga publisher. The science book used also contains practice questions. The practice questions provided in the book are only impressed to move the sentences contained in the reference book so that the answers are fully filled. Another problem found is that worksheets are still rarely used by teachers in the learning process. Teachers sometimes make worksheets that only contain practice questions without giving problems related to the material being taught. In addition, there are no problems in LKS to guide students in solving problems by finding other learning resources such as internet learning resources. Then the unavailability of internet learning resources in the worksheet can be used by students in finding answers. Existing student worksheets make students rely only on textbooks without looking for other sources in accordance with the development of the industrial revolution 4.0.

In the era of the industrial revolution 4.0, 75% of the work involved the ability of science, technology, engineering and mathematics, internet of things (IoT), and lifelong learning (Zimmerman in Yuliati & Saputra, 2019). Education in the era of 4.0 requires learning that is able to apply between knowledge and technology in solving existing problems. The learning process is

no longer about the transfer of knowledge between educators and students, but innovative and creative learning through scientific activities. The teacher is not an expert in the field of science that is taught when learning takes place, each student has his own scientific opinion (Wiyono and Zakiyah, 2019). In accordance with the mandate of the 2013 curriculum, the learning process that takes place in schools must be in accordance with a scientific approach. One of them is a science (science) lesson. According to Yuliati and Saputra (2019), in the face of the industrial revolution 4.0, science education has an important role in producing superior human resources both soft skills and hard skills and adaptive, through their understanding of science concepts and the use of technology, students are directed to produce work to complete problems that arise in everyday life.

2. Methods

This type of research is a research and development that refers to the steps of the modified Borg and Gall model. The stages of research are: (1) needs analysis; (2) product planning; (3) product development; (4) product validation; (5) product revision 1; (6) practicality test; (7) product revision 2; (8) initial field test; and (9) revision of the final product. The validity of the contents and construction on the Student Worksheet is done by involving two experts. Practicality on the Student Worksheet were carried out by three practitioners namely the science teacher. Language validity on the Student Worksheet is done by involving one linguist. Initial field trials were conducted at SMK N 1 Busungbiu with 10 Accounting classes. The initial field trial was conducted in August 2019. Data collection techniques included observation, literature study, and tests. Data collection instruments include notes, validation sheets and test results for learning outcomes. Data analysis methods for assessing content validity and construction use the calculation mechanism according to Gregory. Cross tabulation, for the two assessors as follows

Table 1. Cross tabulation

		Assessor 1	
		Less relevant (Score 1-2)	Very relevant (Score 3-4)
Assessor 2	Less relevant (Score 1-2)	A (-, -)	B (+, -)
	Very relevant (Score 3-4)	C (-, +)	D (+, +)

The practicality of the student worksheet is determined by converting the average score sheet based on the criteria in table 2

Table 2. Criteria of Practicality

Span	Category
3,5 \square SR \square 4,0	Very practical (very decent)
2,5 \square SR \square 3,5	Practical (Decent)
1,5 \square SR \square 2,5	No practical (no feasible)
1,0 \square SR \square 1,5	Very impractical (no very feasible)

(Sadra in Kumala, 2013)

The effectivity of student worksheets was analyzed descriptively by describing the value of student learning outcomes obtained from the posttest and describe the learning process during the use of worksheets.

3. Results And Discussion

The results of this study are in the form of student worksheets of Vocational Natural Science subjects based on internet learning resources to improve student learning outcomes. The developed worksheets were semester 1 of the Natural Sciences worksheets which consisted of five topics

3.1. The Characteristics Of The Science Worksheet Based On Internet Learning Resources

The characteristics of the Science Worksheet based on internet learning resources developed, namely: (1) there is an introduction to the material from each Worksheet; (2) given the problem of a phenomenon and students can identify the problem of the phenomenon and then be able to make questions of each problem found; (3) there are several conceptual questions in the worksheet. (4) internet learning resources are available to find answers; (5) there is a column to fill in the summary of learning outcomes.

3.2 Validity of Student Worksheet

Validation of student worksheet is obtained through expert. Validation by experts from the science education lecturers and Indonesian language lecturers. The average validation score for the content and construction feasibility aspects of student worksheet 1 is 0.6 with valid criteria, student worksheet is 0.8 with very valid criteria, student worksheet 3 is 0.6 with valid criteria, student worksheet 4 is 0.7 with valid criteria and student worksheet 5 that is 0.6 with valid criteria. The aspect of language assessment is 3.8 with valid criteria in terms of language. Overall the validity of the student worksheet developed was categorized as valid and feasible to use. Although the student worksheet that are developed are valid and appropriate for use in learning, but there are still some suggestions that must be followed up to be revised so that the student worksheet that are developed become better. The results of the content validation test by the experts can be seen in full in table 3 below.

Table 3. Content and Construction Validation Results of Experts

Number	Worksheets	Score	Criteria
1	Worksheets	0,6	High validity
2	Worksheets	0,8	Very high validity
3	Worksheets	0,6	High validity
4	Worksheets	0,7	High validity
5	Worksheets	0,6	High validity

The results of the validity study of the worksheet were in the valid and feasible category, this is in line with research conducted by Saidah et al. (2014), shows that the average validity score of the Natural Sciences LKS is 3.9, including the feasible category. Furthermore, research conducted by Anggraini et al. (2016), which shows that the student worksheet validity score is 3.8 in the valid category.

3.3 Practicality of Student Worksheet

The practicality of the student worksheets (LKS) developed was measured by the implementation of the science worksheet based on internet learning resources in the classroom. From the research results the average score of practicality in student worksheet 1 is 3.70 with very practical criteria (very feasible), student worksheet 2 is 3.78 with very practical criteria (very feasible), student worksheet 3 with very practical criteria (very feasible) , student worksheet 4 is 3.81 with very practical criteria (very feasible) and student worksheet 5 is 3.85 with very practical criteria (very feasible). The results of the complete practicality analysis of the student worksheet can be seen in full in table 4 below .

Table 4. Summary of Practical Results of Student Worksheets

Number	Worksheets	Score	Criteria
1	Worksheets 1	3,70	Very practical
2	Worksheets 2	3,78	Very practical
3	Worksheets 3	3,92	Very practical
4	Worksheets 4	3,81	Very practical
5	Worksheets 5	3,85	Very practical

3.4 Effectivity of Student Worksheet

The effectivity of worksheets is measured by the achievement of learning objectives by using the worksheets developed. To determine the effectiveness of student worksheet performed by providing tests of learning outcomes and observations of the learning process. Based on the results of data analysis, the learning outcomes of 36 students from SMK Negeri 1 Busungbiu overall scored above the KKM. This indicates that the worksheet for natural science based on internet learning resources can improve learning outcomes. This is in line with research conducted by Wijayanti, et al. (2015) that the students' creative thinking ability improved after the application of the Science Worksheet based on multiple intelligences. In addition, the results of other studies by Judges, et al. (2018) found that students' scores from cognitive, affective, and psychomotor aspects showed a high percentage after applying guided inquiry-based

worksheets on reaction rate subjects. Based on observations during the application of the student worksheet, students are more active in learning. This is shown from students actively asking when finding problems after observing the contextual phenomena that exist in the LKS. In addition, students are able to find answers to each of the questions given. During the learning process using student worksheet based internet learning resources, students are able to find answers from each learning source that is referenced.

4. Conclusions And Suggestions

Based on the results and discussion, it can be concluded that as follows: (1) Natural science student worksheet based on internet learning resources is declared valid from the aspect of content validity and construction; (2) Natural science student worksheet based on internet learning resources is declared practical from the aspect of implementation in learning; (3) Natural science student worksheet based on internet learning resources is declared effective in the learning process and can improve student learning outcomes. Some of the suggestions are as follows: (1) Natural science student worksheet based on internet learning resources should be used as a learning medium in various schools; (2) Natural science student worksheet based on internet learning resources should be used as a reference for developing student worksheet in other subjects.

References

- [1]. Alfana, M., Dewi, R, N & Sukaesih, S. 2015. Pengembangan Lembar Kerja Siswa IPA Terpadu Berbasis Konstruktivisme Tema Energi Dalam Kehidupan Untuk Siswa SMP. *Journal USEJ*. 4(1): 720-727.
- [2]. Anggraini, R., Wahyuni, S., & Lesmono, A.D. 2016. Pengembangan Lembar Kerja Siswa (LKS) Berbasis keterampilan Proses Di SMAN 4 Jember. *Jurnal Pembelajaran Fisika*. 4(4):350-356.
- [3]. Ernawati, M. D. W, & Yulia. 2014. Pengembangan Lembar Kerja Siswa Berbasis Laboratorium Materi Titration Asam-Basa untuk Siswa Kelas XI SMA Negeri 3 Kota Jambi. *J. Ind. Soc. Chem*. 6(1): 41-50.
- [4]. Effendi, E. & Zhuang, H. 2005. *E-learning, Konsep dan Aplikasi*. Yogyakarta: CV.Andi Offset.
- [5]. Hakim, L., Sugiarta & Jusniar. 2018. Pengembangan Lembar Kerja Siswa (Lks) Berbasis Inkuiri Terbimbing Pada Materi Pokok Laju Reaksi Untuk Siswa Kelas XI IPA SMA. *Jurnal Nalar Pendidikan*. ISSN 2339-0749. 6(1). 47-54.
- [6]. Hanim, F., Suyanti, R.D., & Harahap, F. 2017. The Effect Of Students' Worksheet Based On Skill Of Science And Motivation Process Toward Learning Outcomes At Grade 4 Sdnegeri 164330 Tebingtinggi. *Journal of Research & Method in Education*. ISSN 2320-7388. 7(5): 57-61.
- [7]. OECD. 2012. PISA 2012 Result: What Students Know and Can Do-Student Performance In Reading, Mathematics and Science, Vol I. Paris: OECD Publishing.
- [8]. Saidah, N., Parmin., & Dewi.N.R. 2014. Pengembangan LKS IPA Terpadu Berbasis *Problem Based Learning* Melalui *Lesson Study* Tema Ekosistem Dan Pelestarian Lingkungan. *Journal USEJ*. ISSN 2252-6617. 3(2):549-556
- [9]. Sari, R., Harijanto, A & Wahyuni, S. 2018. Pengembangan LKS IPA Berbasis Kearifan Lokal Kopi Pada Pokok Bahasan Usaha dan Energi Di SMP. *Jurnal Pembelajaran Fisika*. 7(1): 70-77.
- [10]. Septiana, N., Rohmadi, M., Nasir, M & Nastiti, L.R. 2018. Kesulitan Guru IPA SMP/MTS Mengajarkan IPA Terpadu Di Kalimantan Tengah. *Jurnal Pendidikan Sains & Matematika*. ISSN 2338-4387. 6(1):1-11
- [11]. Setyanto, H., Sudarmin & Dewi, N.R. 2015. Pengembangan LKS IPA Berbasis *Problem Based Learning* Pada Tema Pencemaran Lingkungan Guna Menumbuhkan Kemandirian Siswa. *Journal USEJ*. ISSN 2252-6617. 4(3): 990-997.

- [12]. Tania, L & Fadiawati, N. 2015. The Development Of Interactive E-Book Based Chemistry Representations Referred To The Curriculum Of 2013. *Jurnal Pendidikan IPA Indonesia*. 4(2):164-169
- [13]. Turer, B & Kunt, H. 2015. A Review of Relationship between Prospective Science Teacher's Attitudes Towards Science Education and Their Self-Efficacy. *Journal of Education and Training Studies*. 3(6): 166-178.
- [14]. Wedyawati, N. 2010. *Ilmu Alamiah Dasar*. Nanga Pinoh: Sekolah Tinggi Keguruan dan Ilmu Pendidikan Melawi.
- [15]. Widyawati, A & Wijayanti, A. 2019. Pengaruh Media Komik Sains Berbasis Karakter Terhadap Minat Baca Dan Hasil Belajar Mahasiswa Pendidikan IPA. *Jurnal LP3M*. 5(1):66-77

Development of Chemistry Learning Book Based on Case Study to Improve Students' Learning Outcome

L A Widiandari¹, I W Redhana,² and A A I A R Sudiarmika³

Universitas Pendidikan Ganesha, Indonesia, Jalan Udayana 11 Singaraja Bali 81116
Indonesia

*adewidiandari3@gmail.com, redhana.undiksha@gmail.com, r_sudiarmika@yahoo.co.id

Abstract. This study aimed to describe the characteristics, validity, practicality, and effectiveness of case study based chemistry learning books. This type of research is research and development by adopting a 4-D model by Thiagarajan. The research phase carried out is until develop step, namely validity, practicality, and effectiveness. The study design used one group pretest-posttest. Data analysis techniques used descriptive statistics for validity, practicality, and effectiveness of learning books. The research product was in the form of chemistry learning books based on case studies of class XI on colloid topics. Research data includes needs analysis data (literature studies and field studies), product planning results data, validity results data, practicality results data, and effectiveness of chemistry learning books. The results of the study showed that (1) the characteristics of the learning books developed presented cases related to chemical materials, (2) the validity of learning books that were developed received very valid categories in terms of content and media, (3) the practicality of learning books developed that were very practical, and (4) the learning books developed were effective in improving student learning outcomes viewed from the test results of the proportion of one sample amounted to 0.86 and supported by a normalized gain score of 0.59 (medium category).

1. Introduction

Chemistry is a science that has special characteristics. One of the peculiarities is to study abstract concepts, but chemistry is actually very closely related to daily life. Chemistry is also related to analyzing and resolving cases [1]. In studying chemistry, students assume that chemistry lessons are difficult to understand, especially in solving analytical problems related to problem solving skills. This can be proven when students are offered chemical problems related to real life [2]. Students have not been able to apply the knowledge (theories and concepts) they have to solve these problems. Most students are unable to make a link between what they are learning and how that knowledge can be utilized. Respond to the problem, to optimize the quality of education and to help students relate theories (concepts) with context, it is very suitable if learning is managed by applying learning to case study methods.

The case study method is a method that involves a process of analysis using a variety of techniques, materials, and equipment regarding symptoms or problems in groups [3]. This method teaches students an alternative understanding of the concept based on cases. Learning involves cases that are scenarios based on everyday life as well as learning questions related to cases, which allow students to discuss their ideas [4].

The application of learning case study methods makes students motivated to learn and understand material, integrate cases with concepts of knowledge, and encourage students to develop professional skills such as collaboration and communication [5]. The use of case study methods can also improve critical thinking skills, increase student enthusiasm in attending lectures, and create a democratic environment in learning [6]. Similarly, the results of [1] show

that learning chemistry through the application of module-assisted case study methods can improve critical thinking skills and increase enthusiasm student for learning. Meanwhile, the results of the study [7] shows that the process of solving cases in discussions can provide opportunities for students to think and give satisfaction to find new knowledge for students. In addition, the case study method implemented in the discussion activities can develop the ability of students to test their own ideas and understanding so as to facilitate the learning process and improve learning outcomes. Based on this, the case study method is suitable to be applied in chemistry learning, given that chemistry is closely related to daily life so that by giving cases can make it easier for students to solve problems.

The application of the case study method can be applied to learning books. Based on preliminary studies conducted by ten teacher chemistry high school in Denpasar city, learning books are very important in chemistry learning. Learning books used by students are like books from Erlangga and Yudistira publishers. 80% of teachers say that the learning books used have not been able to help the learning process. In addition, as many as 70% of teachers said that the learning books used did not present cases related to chemical materials while the rest said that the books had presented cases, but the percentage of case presentation was still very low (0-20%). There are no students who use learning books developed by teachers, so the concept of existing learning books has not been developed based on the characteristics and needs of students. Therefore, learning books do not meet the standards on accordance with the characteristics of students, which are listed in the curriculum 2013.

Analysis of class XI chemistry learning books was also carried out to support the results of the preliminary study. The result is learning book has presented a case, but the percentage of case presentation is still very low. Not all chapters in learning books present cases, so they do not train students thinking skills. One of the cases presented in the textbook is smoke and fog.

Based on the problems above, it is need to develop chemistry learning books based on case studies. The cases presented are related to chemical material and more cases are presented. This research is research and development. This research adopted from 4-D model by Thiagarajan, such as define, design, develop and disseminate. The purpose of define stage is stipulate and define instructional requirements. The purpose of design stage is to design prototype instructional material. The purpose of develop stage is to modify the prototype instructional material, and the purpose of disseminate step is deploy product. On this stage, only reached until develop stage due to time and cost limitations.

2. Method

This type of research is research and development. This research adopted from 4-D model by Thiagarajan, such as define, design, develop and disseminate. On this stage, only reached until develop stage due to time and cost limitations. This research was conducted at SMA Negeri 6 Denpasar semester II of the 2018/2019 school year in class XI MIPA 5, with 36 students. The research procedure starts from the stages: (1) define stage including front-end analysis, students' analysis, task analysis, concept analysis, and specifying instructional learning objectives, (2) design stage including designing a case study learning book, (3) develop stage including testing of validity, practicality and effectiveness of the case study learning book. The instruments used in this study were questionnaires, case study book assessment sheets, and tests. The types of tests used in this study are objective tests and descriptions. The data in this study were analyzed using descriptive analysis techniques. Validity and practicality data can be determined by calculating the average score. Data of effectiveness can be determined using one sample proportion test and

supported by normalized gain score. Test results of the proportion of one sample are calculated with the SPSS-PC 16.0 program for Windows. While, the normalized gain score can be determined using the formula as follow.

$$g = \frac{Sf - Si}{\text{maximum score} - Si}$$

Information:

g = normalized gain score

Sf = average score of posttest

Si = average score of pretest

3. Result and Discussion

Case study-based chemistry learning books are products that have been developed and have passed the stages of research and development of the 4-D model according to Thiagarajan. The stages taken include define, design, and develop stages. In the define stage, obtained (1) need analysis data of teachers and students by distributing questionnaires about case study learning book. The results of teachers' need analysis data state that the percentage of case presentation in book used by students is still very low at 0-20%, so teachers thought case study learning book need to developed. The results of students' need analysis data show that 27.1% of students are not able to understand the chemical material in the books. (2) The results of students' analysis data seen from the shape of learning style showed 41.67% of students' tend to visual learning styles. The results of students' analysis data seen from the shape of learning motivation showed sufficient category with the level of student motivation of 75.75%. Next, the results of students' ability data were obtained from the students' chemistry test. The results of students' ability data showed that 58.33% of students' chemistry test results have not exceeded the KKM. (3) The results of task analysis data show that task given by the teacher to students on the topic of colloids is project for making sulfur soles and gelatin. (4) The concept of analysis data on the topic of colloids shows 36% is a type of concept based on principles. (5) The specifications of learning objectives are formulated based on core competencies and basic competencies used to design learning tools, then integrated into the material in case study learning books. In the design stage, the design of learning devices and the characteristics of case study learning book are obtained. The characteristics of case study learning book are presenting cases related to chemical material. Characteristics of case study learning book can be seen in Figure 1.



Figure 1. The Characteristics of Case Study Learning Books

In the develop stage, the validity of learning book is tested first. Validity test is conducted to determine the validity of learning book content and media. This validation involved two chemistry lecturers and two chemistry teachers. The results of validity test showed the validity of learning book content and media were respectively very valid with scores of 4.58 and 4.61. Similarly, the results of [8] that the development of learning books oriented to problem solving is classified as very valid because, the results of the criteria for expert validity and related to instrument indicators amounted to 85.46%. Research of [9] declare a developed learning books obtain a very valid assessment from experts, refinements, and students, as well as all parameters proposed in the component which were responded to very positively by respondents. In addition to providing an assessment, the validator gave a positive response to the case study learning book and some suggestions for improving the learning book. All input provided by the validator has been improved, since the improvement is important to perfect the learning book developed. Research of [10] states that products that have been validated by experts will be known to be deficiencies of the products developed so that the deficiencies of these products are then tried to be reduced by improving the product. The product developed is expected to be able and feasible to be used in chemistry learning and can be tested on students.

Readability test data conducted by nine students at SMA Negeri 6 Denpasar showed that the readability of the case study learning books was good and very good. The practicality test on the case study learning book involved three chemistry teachers and 36 students of class XI. Practicality data shows that the case study learning book is very practical with an average score of 4.36.

The effectiveness test of the case study learning book involved 36 students of class XI in SMA Negeri 6 Denpasar. Data were analyzed using a normalized gain score and the results of one sample proportion test. Normalized gain score calculation is seen from the average pretest and posttest scores of students, while the test of one sample proportion is seen from the results of posttest students who passed the percentage of classical completeness. A Summary of students' learning outcome can be seen in Table 1.

Table 1. Summary Study Result

Description	Score	
	<i>Pretest</i>	<i>Posttest</i>
Min	23,33	60,00
Max	70,00	90,00
Average	44,44	77,50
Deviation Standard	12,29	7,14
Gain Normalized	0,59	

Normalized gain scores indicate that student learning outcomes using chemistry learning book based on case studies have increased in the moderate category. Furthermore, the data were analyzed by the test of one sample proportion seen from the posttest results of students who passed the classical completeness of 0.85.

In the test of one sample proportion, if the value of sig. < from 0.05 then, H_0 is rejected and H_a is accepted, conversely if the value of sig. > from 0.05 then H_0 is accepted and H_a is rejected. The hypothesis tested in this study is as follows.

$H_0: \pi \leq 0.85$: learning books developed are not effective in improving student learning outcomes.

$H_a: \pi > 0.85$: learning books developed effectively improve student learning outcomes. Test results of the proportion of one sample can be seen in Table 2.

Table 2. One Sample Proportion Test Results

Binomial Test					
	Category	N	Observed Prop.	Test Prop.	Exact Sig. (1-tailed)
Score	Group 1 ≤ 70	5	,14	,15	,041 ^a
	Group 2 > 70	31	,86		
	Total	36	1,00		

a. Alternative hypothesis states that the proportion of cases in the first group $< ,15$

Based on the table above, it can be concluded that the case study learning book can improve student learning outcomes seen from the test results of one sample proportion by 0.86 and is supported by a normalized gain score that is classified as moderate category.

This development research is supported by other research data. Chemistry learning books based on case study is intend to improve student learning outcomes. Learning that applies the case study method can further stimulate student enthusiasm for learning in the classroom, so as to improve learning achievement [11]. In addition, case studies can also improve students' critical thinking skills [12; 13; 9; 1]. Case-based learning can also motivate students to learn and understand material, integrate cases with concepts of knowledge, and encourage students to develop professional skills such as collaboration and communication [5].

The effectiveness of learning books in improving students learning outcomes is caused by several factors. Chemistry learning books based on case study where the sources of student learning are cases related to chemical material that they must criticize. Each case provided allows students to stimulate thinking skills. Students are given the opportunity to find out or know cases related to chemistry and prove by finding information from various sources to find the answer. Similar to [7], that the effectiveness of learning case studies can be seen from the following points. 1) maximum student involvement in learning, 2) the existence of questions and answers makes students active in critical thinking and increases student learning activities, 3) often practice solving cases makes students have skills and dexterity in solving problems, and 4) with the use of audio media-visuals can help students understand abstract and complex concepts.

4. Conclusion

Based on the findings of research and discussion, it can be concluded that the characteristics of case study-based chemistry learning books was presenting cases related to chemical material. The validity result of the chemistry learning books from the content validator and media are classified as very valid category. The results of practicality are classified as very practical category. The results of the effectiveness of learning books are classified as effective in improving student learning outcomes. This can be seen from the acquisition of the normalized gain score in the medium category and the test result of the proportion of one sample of 0.86.

5. Acknowledgments

Acknowledgments are addressed to: the supervisors for advice and input provided during the study, the head of SMA Negeri 6 Denpasar for permission so that this study could be carried out properly, the teachers who had helped in collecting data about this study, extended families who have provided support, advice and input during the study, and colleagues who have provided assistance so that study can run smoothly.

6. References

- [1] Arum D R and Minangwati S 2014 *Journal Chemistry in Education* **3** 2
- [2] Surakarta I N, Sudiana I K and Sastrawidana I D K 2010 *Jurnal Pendidikan dan Pengajaran* **43** 3 199-206
- [3] Mantiri J 2017 *Jurnal Forum Pendidikan* **13** 2 69–78
- [4] Yalçinkaya E, Taştan-Kirik O, Boz Y, and Yildiran D 2012 *Research in Science and Technological Education* **30** 2 151–172
- [5] Brown K, Commandant M, Kartolo A, Rowed C, Sultan H, Toor K, and Wininger V 2009 *Interdisciplinary Journal of Health Sciences* 48–66
- [6] Anggraeni L 2012 *Jurnal Media Komunikasi FIS* **11** 1 1–15
- [7] Sumarni W, Soeprodjo, and Rahayu K P 2009 *Jurnal Inovasi Pendidikan Kimia* **3** 345–353
- [8] Hanik U and Rusmini 2016 *Unesa Journal of Chemical Education* **5** 2 223–231
- [9] Situmorang M 2013 *Prosiding Semirata FMIPA Universitas Lampung*
- [10] Sugiyono 2014 *Metode Penelitian Pendidikan* (Bandung: Alfabeta)
- [11] Ksaid N H 2015 *Edukasi Alternatif Wacana Pendidikan XI* 183-198
- [12] Gholami M, Saki M, Toulabi T, Moghadam P K, Pour A H, and Dostizadeh R 2016 *Journal of Professional Nursing*
- [13] Huang Y, Chen H, Yeh M, and Chung Y 2012 *International Journal of Nursing Studies* **49** 6

Development of Multiple Representations Chemistry Learning Book to Improve Students' Learning Outcomes

K Widiastari, I W Redhana, and N K Rapi

Science Education Magister Study Program, Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Pendidikan Ganesha, Jalan Udayana 11 Singaraja Bali 81116 Indonesia

*kadekwidiastari95@gmail.com, redhana.undiksha@gmail.com, ketutrapi@yahoo.com

Abstract. This study aimed to produce a multiple representations chemistry learning book. The study was a research and development by adopting a 4-D model by Thiagarajan. The study included define, design, develop, and disseminate steps. However, the disseminate step was not carried out. The data needed on this study were data from define phase (front-end analysis, students' analysis, task analysis, concept analysis, and specifying instructional objectives), product design data from design phase, and product development data (validity, practicality, effectivity). The data were analyzed by descriptive analysis techniques. The results showed (1) teachers and students considered that the learning book was important to use in chemistry learning, (2) the learning book contained three levels of representations of chemistry concepts, including macroscopic, sub-microscopic, and symbolic, (3) the learning book had included very valid, very practical, and effective categories. Based on the study, the learning book could be applied to improve the students' learning outcomes.

Keywords: learning book, learning outcomes, multiple representations

1. Introduction

Chemistry is considered a difficult subject for students. This is due to the abstract nature of chemical concepts, how teacher teach chemistry in the classroom, the lack of teaching tools and difficulties in chemical terms [1]. Lack understanding of the nature of chemistry is also one of the causes [2]. Chemistry is the study of composition, properties, changes in matter, interactions between matter and energy that accompany it. The abstract characteristics of chemistry can be well understood by paying more attention to three levels of chemical representation. First, visible (macroscopic) level, the invisible (sub-microscopic) level, and the symbolic level [3].

If the three level of chemistry concepts is well understood by students, then it'll contribute to the quality of students' understanding of chemistry which will be reflected in students' mental models in explaining chemical phenomena [4]. Because of that, it is important for students to have a complete understanding of three levels of chemical representations (multiple representations).

Multiple representations take a role as a limitation for students in interpreting new representations that they don't know yet, so that students will avoid the misconceptions [5]. Other than that, multiple representations can also be used by students in solving problems. In the learning process, students can choose to use which representations that are appropriate to the situation of the problems they face [6].

From several studies that had been done, the representation ability of students in chemistry learning is still low. The results of research conducted by Desyana *et al.* showed the highest ability of students is known in the symbolic level, especially in the problem of determining elements that are included in the metal [7]. While, the lowest ability of students is in the sub-microscopic level is in the problem of determining the solute and solvent. Inayati and Melati research found that most students have not been able to connect macroscopic, sub-microscopic and symbolic aspects, so that students' answers and reasons are sometimes incompatible with chemical concepts, for example: iron which is turned into a pot is said to form new substances [8]. Wiyarsi research shows that the ability of chemical representation in reaction rate topic is low, especially at the sub-microscopic level, for example: students misrepresent particles [9].

Based on that studies, it can be concluded that the ability of students in multiple representations is still low at all levels, especially at the sub-microscopic level, so it is not surprising that chemistry is considered a difficult subject.

There are several causes of the low multiple representations ability of students. First, the chemistry learning process that lacks integration of the three chemical levels [7] [8] [9]. Second, students cannot imagine and cannot visualize sub-micro aspects [10]. Third, students are not able to explain if the three aspects were changed their representation [10]. Therefore, teachers must be creative in managing chemistry learning.

Chemistry learning that links three levels of chemical concepts can be presented in the form of multiple representations learning book. Helsy *et al.* state that multiple representations are the factor in making students success in enhancing the ability to link the macroscopic, submicroscopic and symbolic levels [11]. Research conducted by Karacop & Doymus shows that learning with multiple representations helps improve students' understanding of chemistry [12]. In addition, research by Ernida, *et al.* shows that multiple representations can improve students' critical thinking [13]. All of that will certainly have a direct impact in improving students' learning outcomes in chemistry. Based on that, we were interested to develop multiple representations chemistry learning books to improve student learning outcomes.

2. Method

This study was done by conducting 4-D model by Thiagarajan [14]. However, this research did not carry out the disseminate stage. This study consists of three main phases, namely: 1) define including front-end analysis, students' analysis, task analysis, concept analysis, and specifying instructional objectives, 2) design including preparation of syllabus, lesson plan and the multiple representations chemistry learning book, 3) develop testing of validity, practicality and effectivity of the book. The instruments used in this study were questionnaires, learning book assessment sheets and test.

Data in this study including data from define phase, product design data from design phase, and product development data (validity, practicality, effectivity) from develop phase. We also got teachers and students response data as an additional data to know how was their responses after using the learning book.

Data from define phase obtained by distributing questionnaires to 64 students and 10 teachers randomly in Denpasar area, product design data obtained after the initial draft of learning book produced, validity data is obtained by distributing learning book and assessment sheets to two lecturers of Undiksha Chemistry Department and one chemistry teacher at SMAN 5 Denpasar, practicality data obtained by distributing practicality assessment sheets to two chemistry teachers from SMAN 4 Denpasar and one chemistry teacher from SMAN 5 Denpasar, and effectivity data obtained by conducting a limited test involving 35 students of grade XI from SMAN 4 Denpasar. Teacher and student response data obtained by distributing questionnaires to teachers and students who use the multiple representations chemistry learning book.

The data is then analyzed with descriptive analysis techniques. The categories of validation and practicality are presented in Table 1.

Table 1. The qualitative categories of validity and practicality of learning book

Score Range	Qualitative Category
$\bar{x} \geq 4$	Very Valid / Very Practical
$3,3 \leq \bar{x} < 4$	Valid / Practical
$2,7 \leq \bar{x} < 3,3$	Enough
$2,0 \leq \bar{x} < 2,7$	Invalid / Impractical
$\bar{x} < 2,0$	Very Invalid / Very Impractical

Data of effectivity was concluded with a normalized gain score analysis. The calculation of the gain score normalization is as follows.

$$g = \frac{S_f - S_i}{\text{max score} - S_i} \quad (1)$$

Information:

g = normalized gain score

S_f = average score of posttest

S_i = average score of pretest

The categorization of the normalized gain score is presented in Table 2.

Table 2. Categorization of the normalized gain score

g Value	Qualitative Category
$g \geq 0.7$	High
$0.7 > g \geq 0.3$	Moderate
$g < 0.3$	Low

3. Result

3.1 Define phase

On this phase, we knew teachers agreed that chemistry learning book is important in learning chemistry. However, the learning book that used by students were not based on multiple representations. Teachers also agreed that multiple representations chemistry learning book need to be developed. The teacher also gave several suggestions on developing a multiple representations chemistry learning book, including: 1) the introduction of topic should starts with a concrete example that attracts students' attention that is clarified with sub-microscopic and symbolic representations; 2) multiple representations should be displayed clearly and attractively so that students enjoy learning chemistry; 3) the learning book should be easily understood, interesting and in accordance with the curriculum; 4) multiple representations should presented correctly according to the concept of chemistry and its presentation can be easily understood by students.

In other hand, on students side we knew they also agreed learning book is important things that students must have. Students also convey a number of things that students need in chemistry learning book, including: 1) exercises and discussion need to be added; 2) need more images and colors to make it interesting; 3) the explanation of the topic should be simplified, so that it is easy to understand; and 4) should added more practical/experimental activities.

The students' analysis results are divide into students' learning style, motivation, and of students' completeness. Based on the learning style (according to VAK learning style), the percentage of students who have a visual learning style is the highest. So that, it can be concluded students are more inclined to the visual learning style. Based on the analysis of student motivation data, the level of student motivation classified in sufficient category. The last, the results of the analysis of students' completeness seen from the completeness of the daily tests of chemistry it was found that 56% of students had not passed the minimum standard.

Task analysis results was accordance with 2013 curriculum. Students are required to have a competence to make a food or other products that are involved colloidal principles. From that, we know the learning book need to add activities to make a food or other products that are involved colloidal principles. From the concept analysis, we found colloidal concept consist of 14.29% abstract with concrete examples concepts, 33.33% concrete concepts, 42.86% principal based concept, and 9,52% concepts that describe process. Accordance to 2013 curriculum we specified six instructional learning objectives on colloidal that used in developed a multiple representations chemistry learning book.

3.2 Design phase

The multiple representations chemistry learning book contains explanation of the concept by presenting three levels of chemistry concepts (macroscopic, sub-microscopic, and symbolic). The learning book also using various colors, images, and contain interesting info.



Figure 1. The layout of multiple representations chemistry learning book

3.3 Develop phase

The results of this phase are divided into several parts, including: 1) validity, 2) practicality, 3) effectivity, and 4) teacher and student responses to the use of the learning book.

The validity test divided into two, content validity and media validity. The results showed that the learning book was classified very valid as presented in Table 3.

Table 3. Validity test results

No	Aspects	Score	Category
1	Content validity	4.12	Very valid
2	Media validity	4.46	Very valid

During the validation process, the validator also provides comments and suggestions for revising the book, so that we can produced the better one for use in the learning process.

Practicality assessment covers several aspects: ease of carrying, ease of distribution and storage, ease of use, usefulness for users, efficient in time, and language. The results showed that the learning book was classified very practical as presented in Table 4.

Table 4. Practicality test results

No	Aspects	Score	Category
1	Practicality (from teachers)	4.52	Very practical
2	Practicality (from students)	4.42	Very practical

The effectivity test was carried out by conducting pretest and posttest involving 35 students from SMAN 4 Denpasar. The summary of pretest, posttest and normalized gain scores that obtained are presented in Table 5.

Table 5. Summary of pretest, posttest and normalized gain scores

Description	Score
-------------	-------

	Pretest	Posttest
Highest	73.00	92.00
Lowest	13.00	56.00
Average	43.70	79.43
Standard deviation	14.45	8.15
Normalized gain score		0.63

Based on Table 5, it was known that student learning outcomes increase and the results of normalized gain score was classified in moderate category so it can be concluded that multiple representations chemistry learning book is effective to improve student learning outcomes.

4. Discussion

Chemistry will be easily understood by linking three levels of chemical concepts, namely the level of the invisible (macroscopic), the level of the invisible (sub-microscopic) and the symbolic level. Chemistry learning that links these three levels is expected to increase students' understanding of chemistry learning and can change students' perceptions of chemistry lessons.

The difference between the multiple representations chemistry learning book and the learning book that used by students before was lied in the characteristics of the book. The characteristics of the multiple representations chemistry learning book is present a chemical concept by displaying three level representations of chemistry concepts (macroscopic, sub-microscopic, and symbolic) according to the Johnstone triangle [15].

Representation of macroscopic concepts presented with real pictures/photos of objects or everyday phenomena that are often seen by students. Representations of sub-microscopic concepts are presented with pictures of particle models and the structure of compounds that made in variety color to make them interesting for students. Symbolic representations presented with term, chemical symbols, chemical equations and chemical reactions. Presenting concept with pictures, various color, and animation is very suitable for students' learning styles (according to VAK learning style) because from students' analysis most of students have a visual learning style.

The developed learning book is also complemented by practical activities, such as observing differences and doing some experiments. Practical activities presented in the developed learning book are expected to increase student interest in learning, because experimental activities are things that make students curious to learn chemistry [16]. It was also accordance to students need based on need assessment in this study.

The learning book that was developed also contains small notes to make it easier for students to focus on important things in a chapter, interesting info that contains information about things that happen to students' daily lives that are still related to the topic presented, and additional information that contains additional information beyond the topic presented. The present of notes, interesting info, and additional info can increase students' insights about the role of chemistry in daily life while increasing student interest in learning chemistry.

The beginning of every chapter in the book contains introductory paragraphs and pictures of objects or phenomena related to the chapter to attract students' curiosity. In addition, several analogies are also used in this book to make students easier to understand the topic presented. This learning book also used communicative language, so that it is easy for students to understand.

The validation of the developed learning book was focus on content and media validation (graphics, and language) obtained from validators. Content validity means that the development process has been based on theories that are used as guidelines in the preparation of chemistry learning book. Graphic validity means that the learning book has paid attention to the physical attractiveness or appearance of the learning book. Language validity means the use of language is accordance with language rules.

The final validation test results showed that the multiple representations chemistry learning book was included into very valid criteria. In addition to giving score, validators also provide input and comments on the learning book. In aspect of display, validators agree that in general the display of learning book

was good. In the aspect of content, comments were given regarding the depiction of concept maps, the use of chemical terms, completeness of summaries, and exercises that have not led to multiple representations.

The level of media validation (graphic and language) was included into very valid criteria. In the graphic aspect, comment was given regarding additional introduction to the term multiple representations at the beginning of the book. In the language aspect, comments were given regarding the procedures for writing numbers and replacing terms that less familiar to students. All entries given by validators were followed up with improvements. Most improvements were made to the procedures for writing and presenting figures and tables. The revisions was aimed to perfect the product so that it is fit for use in chemistry learning, and can be tested on students.

The level of practicality of developed learning book was classified into very practical categories for use by teachers and students. Based on the effectivity test, the use of learning book is known to be effective in improving student learning outcomes as shown by the normalized gain scores of students who are classified as moderate (0.63).

Multiple representations learning book is effective in improving student learning outcomes because they present three levels of chemical concepts, macroscopic, sub-microscopic and symbolic levels according to the characteristics of chemistry [15]. The presentation of multiple representations in the learning book makes it easy for students to understand the chemical phenomena that are mostly related to the sub-microscopic level because visualize concepts at the particle level is one solution to improves students' understanding in chemical phenomena [17][18]. Other than that, chemistry would be easier to understand if students could connect the sub-microscopic level with other concept levels, macroscopic and symbolic levels [19][20].

Learning with multiple representations can also improve students' ability to change and connect macroscopic, sub-microscopic and symbolic phenomena [11][21] and optimize students' imagination abilities in solving chemical problems [22]. If students can already understand the macroscopic, sub-microscopic and symbolic levels, then students can choose to use representations that are appropriate to the problems they face [6].

Paying attention to the three levels of chemical concepts can also increase students' reasoning abilities [22][23] so that students' understanding becomes meaningful and last longer in the brain [24]. In addition, learning with multiple representations is also known to increase students' critical thinking [13], improve student understanding [12][25][26][27][28][29], and reduce student misconceptions [30][31].

Teachers who implement the multiple representations learning book gave a very good response to the use of the book in this learning chemistry. The most good responses were on two aspects, the developed learning book can help teachers in guiding students in learning and presenting the material in accordance with the level of student development. The teacher agrees if the learning book that used in learning is based on multiple representations. The teacher also comments that the book developed is good and easy to understand.

In line with the responses given by the teacher, students who use the developed learning book also gave a very good response overall. The most good response is given to the statement most students enjoy learning by using the developed learning book. Some students also commented on the use of the learning book that were developed: 1) I like this book because this book emphasizes the concept so that I quickly understand, hopefully all chemicals can be recorded like this, 2) I become more understanding of colloids after reading this book because the language is simple and easy to understand, 3) this book is complete and interesting, the book design is very good, it's just need to pay attention to some word typing errors.

5. Conclusion

Based on the results and discussion of this study, several things can be concluded. The conclusions of this study are:

- 1) characteristics of multiple representations chemistry learning book was presented chemical concepts with three chemical concept representations (macroscopic, sub- microscopic, and symbolic). Presentation of concepts with multiple representations makes easy for students to connect three levels of chemical concepts. Representation of macroscopic concepts is presented with real pictures/photos of objects or everyday phenomena that are often seen by students. Representations of sub-microscopic concepts are presented with pictures of particle models and the structure of compounds made in color to make them interesting for students. Symbolic representations were presented with terms, chemical symbols, chemical equations, and chemical reactions. This book also equipped with small notes, interesting info, summaries, practical activities, and practice questions,
- 2) the content and media validity of multiple representations chemistry learning book were 4.12 and 4.46, that means the learning book was included into very valid criteria,
- 3) the practicality of multiple representations chemistry learning book from teachers and students were 4.52 and 4.42 which means that the learning book was included into very practical categories for use by teachers and students,
- 4) the effectivity of multiple representations chemistry learning book was seen from the average of normalized gain score. The average value of the normalized gain score obtained is 0.63 which is included in the medium category so that the developed learning book is said to be effective in improving student learning outcomes.

6. Acknowledgments

We would like to express our highest gratitude to the head of SMA Negeri 4 Denpasar and SMA Negeri 5 Denpasar for the permissions so that this study could be carried out properly. We also expressed our gratitude to the teachers and students who helped us in collecting data on this study.

References

- [1] Woldeamanuel M M, Atagana, H, & Engida, T 2014 *Special Issue* **4** 2 31–43
- [2] Osman K & Sukor N S 2013 *American Journal of Applied Studies* **10** 5 433–441
- [3] Wu H, Krajcik J S, & Soloway E 2001 *Journal of Research in Science Teaching* **38** 7 821–842
- [4] Stieff M 2005 *Journal of Chemical Education* **82** 3 489–493
- [5] Ainsworth S 2006 *Learning and Instruction* **16** 3 183–198
- [6] Rosengrant D, Etkina E, & Heuvelen A Van 2007 *Proceeding: AIP Conference* 149–153
- [7] Desyana V, Erlina, & Melati H A 2014 *Jurnal Pendidikan dan Pembelajaran* **3** 11
- [8] Inayati N, & Melati H 2014 *Jurnal Pendidikan dan Pembelajaran* 1–19
- [9] Wiyarsi A 2018 *Proceeding: The 2nd International Seminar on Chemical Education*
- [10] Gilbert J K & Treagust D F 2009 *International Journal of Science Education* **31** 16 2271–2273
- [11] Helsy I, Maryamah, Farida I, & Ramdhani M A 2017 *Journal of Physics: International Conference on Mathematics and Science Education (ICMScE)*
- [12] Karacop A & Doymus K 2013 *Journal of Science Education and Technology* **22** 2 186–203
- [13] Ernida R, Hamid A, & Nurdiniah H S 2017 *Journal of Chemistry and Education (JCAE)* **1** 1 119–130
- [14] Thiagarajan S, Semmel D S, & Semmel M I 1974 *Instructional Development for Training Teachers of Exceptional Children Indiana University*
- [15] Johnstone A H 1991 *Journal of Computer Assisted Learning* **7** 75-83
- [16] Sausan I, Saputro S, Indriyanti N Y 2018 *Advances in Intelligent Systems Research (AISR)* 157 42-45
- [17] Gabel D L 1993 *Journal of Chemical Education* **70** 3 193-194
- [18] Tang H & Abraham M R 2016 *Journal of Chemistry Education* **93** 31-38
- [19] Bain K, Moon A, Mack M R, & Towns M H 2014 *Chemistry Education Research and Practice* **15** 320-335
- [20] Hernández G E, Criswell B A, Kirk N J, Sauder D G & Rushton G T 2014 *Chemistry Education Research & Practice* **15** 3 354–365

- [21] Sunyono, Yuanita L, & Ibrahim M 2013 *Pendidikan Progresif* **3** 1 65–79
- [22] Yuanita L, Ibrahim M & Sunyono 2015 *Science Education Internasional* **26** 2 104-125
- [23] Jaber L Z & BouJaoude S 2012 *International Journal of Science Education* **34** 7 973–998
- [24] Yakmaci-Guzel B, & Adadan E 2013 *International Journal of Environmental and Science Education* **8** 1 109–130
- [25] Rizal M 2014 *Jurnal Pendidikan Sains* **2** 3 159–165
- [26] Kurnaz M A & Arslan A S 2014 *Procedia Social Behaviorial Sciences Science Direct* 116 627–632
- [27] Anwar K, Sunyono & Kadaritna N 2015 *Jurnal Pendidikan dan Pembelajaran Kimia* **4** 3 795–806
- [28] Davidowitz B, Chittleborough G, & Murray E 2010 *The Royal Society of Chemistry* 11 154–164
- [29] Merchant Z, Goetz E T, Keeney-kennicutt W, Kwok O, Cifuentes L & Davis T J 2012 *Computers & Education* **59** 2 551–568
- [30] Nilawati P A, Subandi & Utomo Y 2015 *Proseding Seminar Nasional Teknologi Pendidikan UM*
- [31] Rahayu A D P & Nasrudin H 2014 *Unesa Journal of Chemical Education* **3** 2 88–98

Analysis of Students' Learning Interest toward Chemistry

L G Suryani, I N Suardana, and I W Redhana

Universitas Pendidikan Ganesha, Indonesia, Jalan Udayana 11 Singaraja Bali
81116 Indonesia

*suryaniluhgede@gmail.com

Abstract. This study aimed to describe the profiles of student's learning interest toward chemistry of public senior high schools in Tabanan City, Bali Province, Indonesia and the factors that affect that interest. The study was survey research. The population consisted of 418 the tenth- and eleventh-grade students of Mathematics and Natural Sciences Classes of public senior high schools in Tabanan City, Bali Province, Indonesia in a school year of 2018/2019. The number of samples used in the study was 223 students of SMA Negeri 1 Tabanan and 195 students of SMA Negeri 2 Tabanan taken using proportionate a stratified random sampling technique. Data were collected by using a questionnaire, an observation sheet, and an interview sheet, while the factors that affect that interest were collected using the questionnaire and the interview sheet. The results showed that in general, the profiles of students' learning at public senior high schools were very high (6%), high (45%), moderate (32%), low (17%), and very low (2%). The students' learning interest was affected by internal and external factors. The internal factors included intelligence, motivation, and learning styles. Meanwhile, the external ones included families, teachers, teaching materials, as well as school and social environment.

Keywords: chemistry, learning interest, public senior high schools

1. Introduction

Education is a conscious and planned effort to create an atmosphere of learning and learning process so the students can actively develop their potential to have spiritual strength, self-control, personality, intelligence, noble character, and the skills needed by themselves and the community. Education has an important role to create qualified and potential human beings because education is the main tool in efforts to increase human resources. Recognizing the importance of the education sector, each country is competing to improve the quality of education in order to produce people who have high human resources in order to compete in the global world. In the era of globalization, the development of science and technology growing very rapidly, one of them is chemistry.

Chemistry is a branch of natural science. Chemistry is seen as a process and a product. As a process, it can be interpreted as a scientific activity to make knowledge perfect and to find a new knowledge. As a product, chemistry is interpreted as a result of process in the form of facts, concepts, principles, and laws as well as theoretical findings of chemical scientists. Chemistry is very important to learn in senior high school but in the reality, high school students are less interested in learning chemistry. Akram, et al [1] stated that not all of high school students had a high interest in learning and students' motivation to learn chemistry is low.

Interest is the main key in the field of education [2]. According to Hidi, interest is a unique psychological state that occurs during interactions between people and the objects that they are interested in [3]. When students are asked what conditions or conditions most influence their learning success, they usually said that an interest in what is taught [4]. Interest in learning is one of the internal factors that can affect student learning achievement. Interest is one of the most important aspects in encouraging learning success because it will bring up good memories for students. When students lose their interest in learning, they will forget the subject easily [5]. Hidi, Renniger, and Krapp [6] state that interest refers to attention,

involvement, or both with the affordability of certain content. Ainley in Taylor [7], state that feeling interest involves positive activation (affect), directed attention, impulses to action (motivation), and information-seeking (cognition).

The interest that exists in an individual that were influenced by two factors, namely internal factors and external factors. Internal factors are factors that influence students' interest in learning that comes from within the individual himself, namely motivation, intelligence, and ways of learning. Meanwhile, external factors are factors that influence students' interest in learning that comes from outside themselves, namely family, school, and society [8].

2. Method

The study was a survey research. The population consisted of 418 the tenth- and eleventh grade students of Mathematics and Natural Sciences Classes of public senior high schools in Tabanan City, Bali Province, Indonesia in a school year of 2018/2019. The number of samples used in the study was 223 students of SMA Negeri 1 Tabanan and 195 students of SMA Negeri 2 Tabanan taken using proportionate a stratified random sampling technique. Data were collected by using a questionnaire, an observation sheet, and an interview sheet, while the factors that affect that interest were collected using the questionnaire and the interview sheet. Data of the questionnaire was measured using a Likert scale. The range categories of interest in learning chemistry based on the range of categories that was proposed by Rohani (2004) [9].

3. Result and Discussion

The results of this study consist of two components, namely: (1) profile of interest in learning chemistry and (2) factors that influence interest in learning chemistry.

3.1 Profile of Interest in Learning Chemistry

Profile of interest in learning chemistry consists of six indicators namely 1) attention; 2) concentration; 3) readiness; 4) pleasant feeling; 5) willingness to learn; 6) information seeking. The acquisition score of students' interest in learning chemistry through a questionnaire is categorized into five namely 1) very high; 2) high; 3) medium; 4) low; and 5) very low.

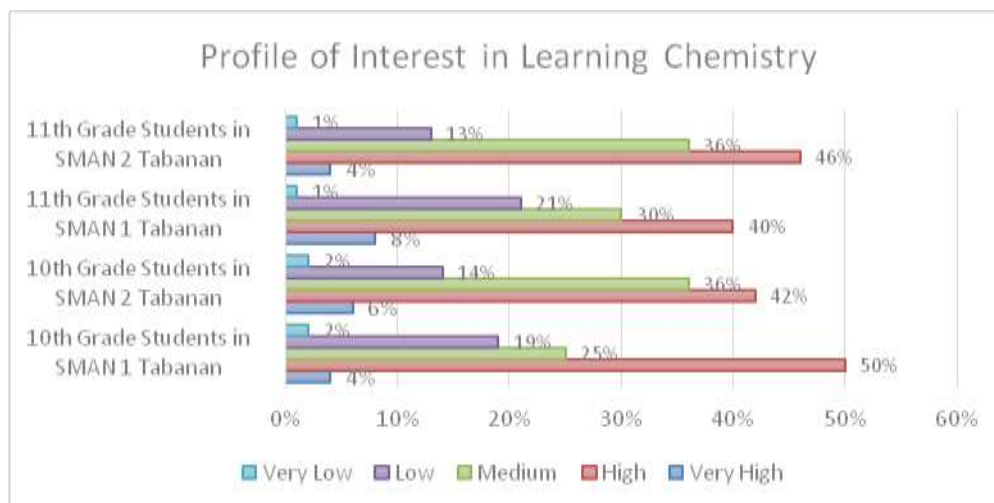


Figure 1. Profile of Interest in Learning Chemistry

Based on the results of the research, it is generally known that the interest in learning chemistry of students of 10th grade and 11th grade of Mathematics and Natural Sciences in Tabanan City High Schools in general was high. The result is presented in a graph in Figure 2

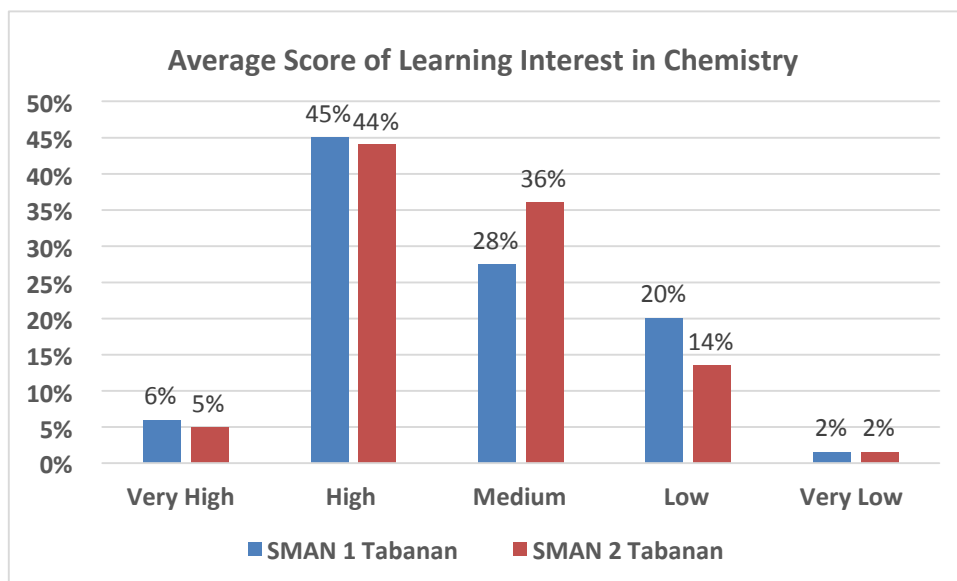


Figure 2. Average Score of Learning Interest in Chemistry

3.2 Factor that Influence Interest in Learning Chemistry

3.2.1 Factor that Influence Interest in Learning Chemistry in SMAN 1 Tabanan

Factor that influence interest in learning chemistry in SMAN 1 Tabanan can be shown in Table 3.

Table 3. Factor that Influence Interest in Learning Chemistry in SMAN 1 Tabanan

SMAN 1 Tabanan										
Factor	10 th grade					11 th grade				
	Categories (%)					Categories (%)				
	Very High	High	Medium	Low	Very Low	Very High	High	Medium	Low	Very Low
Internal Factor										
Intelligence	7	25	36	26	6	4	31	46	15	4
Motivation	34	39	25	3	0	24	38	37	1	0
Learning Style	3	16	52	23	6	9	22	51	18	0
External Factor										
Families	73	16	10	1	0	60	27	12	1	0
Teacher	21	36	29	11	3	20	39	38	3	0
School	14	42	35	8	1	9	43	42	7	0
Environment										
Social	7	17	47	23	7	5	32	47	14	2
Environment										

Based on Table 3

it can be seen that the most important internal factors influencing students' interest in learning chemistry are motivational factors, while the external factors that most influence students' interest in learning chemistry are family environment factors.

3.2.2 Factor that Influence Interest in Learning Chemistry in SMAN 2 Tabanan

Factor that influence interest in learning chemistry in SMAN 2 Tabanan can be shown in Table 4.

Table 4. Factor that Influence Interest in Learning Chemistry in SMAN 2 Tabanan

Factor	SMAN 2 Tabanan									
	10 th grade					11 th grade				
	Categories (%)					Categories (%)				
	Very High	High	Medium	Low	Very Low	Very High	High	Medium	Low	Very Low
Internal Factor										
Intelligence	2	20	58	17	3	6	46	28	18	4
Motivation	32	49	17	1	1	33	47	19	1	0
Learning Style	3	16	62	15	4	7	23	52	18	0
External Factor										
Families	50	44	5	1	0	78	17	4	1	0
Teacher	24	56	18	2	0	44	43	12	0	0
School	10	43	45	3	0	14	49	31	6	0
Environment										
Social	9	32	32	20	7	12	34	40	6	8
Environment										

Based on Table 4 it can be seen that the most important internal factors influencing students' interest in learning chemistry are motivational factors, while the external factors that most influence students' interest in learning chemistry are family environment factors.

The students' learning interest were affected by internal and external factors. The internal factors included intelligence, motivation, and learning styles. Meanwhile, the external ones included families, teachers, teaching materials, as well as school and social environment. Tytler and Symington [10] mentioned that the students' personal motivation and learning styles are important for the chemistry learning. The teachers are doing well but not best for developing students' interest in chemistry. Their teachers teaching style were satisfactory but they did not use enough charts, models, and daily life examples to make students interest in learning chemistry [11]. The role of the family is to provide the facilities needed by students to increase student interest in chemistry. The role is to accompany students while learning, give directions, give advice, provide the necessary facilities, and other supports that will be able to increase students' interest in learning chemistry.

Based on the interview, students assumed that chemistry is abstract and uses too many formulas so that students have difficulty learning chemistry. Gabel [12] stated that abstractness in chemistry makes chemistry a complex subject. Yunus and Ali [13] also stated that students in Malaysian secondary schools considered most topics on chemistry subjects is difficult and require a long time to study. Friends or social environment also had a strong influence on the formation of character and behavior of children in

school. Peer influence is important for child development. Interaction between friends as will encourage intellectual development and potential towards a better direction.

4. Conclusion

Based on the results of the study and discussion can be concluded as follows. The profiles of the students' learning interest of SMA Negeri in Tabanan city are as follows. The profiles of the students' learning interest in SMA Negeri 1 Tabanan were very high (6%), high (45%), moderate (28%), low (20%), and very low (1%). The profiles of the students' learning interest in SMA Negeri 2 Tabanan were very high (5%), high (44%), moderate (36%), low (14%), and very low (2%). In general, the profiles of students' learning at public senior high schools were very high (6%), high (45%), moderate (32%), low (17%), and very low (2%).

The student's learning interest was affected by internal and external factors. The internal factors included intelligence, motivation, and learning styles. Meanwhile, the external ones included families, teachers, teaching materials, as well as school and social environment. Analysis of students' interest in learning chemistry can help schools especially teachers to find out students' interest in learning chemistry and overcome problems of student interest in learning so the process of learning chemistry is much better.

5. Acknowledgments

We would like to express our highest gratitude to the head of SMA Negeri 1 Tabanan and SMA Negeri 2 Tabanan for permission so that this study could be carried out properly. We also expressed our gratitude to the teachers who helped us in collecting data on this study.

6. References

- [1] Akram T M Ijaz A and Ikram, H 2017 *Int. Journal of Information and Edu. Technology*, 7(2), p 88–94.
- [2] Krapp and Prenzel 2011 *Int. Journal of Science Education*, 331, 27-50
- [3] Hidi. 2006 *Interest: A unique motivational variable*, *Educational Research Review*, vol. 1, no. 2, pp. 69- 82
- [4] Gräber W 2011 *German High School Students' Interest in Chemistry – A Comparison between 1990 and 2008*, 22(2), 134-140
- [5] Adodo S O and Gbore L O 2012. *Int. Journal of Psychology and Counselling*, 4(6), 68-72.
- [6] Renniger, Hidi, and Krapp 2014 *The Role of Interest in Learning and Development*
- [7] Taylor W 2012 *Studying and Understanding Motivation*
- [8] Slameto 2010 *Belajar dan Faktor – Faktor yang Memengaruhi*
- [9] Rohani 2004 *Pengelolaan Pengajaran*
- [10] Tytler and Symington 2006 *Science in school and society, Teaching Science: The Journal of the Australian Science Teachers Associations*, vol. 52, no. 3, pp. 10-15,
- [11] Akram T M Ijaz A and Ikram, H 2017 *Int. Journal of Information and Edu. Technology*, 7(2), p 88–94.
- [12] Gabel D 1999 *Improving Teaching and Learning through Chemistry Education Research: A Look to the Future. Journal of Chemical Edu.* 76 (4), 548-553.
- [13] Yunus and Ali 2013 *Journal of Asian Behavioral Students*, 3(1).

Website Based Multimedia Development as Learning Media on Wave and Sound Vibration Materials to Increase Student Motivation and Learning Outcomes

Ni Putu Dewi Masyuni¹, Ketut Suma² and I Dewa Ketut Sastrawidana³

¹Universitas Pendidikan Ganesha

²Universitas Pendidikan Ganesha

³Universitas Pendidikan Ganesha

Email: iinmasyuni17@gmail.com, sumakt1959@gmail.com, sastrawidana@gmail.com

Abstract. This study aims to produce a product in the form of a multimedia-based website as a learning media that is valid, practical and effective to improve student learning outcomes and motivation. Design of study consisted 1) Define, 2) Design, 3) Develop, and 4) Disseminate. The data collected in this study are product validity test data, practicality test data, and effectiveness test data. The results of this study is (1)The validity of experts on multimedia based websites as learning media gets results, content experts 0,9 with a very valid category, media experts 0,72 are categorized valid, and design experts 0,84 are categorized very valid. (2) the practicality of a multimedia-based website in terms of 3 things: readability with a score of 4.42 with a very practical category, teacher response score of 4.55 a very practical category, response of small group students a score of 4.12 practical categories (3) Effectiveness of a website based multimedia is reviewed through student learning outcomes with an average score of 86.31 with a classical completeness of 86%. Based on the learning outcomes data obtained it can be concluded that the application of multimedia-based websites as learning media can improve learning outcomes.

Introduction

The era of the industrial revolution 4.0 also changed the perspective of education. Changes made are not just ways of teaching, but are far more essential, namely changes in the way of viewing the concept of education itself. The relationship of the industrial revolution 4.0 with the education system related to the impact of industry 4.0 with the ' Digitalization System '. The learning system and media which were originally based on face to face directly in the classroom, is not impossible to be replaced with systems and learning media that are integrated through the internet network (online learning).

Learning with an online system can maximize the learning process in the classroom that tends to be short of time (Rusman, 2011). Online learning is a process in the application of website - based learning media . Muhtar (1992) states that the teacher becomes a facilitator to help students transform online learning activities so that the potential possessed by students becomes useful for these students. Learning activities expect teachers to always provide new innovations to the learning media used so that students are able to gain new experiences and increase student motivation in the learning process. The learning process in the classroom does not only come from textbooks but also requires interesting and interactive media so that the learning process can take place dynamically.

In fact, the use of instructional media that has not been utilized in teaching and learning activities, makes the learning process monotonous and boring. This will certainly affect student learning motivation to decrease (Safiral, 2018). The learning process created tends to direct students only to accept material without having to reason it, so that the potential possessed by students tends not to be honed to the maximum (Natalia et al. , 2016). The teacher helps students

transform the potential possessed by students into abilities and skills which when developed will benefit the student's life (Muhtar, 1992). This ability can be developed through learning activities that innovate more dynamically and interactively.

Rachmadtullah (2018) states that innovation in learning activities is needed so that the learning process becomes fun and interesting so that students who are initially low in learning motivation will increase. This innovation can be in the form of developing learning media and learning methods. The examples of learning media are power points learning videos, interactive multimedia, and others. Development is carried out to create interesting learning media. Media and interesting learning methods will make it easier for teachers to increase student motivation and understanding in absorbing learning material (Natalia, 2016).

Based on Sudjana (2013), learning media can increase motivation and student learning outcomes. The reason with respect to the benefits of learning media in the learning process of students include: 1) teaching will attract more attention of students so that it fosters motivation to learn, 2) teaching material will be clearer so that it will be better understood by students and enable students to better master teaching objectives, 3) teaching methods will be more varied, and 4) students do more learning activities because they not only listen to the teacher's description but also do other activities such as observing, reasoning, demonstrating, and others.

Interactive multimedia-based learning media will provide a different atmosphere that can change students' perceptions of learning. Multimedia brings a good impact for teachers, because with multimedia teachers have the opportunity to develop learning techniques so that they can improve learning outcomes for the better. Multimedia for students is expected to make it easier for them to absorb lesson material quickly and efficiently and independent learning can be applied. The use of interactive multimedia-based learning media in the learning process will shift boring learning into enjoyable learning. Utilizing interactive multimedia can make teachers no longer the only source of student learning and multimedia is expected to make students active in learning.

Student interest in interactive multimedia-based learning media will also increase student motivation (Ningrum, 2016). Astawa et al. (2016) Multimedia learning provides opportunities for students to learn independently, so learning can be done anytime. Learning media is used to attract attention and make students active in the learning process, one of which is to use interactive multimedia-based learning media using website -based multimedia.

The packaging of learning material in the form of audio-visual shows can capture 90% of the entry channels of messages or information into the human soul through the eyes and ears. Audio visual media can make people generally remember 50% of what they see even if little or only aired once. Or in general people will remember 85% of what they see from an impression after 3 hours later, and 65% after 3 days later (Akhli, 2018). Therefore website-based multimedia can facilitate students in capturing learning material. Website-based multimedia is a combination of text, sound, video and animation. This integration can present learning that is fun, interesting, easy to understand, and clear, so that the information conveyed will be easily absorbed and understood (Mawardi, 2016).

SMP Negeri 7 Denpasar is one of the junior high schools that have implemented UNBK and obtained an average UNBK score in science subjects in 2018 of 73.06. SMP Negeri 7 Denpasar ranks 21st out of 36 SMPs in Denpasar that have conducted UNBK . It is known that the facilities at SMP Negeri 7 Denpasar are adequate, including LCD in each class, and has a computer laboratory. In addition, some students are known to have brought laptops to school and in class VIII students it is known that most students are familiar with the website. Information

was also obtained that online-based learning is still not very developed. The school area has also been equipped with wifi in each building. The facilities in the school are possible to be developed, but teachers still do not utilize the existing facilities.

Based on the description above, it is necessary to conduct research and development. The research in question is the development of website-based multimedia with the research title "Website- Based Multimedia Development as Learning Media on Wave and Sound Vibration Materials to Increase Motivation and Learning Outcomes of Class VIII Students of SMP Negeri 7 Denpasar".

Based on the above background, formulated per issue an namely: how to validity, practicality, effectiveness of multimedia -based website as a medium of learning the material vibration and sound waves to increase motivation and learning outcomes of the eighth grade students of SMP Negeri 7 Denpasar ?

Method

This type of research is research and development (R & D). This type of research is used to produce products in the form of learning websites, and test the feasibility of these products. 4-D development procedures developed by Thiagarajan et al. (1974). This development procedure consists of four stages, namely 1) Define, 2) Design, 3) Develop, and 4) Dessiminate. Website-based multimedia developed was tested based on 3 aspects, namely validity, practicality and effectiveness. Validity test is done based on the assessment of experts to provide an assessment based on three aspects: media, design and content / material. The practicality test in this study was assessed from 3 aspects, namely the readability test, the responses of teachers and students as website users. The effectiveness test is assessed based on the results of the posttest t given to students at the end of the meeting. Posttest is done by giving multiple choice tests consisting of 20. The population of this study is students of class VIII of SMP Negeri 7 Denpasar and the sample in this study is students of class VIII-1 and VIII-2 sampling in this study using simple random sampling technique.

Result and Discussion

1.1. Characteristics of Website-Based Multimedia

The result of developing a website-based multimedia as a learning medium is a website / website that has been uploaded online with the url address: <http://imphysicopedia.com>. The following is a menu content contained in website-based multimedia as a media. The Home page is the main page or Home page. Users will go directly to this page when typing the website address. On the main page, there is a greeting from the author for users to better know about the website that will be used as a learning medium. Sign Up page is a page that contains a form to register as a member in the discussion forum. On this page the user who wants to register as a member so they can discuss the tasks and material in learning. Introductory page, contains details of learning activities on website-based multimedia and basic competencies that must be achieved in the learning process. Structurally this page aims to make it easier for users to use this media to learn the vibrations of waves and sound. This page contains science learning materials for class VIII semester II, namely wave and sound vibrations. This material is the main content of this learning media. It contains exposure to basic competencies and indicators of the material in accordance with the applicable curriculum. The material page is divided into 3 sub namely: 1) Vibration, 2) Waves and 3) Sound. The download page contains material and media that can be downloaded so that users can learn material vibration waves and sounds offline. The download page contains power points, video and flash that are relevant to the material of the vibrations of waves and sounds. In addition to the students' needs, the download page is also included with a learning tool in the form of lesson plans for vibration and sound waves that can help the teacher in the learning process.

1.2. Website Based Multimedia Validation

Websites that have been designed at the design stage called draft I will be tested at the development stage. The trial is carried out in three stages, namely (1) the feasibility assessment of the first draft by experts, (2) the feasibility assessment by a small group of 9 students in the second draft which will be used for practicality test data and the feasibility assessment will be done through a questionnaire teacher response to readability on the website (3) the feasibility assessment of the draft III field to test the effectiveness of multimedia-based learning websites as a learning medium in the learning process in class.

The first draft of a website-based multimedia as a learning medium is assessed by content experts, design experts and media experts to get an assessment and input. The assessment is done by 2 experts (Drs. Ida Bagus Putu Mardana, M.Sc and Prof. Dr. I Wayan Redhana, M.Sc. The assessment results from the experts are used as a basis for revisions and improvements to the website. Based on the results of the validation assessment by the experts the two experts in the first draft were revised to produce a draft II. The draft I of the research product was declared valid after being analyses through Gregory's analysis. Following are the results of Gregory's expert validation analysis. Material / content validation with a score of 0.9 is in the very valid category. Media validation score of 0.72 category valid. Design validation with a score of 0.84 in the category is very valid.

Based on the results of the validation analysis by the experts in first draft. The validation of development products based on material, media and village design of website-based multimedia development products as learning media can be tested on a small group scale.

1.3. Practicality Tests for Multimedia-Based Websites

Website-based multimedia practicality test is done by conducting a small group test consisting of 9 students and 4 science teachers at SMP Negeri 7 Denpasar. Practicality analysis analyses is done by using an analysis of the website-based multimedia readability test in the form of a teacher's response questionnaire and student response questionnaire. The results of the practicality test will be used as input to reform the website-based multimedia II so that it will get website-based multimedia called draft III.

The results of all three aspects are tested as follows. The readability of teachers and students with a score of 4.42 falls into the very practical category. Teacher responses with a score of 4.55 are in the very practical category. Small group student responses with a score of 4.12 fall into the practical category. Website-based multimedia practicality test there are a number of things that occur in small-scale group testing, which are recorded and used as references, improved for later applied in field trials. Revisions are made referring to suggestions and comments from users. The suggestions and input that have been summarized are: (1) providing practice questions on the website that can be downloaded to be done manually, (2) providing worksheets or worksheets complete with demonstration media, (3) providing instructions for using the quiz creator so that it can be used just easily. In addition, in this study a practical test was also carried out in the field test using a practicality test questionnaire given to all samples in this study. The following is a practical test analysis table in the field test.

1.4. Multimedia-Based Website Effectiveness Test

Website-based multimedia effectiveness test as a learning media is done with limited field trials. This limited field trial was carried out in Denpasar 7 Public Middle School by using two classes, namely VIII-1 and VIII-2 classes. This limited trial was conducted for 6 meetings.

After the treatment is completed, the students are given a final test in the form of a test of learning outcomes (post-test) as well as capturing student responses to the learning process using

website-based multimedia as a learning medium and analysed student learning motivation in the learning process.

The post-test is done at the end of the lesson with a total of 20 items in the form of multiple choice. The data obtained from 72 students a grade point average of 89 with 86% mastery learning. The test results were analysed by looking for grade averages and classical learning completeness criteria.

Based on the results of the post-test shows that student learning outcomes are complete, because it is in accordance with the provisions of the Ministry of National Education in Trianto (2010) that the learning process in class is said to be classically complete if 85% of students in the class get a value of ≥ 77 . A complete analysis of learning completeness is presented in attachment 03.

After analysing the completion of the study a proportion test is performed to see the overall percentage of students (population) who have completed the learning process. The average post-test value was 86.31 with a minimum value of 69 and a maximum of 100. While a significant 5% obtained a standard deviation (standard deviation) of 8.75. Based on this, the decision H_0 is taken and H_a is rejected. So, the dependent variable in this study is the learning outcomes significantly ($p > 0.05$) greater than 77 (in the high category)

In table 4.11 we can see that the value of sig. (1-tailed) of 0.524. Because the sig value is $0.524 > 0.05$, H_0 is accepted. This means that the average value of learning outcomes after using website-based multimedia as a learning medium exceeds the KKM which is 77. In other words it can be said that the average value of student learning outcomes after using multimedia-based websites as teaching media is higher than KKM. This study also looked at students' learning motivation. High learning motivation is one of the factors needed to improve student learning outcomes. Therefore, an assessment of students' learning motivation is carried out by giving a learning motivation questionnaire to all students who were sampled in this study. The learning motivation questionnaire consisted of 43 statements graded according to a Likert scale.

Based on the results of the questionnaire, it was found that the mean score of students' learning motivation was equal to a standard deviation of 77.25, a maximum score of 215 and a minimum score of 131. The mean scores indicated that students' learning motivation was in the high category according to the learning motivation questionnaire given to students. Thus it can be said that students are motivated to learn in learning activities with website-based multimedia as a learning medium.

Conclusions and Suggestions

Based on the results of the research and discussion described previously, three conclusions can be made according to the formulation of the problem presented, among others as follows.

1) A multimedia-based website as a learning media consists of several menu pages, namely: home, introduction, material, quizzes, forum and contact us. This multimedia-based website has a website address, www.imphysicopedia.com. The multimedia based learning website will contain the subject matter of wave and sound vibrations.

2) The validity of a multimedia-based website based on the assessment of two experts is in the valid category. The mean score of multimedia-based website validity test by the two experts as follows the content expert validation is in the very high category, media expert validation is in the high category, and design validation is in the very high category. Based on the results of the analysis, multimedia-based websites as learning media are said to be valid in material / content, media and design.

3) The practicality of multimedia-based websites in this study was assessed based on 3 aspects, namely (1) readability, (2) teacher responses (3) student responses to multimedia-based websites. The average practicality score for the three types of data is the readability of multimedia-based websites as learning media are in the very practical category, the responses of the teacher's response are in the very practical category and the responses students get are in the practical category. Based on these results the multimedia-based website generated from this research is in the practical category.

4) Multimedia-based website as an effective learning media to improve student learning outcomes. This is in accordance with the results of analysis of student learning outcomes using the proportion test statistic with an average value of 86, 31 with mastery learning by 86% so that it has exceeded the classical completeness of 85%.

References

- [1] Akhlis I and Aryani P 2018 Development of multimedia web-based physics learning tools to strengthen students' characters *Unnes Science Education Journal* (Available at <https://www.journal.unnes.ac.id>)
- [2] Astawa I N W, Tegeh I M and Sudhita W R 2016 Development of interactive learning multimedia science subjects to improve student achievement in class VII *Edutech e-Journal of Ganesha University of Education Department of Educational Technology* **5(2)** (Available at <https://www.ejournal.undiksha.ac.id>)
- [3] Hutapea N, Nyeneng I DP and Suana W 2016 Development of interactive learning media on impulse and momentum material with a scientific approach *Journal of FKIP Lampung University* (Available on <https://www.portalgaruda.org>)
- [4] Mawardi I 2016 ICT (information and communication technology) as a vehicle for educational transformation. *Journal of Islamic research and education* (Available at <https://www.en.portalgaruda.org>)
- [5] Muhtar 1992 Guidance for teacher guidance in teaching and learning (Jakarta:PGK & PTK Ministry of Education)
- [6] Natalia E, Nyeneng I DP and Suyatna A 2016 Development of e-learning with schoology on rigid body dynamics material (Available at <https://www.urnal.fkip.unila.ac.id>)
- [7] Purnomo A, Ratnawati N, and Aristin NF 2016 Development of blended learning learning in generation z *Journal of Social Theory and Praxis of Learning* **1(1)** (Available at journal.um.ac.id)
- [8] Rachmadtullah R, Zulela and Sumantri M 2018 Development of computer-based interactive multimedia: study on learning in elementary education *International Journal of Engineering & Technology* **7(4)** (Available at <https://www.sciencepubco.com>)
- [9] Safira I, Ismail and Mushawwir T 2018 Development of web-based biology learning media on the concept of the digestive system in high school *UNM Journal of Biological Education* **1(2)** (Available at <https://ojs.unm.ac.id>)
- [10] Ningrum P, Sri E and Widiatmoko S 2016 Development of web-based learning media to improve the ability to determine the relationship between units of time, between units of weight, between long units of students in grade 4 at SDN Burengan 2 Kediri *Journal Simki Pedagogia* **1(1)** (Available at <https://simki.unpkediri.ac.id>)
- [11] Rusman Kurniawan D and Riyana C 2011 Information and communication technology based learning (Jakarta: Rajawali Press)

- [12] Thiagarajan S, Semmel D and Semmel M 1974 Instructional development for training teachers of exceptional children .roomington (Indiana University)

The Effect of Self-Efficacy, Achievement Motivation, and Study Habits to Science Literacy at Junior High School Students

I Gede Sandi Wiarsana¹, I Wayan Sadia² and Ida Bagus Putu Arnyana³

¹Universitas Pendidikan Ganesha

²Universitas Pendidikan Ganesha

³Universitas Pendidikan Ganesha

Email: sandiwiarsana@gmail.com, wayan.sadia@undiksha.ac.id,
putu.arnyana@undiksha.ac.id

Abstract. This study aimed to describe and explain the effect of self-efficacy, achievement motivation, and study habits to science literacy at junior high school students. This type of study is a quantitative with ex-post facto design. The total population in this study was 3880 students. The selection of school samples is determined by regional sample techniques. The research sample used was 410 students. Data collection using questionnaires and tests. The data was analysed by descriptive analyses and hypotheses was tested by path analyses. The results showed that there were: (1) direct effect coefficient of self efficacy on science literacy is 0.345, (2) indirect effect coefficient of self efficacy through achievement motivation on science literacy is 0.130, (3) indirect effect coefficient of self efficacy through study habits on science literacy is 0.286, (4) indirect effect coefficient of self efficacy through achievement motivation and study habits on science literacy is 0.139, (5) direct effect coefficient of achievement motivation on literacy is 0.165, (6) indirect effect coefficient of achievement motivation through study habits on science literacy is 0.176, (7) direct effect coefficient of study habits on science literacy is 0.489.

Keyword: science literacy, self efficacy, achievement motivation, study habits

1. Introduction

Education has a role in showing the quality of a country's human resources. Based on Muelas & Navarro (2015), quality education is not only determined by education providers, but also by students because education places students as the main characters in the teaching and learning process. Students are expected to be able to process actively by utilizing all the potential they have in building knowledge, skills, and attitudes so that the learning achievements achieved are more optimal. Achievement of student learning achievement and scientific literacy optimally characterizes the improvement in the quality of education. Science education is responsible for scientific literacy of students, therefore the quality of science learning needs to be improved in order to achieve a sustainable level of development (Liliasari, 2011). This goal will be achieved if supported by conducive learning and psychological factors of students. Science literacy is very important for every student, according to Widiyanti et al. (2015) that developed countries have built scientific literacy for a long time which is integrated in learning. The survey program that assists in the assessment of scientific literacy is the PISA-OECD which focuses on practical knowledge, answers questions

scientifically, identifies relevant evidence, evaluates conclusions critically and connects scientific ideas (PISA, 2016).

In fact, based on the results of the Program for International Student Achievement or PISA (PISA, 2016), the quality of scientific literacy in Indonesia is still relatively low, where shows that Indonesia is ranked 62nd out of 70 participating countries with an average score of 403, while the international average score is 500 (PISA, 2016). Whereas in the Human Development Index or HDI 2016, Indonesia is in position 113 of 188 countries in the category of human resource development. These results indicate that the achievement of the quality of education in Indonesia is still low. The gap that occurs between effort and reality is caused by many factors that will lead to a decrease in the quality of education. Some of the factors that cause low quality of education in Indonesia are lack of student literacy, poor quality standardization, less developed educational innovations, and low student achievement (Yuliati, 2017).

The low quality of education is reflected in the scientific literacy of students who tend to be still not optimal, because scientific literacy is a tangible result that can be used as a guide for measuring the quality of education in Indonesia (Adams-Budde et al., 2013). According to Sandhu (2014), there are two factors that influence students' literacy, namely internal factors that originate in students (psychological) and external factors that originate from outside of students. In this study only focused on the realm of psychology or internal factors of the students themselves that can influence students' scientific literacy.

Judging from the internal factors of students include attitudes towards learning, achievement motivation, learning concentration, processing learning materials, storing acquisition of scientific literacy, exploring stored scientific literacy, achievement ability, self efficacy or self-confidence, intelligence and learning success, study habits and goals students 'ideals which in the end as a benchmark are students' scientific literacy in the learning process (Gucluer & Kesercioglu, 2012).

Judging from the external factors students can be in the form of objectives of the learning process undertaken by the teacher, strategies, models or learning methods used, facilities in the learning process, assessment policies and implementation of school curricula have not referred to student literacy (Rathburn, 2015).

Learning outcomes and optimal scientific literacy from students are the goals of the learning process. Optimal student performance is definitely done by students seriously and has high self efficacy in achieving achievements. This is certainly a positive thing for students where students have scientific literacy based on the student's self-efficacy. If students do not have self efficacy in their lives, the students will not be able to develop in achieving achievements and tend to feel pessimistic in achieving something. Based on Sultan et al. (2018) states that learning is controlled by internal aspects of self efficacy , so that one of the psychological factors that influence science literacy can be said that one of them is student's self efficacy

Ozgen (2013) revealed that self efficacy has a positive impact on the achievement of scientific literacy and student learning achievement. Individuals who have high self efficacy believe that they can effectively deal with the situations and conditions they face and continue to build up optimistic expectations of success in overcoming problems and strive to display tireless perseverance (Riyadi et al., 2018). (Bulent, 2015) in his research also found that Intrinsic motivation and self efficacy are predictive variables for scientific literacy. In addition, based on research by (Rosyida et al., 2016), self efficacy significantly influences direct study habits or study habits and scientific literacy. High self-efficacy of students will directly influence the study habits of these students. Based on the explanation, self efficacy can influence achievement motivation, study habits and scientific literacy of students.

On the other hand, achievement motivation also plays a role and influences the achievement of scientific literacy and study habits of students. Based on Suresh (2015) revealed that there is a positive relationship between achievement motivation and study habits together on students' learning achievement and scientific literacy. Study habits begin with the achievement motivation or desire to achieve. Good study habits are difficult to implement if students do not have ambition to achieve something, this means that study habits are predicted by achievement motivation. In addition, based on

Atkinson & Feather (1966) stated that self efficacy is one of the aspects needed to build achievement motivation. Based on Mudjijanti (2013) the condition of students or students who are lazy, lack enthusiasm in learning, indifferent, less like tasks that are challenging and prefer tasks that are easy and not much require thinking are indicative of low student achievement motivation. On the contrary students who have high achievement motivation appear in diligent behavior, passionate in learning, active, like challenging task assignments.

The third psychological factor that influences student achievement and scientific literacy is the study habits of students. Students' satisfying scientific literacy can only be achieved by diligent, regular, and gradual learning efforts. In other words, maximum learning success can be achieved if students have good study habits (Garner-O'Neale et al., 2015). Student achievement certainly has different study habits that will generate knowledge that different (Chaudhari, 2013). Sandhu (2014) also revealed that poor study habits would lead to low academic achievement. Garner-O'Neale et al. (2015) suggest that there is a significant positive correlation between study habits and students' scientific literacy. The better the study habits students have, the higher academic achievement is achieved, so academic achievement is influenced by study habits .

Departing from this The researcher wanted to do research with the title "The Effect of Self Efficacy, Achievement Motivation and Study Habits of Students on Science Literacy of Class VIII Students of All Cities in Denpasar". The reason for conducting this research is because based on the results of the research that has been presented, the internal factors of students do more influence scientific literacy, especially self efficacy, achievement motivation, and study habits . Data collection is carried out in Denpasar because the progress of education or renewal of the learning system is more dynamic so that the improvement in the quality of learning is more significant in Denpasar.

Based on the background , problems are formulated including 1) whether there is a direct influence between students' self efficacy on science literacy of class VIII students in science subjects in Denpasar City Middle Schools? 2) is there an indirect effect of students' self-efficacy through achievement motivation on science literacy of class VIII students in science subjects in Denpasar City Middle Schools? 3) Is there an indirect effect of students' self efficacy through study habits of science literacy of class VIII students in science subjects in Denpasar City Middle Schools? 4) is there an indirect effect between self efficacy through achievement motivation and study habits of science literacy of class VIII students in science subjects in Denpasar City Middle Schools? 5) is there an indirect influence between achievement motivation on science literacy of class VIII students in science subjects in Denpasar Public Middle Schools? 6) whether there is an indirect influence between achievement motivation through a study habits of scientific literacy of class VIII students in science subjects in Denpasar Public Middle Schools? 7) is there a direct influence of study habits on science literacy of class VIII students in natural science subjects in Denpasar City Middle Schools?

Based on the formulation of the problem, the purpose of this research will be in line with describing and explaining the problems in each formulation

2. Method

This type of research is quantitative research with research design ex post facto to a statistical model of path analysis (path analysis). The total population studied was 3880 students. Selection of school samples using area techniques sampling while the selection of research samples in each school was determined using the proportionate stratified random sampling technique. Determination of a sample of the population can use the Krejcie and Morgan tables. Based on the table, if the population is 4000 students (3880 rounded to 4000) then the number of samples taken in the study amounted to 351 students with an error rate of 5%.

$$JS = \frac{n}{(0,90)(0,95)}$$

Based on these calculations obtained the number of samples taken to 410 students. From the total sample obtained, the number of classes required if the number of class students in Denpasar is around

35 people is 12 classes. Researchers used six junior high schools in Denpasar, namely SMPN 1 Denpasar, SMPN 4 Denpasar, SMPN 5 Denpasar, SMPN 7 Denpasar, SMPN 10 Denpasar, and SMPN 11 Denpasar. The reasons for selecting 6 schools out of the 12 schools are (1) Because the new junior high school admission system now uses the regional system, it is difficult to determine whether or not to favorite schools, so researchers divide them based on districts in the city of Denpasar. (2) Consideration of adjusting the ratio of the number of schools per district in the city of Denpasar. This was done because of differences in the number of schools in each district. (3) In addition, the number of schools studied was only 6, due to the efficient allocation of time and funds. According to researchers, 6 schools are sufficient to represent the overall population of 12 existing schools. Based on the total number of samples obtained, the percentage of samples in each school was determined again by the formula:

$$= \frac{\quad}{\quad} \times 100\%$$

Determination of proportions is done using the formula:

$$= \times$$

Table 1. Samples of Class VIII Students in Each School

No	School	Sub-district	Total
1	SMP Negeri 4 Denpasar	Denpasar Utara	67
2	SMP Negeri 5 Denpasar	Denpasar Utara	63
3	SMP Negeri 10 Denpasar	Denpasar Utara	80
4	SMP Negeri 1 Denpasar	Denpasar Timur	67
5	SMP Negeri 7 Denpasar	Denpasar Barat	75
6	SMP Negeri 11 Denpasar	Denpasar Selatan	58
Total			410

The method of data collection uses an instrument in the form of a self efficacy questionnaire, achievement motivation questionnaire, study habits questionnaire, and scientific literacy test. Before being used to obtain data, questionnaires and tests must pass the instrument trial phase. The trials for each instrument go through the stage of content validity test, item internal consistency test, and reliability test. The data analysis technique was done by descriptive analysis and then analysis prerequisite tests which included data distribution normality test, data linearity test, significance of the regression direction, and heterokedastity test. Then proceed with the hypothesis test.

The reliability values of the self efficacy questionnaire, achievement motivation questionnaire, study habits questionnaire, and scientific literacy tests were: 0.935, 0.933, 0.906, and 0.608.

Data were analyzed by descriptive analysis and hypotheses were tested by path analysis techniques. Figure 01 shows the path diagram model set by the researcher.

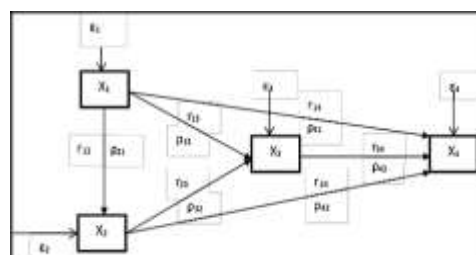


Figure 1. Research Path Diagram Model.

Based on the path diagram, X1 is self efficacy, X2 is achievement motivation, X3 is study habits, dan X4 is science literacy. In this research design, variable X1 has a direct relationship path with variables X2, X3, and X4. Variable X1 also has an indirect relationship path with X3 because it must pass X2 and an indirect relationship path with X4 because it must pass X2 and X3. Variable X2 has a direct relationship with variables X3 and X4. Variable X2 also has an indirect relationship path with X4 because it must pass X3. Variable X3 has a direct relationship with X4.

3. Result and Discussion

The results showed that the average score or Mean (M) of data self-efficacy of students at 155.70. Based on the criteria set, the tendency of self efficacy is included in the high category. Average or Mean Score (M) data on student achievement motivation amounting to 165.10. Based on the criteria set, the tendency of achievement motivation included in the high category. Average or Mean Score

1 students study habits data amounted to 167.59. Based on the established criteria, the tendency of study habits is included in the high category. Average score or Mean (M) science literacy data of students is 60.97. Based on the established criteria, the tendency of scientific literacy included in the high category.

Based on the results of these studies, self efficacy, achievement motivation, and study habits of class VIII students of State Junior High Schools in Denpasar City have been able to stimulate strongly the increase in students' scientific literacy. This was due to the competitive environment of the schools in Denpasar due to the school entrance selection system that uses the zoning system or the regional system, resulting in equal distribution of students' abilities. From this equality students tend to want to compete to be the best so as to create positive competition between students to improve their learning achievement.

3.1. *The Effect of Self Efficacy on Science Literacy of Class VIII Middle School Students in Denpasar City*

The results of this study indicate that there is a direct effect of self efficacy on scientific literacy of students with a direct effect value of $\rho = 0.345$ and significance of ($p < 0.05$). The value of $\rho = 0.345$ means that the effect of the variable self efficacy on the scientific literacy variable is 0.345. This means that student self-efficacy has a direct impact significantly on the junior high school students' science literacy as the city of Denpasar.

Self efficacy what is meant in this research is the perception of one's willingness to produce action. This willingness is a form of the level of individual confidence in his competence in achieving goals.

Self efficacy directs someone to face challenges that occur in everyday life (Saraih et al., 2018) High self efficacy levels will help a person to create a feeling of calm in facing difficult problems or activities. Someone with low self efficacy will easily give up, tend to be stressed, depressed, and have a narrow vision of what is best to solve the problem. However, people who have strong self-efficacy in competence will maintain their business despite difficulties (Riyadi et al., 2018).

Students with high self efficacy will say that they are able to learn the material given in class and have the confidence that it can work well. Students who have higher self efficacy will help them to build a sense of calm in facing certain tasks. The level of self efficacy can be considered as a predictor of students' scientific literacy (Ismail et al., 2017).

In addition, the findings about the direct effect of students' self efficacy on students' scientific literacy are in line with the results of previous studies, namely: (1) research conducted by (Sultan et al., 2018) which shows that there is a significant direct effect between self efficacy on scientific literacy, where to increase and optimize the scientific literacy of students, one of them is by increasing the self-efficacy of students; (2) research conducted by Taran et al. (2015) found that someone who has high self efficacy believes that he is capable of doing the activities that will be carried out. Conversely, someone who has low self efficacy is not sure about the ability to carry out an activity and this will greatly influence his scientific literacy;

Based on this, the results of this study reinforce the theory that students' self efficacy directly influences students' scientific literacy.

In addition to reviewing the value of direct influence, researchers also reviewed the indirect effect of students' self efficacy on students' scientific literacy by considering the existence of other factors as intervening / mediating variables between students' self efficacy and scientific literacy.

First, the researchers examined the indirect effect of students' self efficacy on scientific literacy through achievement motivation variables. The path coefficient calculation is done manually. The path taken for this relationship is as much as two paths, namely the path of self efficacy of students (X1) towards achievement motivation (X2), then the path of achievement motivation (X2) towards student scientific literacy (X4). The value of the indirect effect of the pattern of self- efficacy on students' scientific literacy through achievement motivation is the result of multiplication between path coefficients X1 to X2 (p_{21}) with path coefficients X2 to X4 (p_{42}). The value of indirect influence obtained is 0.130. It is known that both the path coefficient values multiplied are significant ($p < 0.05$). This shows that self efficacy has a significant indirect effect on students' scientific literacy through achievement motivation of junior high school students throughout Denpasar.

Self efficacy is closely related to achievement motivation. A person's high self efficacy level can arouse someone's motivation to struggle to reach their goals. Motivated people can be seen from the characteristics that exist in the person, namely diligent in facing the task, resilient facing difficulties, showing interest in various problems, preferring to work independently, get bored quickly on routine tasks, can maintain his opinion, it is not easy to let go of things that are believed, and like to find and solve problems (Sardiman, 2014).

The findings of the indirect effect of self efficacy on students' scientific literacy through student achievement motivation are relevant to the results of previous studies, namely as follows. (1) Results of research conducted by Liu and Cheng (2018) showed a direct influence and indirect effect of self efficacy through achievement motivation on students' scientific literacy. This shows the meditative role of achievement motivation and learning strategies towards the relationship of self efficacy with scientific literacy. (2) Bulent, (2015) in his research found that the students' self-efficacy aspects had a significant and linear effect on motivation for achievement. The better and higher self efficacy in students will be followed by an increase in student achievement motivation, and vice versa.

Based on the explanation above, the researcher can conclude that is to improve students' scientific literacy, we really need to pay attention to students' self efficacy. By using path diagram techniques, we can get the total influence of the self efficacy variable which consists of direct influence or indirect influence.

Second, researchers examined the indirect effect of self efficacy on students' scientific literacy through a study habits variable. The path coefficient calculation is done manually. The path taken for this relationship is as much as two paths, namely the path of self efficacy (X1) to study habits (X3), then the path of study habits (X3) to students' scientific literacy (X4). The value of students' indirect self efficacy on students' scientific literacy through study habits is the result of multiplication between path coefficients X1 against X3 (p_{31}) with path coefficient X3 against X4 (p_{43}). The value of the indirect effect is 0.286. It is known that both the multiplied path coefficient values are significant ($p < 0.05$). This shows that students' self-efficacy has a significant indirect effect on students' scientific literacy through the study of the habits of junior high school students throughout Denpasar.

Based on the research of Sukmawati et al. (2013) where self efficacy and study habits have a positive and significant relationship to scientific literacy and student achievement because these two things have an influence on student's affection during the learning process. Thus it can be said that the higher the study habits and self efficacy of students, the better the learning outcomes.

Third, the researcher examined the indirect effect of students' self efficacy on scientific literacy of students through achievement motivation variables and study habits. The path coefficient calculation is done manually. The path taken for this relationship is as many as three paths, namely the path of self efficacy (X1) towards achievement motivation (X2), then the path of achievement motivation (X2) to study habits (X3), as well as the path of study habits (X3) to students' scientific literacy (X4). The value

of students' indirect self-efficacy influence on students' scientific literacy through achievement motivation and study habits is the result of multiplication between path coefficients X1 against X2 (p_{21}) with path coefficients X2 against X3 (p_{32}), as well as path coefficients X3 against X4 (p_{43}). The value of the indirect effect is 0.139. It is known that the three path coefficient values multiplied are significant ($p < 0.05$). This shows that students' self efficacy has a significant indirect effect on students' scientific literacy through achievement motivation and study habits of junior high school students throughout Denpasar.

Based on the pathway of the influence of self efficacy on scientific literacy of students through achievement motivation and study habits, the value of the effect of total self efficacy on scientific literacy is 0.139. The value of this influence is smaller than the value of direct influence. The difference in value between direct influence and total influence due to self efficacy can directly influence scientific literacy without affecting other variables first, namely achievement motivation and study habits. Self-efficacy of students plays an important role in shaping interest, motivation, and study habits of students. In this study, it was explained that self efficacy not only affects students' learning achievement directly but can be influenced indirectly through the contribution of two variables together, namely achievement motivation variables and study habits.

The findings of the indirect effect of self efficacy on scientific literacy through achievement motivation and student study habits are in line with the results of previous studies, namely as follows. [3].Ghobadi et al. (2016) in their study found that self efficacy has a positive important role to predict student achievement motivation. (2) (Yusuf, 2011) also found that self efficacy can significantly improve learning achievement. Self efficacy determines how a person feels, thinks, motivates, and acts. Based on this, it can be stated that when students' self-efficacy increases, their learning achievements and scientific literacy will also increase and vice versa. In other words, self efficacy is a predictor of student achievement motivation and scientific literacy.

Based on the explanation above, the researcher can conclude that to improve students' scientific literacy, we really need to pay attention to students' self efficacy. By using path diagram techniques, we can obtain the total influence of the students' self efficacy variables which consist of direct influence or indirect influence.

3.2. The Effect of Achieving Motivation on Science Literacy of Class VIII Middle School Students in Denpasar City

Based on the results of the analysis it can be concluded that there is a direct effect of achievement motivation on scientific literacy of students with an influence value of 0.165 and significance ($p < 0.05$). This means that students' achievement motivation has a significant direct effect on the scientific literacy of junior high school students in Denpasar City.

The most important motivation in the psychology of education is achievement motivation. According to McClelland (1987) achievement motivation is an effort to achieve success or success in competition with a measure of excellence that can be in the form of other people's achievements or their own achievements. An effective learning process is formed when students have high motivation. Someone with high achievement motivation tends to struggle to achieve success, especially in the world of education. Students who have the motivation to excel will realize that the learning process is important, so that the willingness to learn will come from themselves, not because they have to. Motivation for achievement is very important for students, because with a strong desire to learn, students can avoid stress.

Kartal & Kutlu (2017) states that the achievement motivation has a very high positive correlation premises n scientific literacy that shows students with better achievement motivation has given students better scientific literacy. Students who have good achievement motivation are characterized by a number of things, namely: students try to excel in competition, complete tasks well, be rational in achieving success, like challenges, accept responsibility for social interests, like work situations for personal responsibility, feedback back, and middle level risk.

In addition, the findings about the direct effect of achievement motivation on students' scientific literacy are relevant to the results of previous studies, namely as follows. (1) Based on the findings of Yazdani et al. (2014) stated that achievement motivation has a very high positive correlation with science literacy that shows students with better achievement motivation has provided better academic achievement and scientific literacy. (2) Research conducted by Daniel (2015) shows that achievement motivation has a significant impact on scientific literacy. Increasing students' scientific literacy in line with the increase in achievement motivation.

Based on this, the results of this study reinforce the theory that achievement motivation directly influences students' scientific literacy and learning achievement.

In addition to reviewing the value of direct influence, the researchers also reviewed the indirect effect of achievement motivation on scientific literacy through study habits. The path coefficient calculation is done manually. The path taken for this relationship is as many as two paths, namely the path of achievement motivation (X2) towards study habits (X3), then track the study habits of students (X3) on students' scientific literacy (X4). Value of indirect effect of achievement motivation (X2) towards student scientific literacy through study habits (X3) is the result of multiplication between path coefficient X2 against X3 (p_{32}) with path coefficient X3 against X4 (p_{43}). The value of the indirect effect is 0.176. It is known that both the multiplied path coefficient values are significant ($p < 0.05$). This shows that achievement motivation has a significant indirect effect on students' scientific literacy through study habits of junior high school students throughout Denpasar. The effect of total achievement motivation on scientific literacy is 0.341.

Achievement motivation is closely related to study habits. High achievement motivation will also have implications for the study habits of students, where based on the results of research several sources state that study habits begin with the presence of achievement motivation or the desire to achieve.

In the millennial era like today, there are many students who have their own views and dreams in achieving this, this will lead to differences in the study habits of each student to achieve the desired achievement. So good study habits are difficult to implement if students do not have ambition to achieve something, this means that study habits are predicted by achievement motivation.

The findings about the indirect effect of achievement motivation on students' scientific literacy through study habits are relevant to the results of previous studies, namely as follows. (1) The results of a study conducted by Suresh (2015) showed a positive relationship between achievement motivation and study habits together on student achievement. Study habits begin with the achievement motivation or desire to achieve. Study habits the good is difficult if the students do not have ambition to achieve something. (2) Mudjijanti (2013) in his research on the condition of students or students who are lazy, lack enthusiasm in learning, ignorant, less like tasks that are challenging and prefer tasks that are easy and don't require much thinking are indicative of low student achievement motivation. On the contrary students who have high achievement motivation appear in diligent behavior, passionate in learning, active, like challenging task assignments.

Based on the above explanation, researchers can draw a red thread, namely to improve students' scientific literacy, we really need to pay attention to student achievement motivation. By using path diagram techniques, we can obtain a large total effect of achievement motivation variables consisting of direct influence or indirect influence.

3.3. The Effect of Study Habits on Science Literacy of Class VIII Students of Middle School in Denpasar City

Based on the results of the analysis it can be concluded that there is a direct influence of study habits on scientific literacy with an influence value of 0.489 and significance ($p < 0.05$). This means that study habits have a significant direct influence on the scientific literacy of junior high school students in Denpasar City. The total influence of the variable achievement motivation on learning achievement in science is the same as direct influence because it only consists of one path.

Study habits are learning patterns carried out by students regularly with good techniques and effective and efficient learning time. Good study habits will be able to improve student learning achievement, whereas study habits that are not good tend to cause student learning achievement to be low (Suresh, 2015). According to Crede & Kuncel (2008), study habits are learning patterns carried out by students, regularly, and are familiar with good techniques and effective and efficient learning time, so learning becomes a necessity.

In addition, the findings about the direct influence between study habits on students' scientific literacy are relevant to the results of previous studies, namely as follows. (1) In the study of Yazdani et al. (2014), it was shown that overall study habits had a very high positive correlation with students' scientific literacy, so better study habits led to better scientific literacy. (2) Research conducted by Rosyida et al. (2016) shows that differences in student learning outcomes in class are caused by differences in methods of learning, reading, and making notes. These three indicators are included in the study habits students. If the three indicators are high, the learning outcomes will be better.

Study habits play an important role in learning, where successful learning or satisfying learning achievement can only be achieved by diligent, regular, and gradual learning efforts. In other words, scientific literacy and maximum learning achievement can be achieved if students have good study habits. This indicates that it is reasonably suspected that study habits have a direct effect on students' scientific literacy.

4. Conclusions and Suggestions

Based on data and results of data analysis, and discussion on this study, the following conclusions can be drawn. (1) There is a direct effect of self efficacy (X1) on student literacy (X4) class VIII on science subjects in junior high schools throughout Denpasar with a direct effect coefficient of 0.345. (2) There is an indirect effect of self efficacy (X1) through achievement motivation (X2) on scientific literacy of students (X4) class VIII in science subjects in junior high schools throughout the city of Denpasar with an indirect effect coefficient of 0.130. (3) There is an indirect effect of self efficacy (X1) through study habits (X3) on student literacy (X4) class VIII on science subjects in junior high schools throughout Denpasar with an indirect effect coefficient of 0.286. (4) There is an indirect effect of self efficacy (X1) through achievement motivation (X2) and study habits (X3) on student literacy (X4) class VIII on science subjects in junior high schools throughout Denpasar with a coefficient of influence indirect amounting to 0.139. (5) There is a direct effect of achievement motivation (X2) on students' scientific literacy (X4) class VIII in science subjects in junior high schools throughout the city of Denpasar with a direct effect coefficient of 0.165. (6) There is an indirect effect of achievement motivation (X2) through study habits (X3) on student literacy (X4) class VIII on science subjects in junior high schools throughout Denpasar City with an indirect effect coefficient of 0.176. (7) There is a direct influence of study habits (X3) on student literacy (X4) class VIII in science subjects in junior high schools throughout the city of Denpasar with a direct effect coefficient of 0.489.

Based on discussion, and conclusions, then some suggestions can be proposed as follows. (1) The headmaster can provide a mandate to counseling teachers to provide sharing services related to the study habits problems experienced by students at home, especially related to effective learning methods and learning skills. (2) For teachers, can help develop self-efficacy students externally through verbal persuasion and social esteem, it will increase the dimensions of the level and strength in students. Students will be able to sort out the difficulty level of a task, and will be able to compete in solving a problem. Student achievement activation can be developed with several adequate techniques, such as discussion, giving scaffolding and giving rewards. teacher can provide counseling to students related to problems of study habits were less effective at home. The teacher must also pay attention and understand the curriculum study contained in the syllabus in order to improve students' scientific literacy. (3) For parents as an effort to improve self efficacy , achievement motivation, study habits and scientific literacy of students is parents should meet the needs of children, especially in the form of attention which can also be used to build warmth between the two parties. Parents' attention has an impact on children's sociocognitive development. (4) Teenagers, especially junior high school

students who are still in the search for identity. Adolescents should use their time to interact more with parents. Increase cooperative spirit in oneself so that it is more motivated to learn, strengthen each other between friends, and learning goals can be achieved. Teenagers who have self efficacy high in the community will be able to carry out all the tasks that are delegated to him, one of which is to take part in organizational activities in the banjar. In addition, teenagers who have motivation and positive study habits will find it easier to mingle with the community.

5. References

3. Adams-Budde, M. E., Howard, C. M., Jolliff, G. D., & Myers, J. K. (2013). Examining the literacy histories of doctoral students in an educational studies program through surveys and interviews: A mixed methods study. *Journal of the Scholarship of Teaching and Learning*. <https://doi.org/10.14434/josotl.v14i1.3327>
4. Al Sultan, A., Henson, H., & Fadde, P. J. (2018). Pre-Service Elementary Teachers' Scientific Literacy and Self-Efficacy in Teaching Science. *IAFOR Journal of Education*. <https://doi.org/10.22492/ije.6.1.02>
- 7 Atkinson J W and Feather N T 1966 *A theory of achievement motivation* (New York: Wiley)
- 8 Bulent, A. (2015). The influence of self-efficacy and motivational factors on academic performance in general chemistry course: A modeling study. *Educational Research and Reviews*. <https://doi.org/10.5897/err2014.2003>
- [16] Crede, M., & Kuncel, N. R. (2008). Study Habits , Skills , and Attitudes. *Perspectives on Psychological Science*. <https://doi.org/10.1111/j.1745-6924.2008.00089.x>
- [17] Daniel A 2015 Influence of achievement motivation and study habits on students academic achievement in Mathematics *Indian J. Applied Research* 5(8) 562-65
- [18] Garner-O'Neale, L., & Ogunkola, B. (2015). Effects of Interest in Science, Study Habits, Sex and Level of Study on the Nature of Science Literacy Level of Undergraduate Chemistry Students of the University of the West Indies, Barbados. *Journal of Educational and Social Research*. <https://doi.org/10.5901/jesr.2015.v5n2p267>
- [19] Ghobadi B, Batmani S, Mohammadi Y and Bamani P 2016 Relationship between parenting styles and self-efficacy with academic achievement's motivation among male students in Sanandaj City *J. Admin. Management Education and Training* 12(4) 202-10
- [20] Gucluer, E., & Kesercioglu, T. (2012). The Effect of Using Activities Improving Scientific Literacy on Students' Achievement in Science and Technology Lesson. *Online Submission*.
- [21] Ismail M, Aziz F H, Fajil M F, Ismail M F and Shah A 2017 The relationship between self-efficacy and GPA grade scores of students *Inter. J. Applied Psychology* 7(2) 44-7
- [22] Kartal, S. K., & Kutlu, Ö. (2017). Identifying the Relationships between Motivational Features of High and Low Performing Students and Science Literacy Achievement in PISA 2015 Turkey. *Journal of Education and Training Studies*. <https://doi.org/10.11114/jets.v5i12.2816>
- [23] Liliyasi. (2011). Membangun Masyarakat Melek Sains Berkarakter Bangsa Melalui Pembelajaran. *Prosiding Seminar Nasional FMIPA UNNES*.
- [24] Liu L and Cheng L 2018 The relationship between self-efficacy and achievement motivation in adolescents: A moderated mediating model of self-identity and hope *J. Psychology and Behavioral Sciences* 7(3) 39-46
- [25] McClelland D 1987 *Human motivation* (New York: Cambridge University)
- [26] Mudjijanti F 2013 Pengaruh motivasi berprestasi dan kebiasaan belajar terhadap keberhasilan belajar mahasiswa program studi bimbingan dan konseling tahun akademis 2011/2012 *Widya Warta* 2(2) 236-54
- [16] Muelas, A., & Navarro, E. (2015). Learning Strategies and Academic Achievement.

- Procedia - Social and Behavioral Sciences*. <https://doi.org/10.1016/j.sbspro.2014.12.625>
- [30] Ozgen, K. (2013). Self-Efficacy Beliefs In Mathematical Literacy And Connections Between Mathematics And Real World: The Case Of High School Students. *Journal of International Education Research (JIER)*. <https://doi.org/10.19030/jier.v9i4.8082>
- [31] PISA. (2016). PISA 2015 Results in Focus. In *OECD*. <https://doi.org/10.1787/9789264266490-en>
- [32] Rathburn, M. K. (2015). Building Connections Through Contextualized Learning in an Undergraduate Course on Scientific and Mathematical Literacy. *Georgia Educational Researcher*. <https://doi.org/10.20429/ijsofl.2015.090111>
- [33] Riyadi, T., Sunyono, & Efkar, T. (2018). Hubungan Kemampuan Metakognisi dan Self Efficacy dengan Literasi Kimia Siswa Menggunakan Model SiMaYang. *Jurnal Pendidikan Dan Pembelajaran Kimia*.
- [34] Rosyida, F., Utaya, S., & Budijanto, B. (2016). Pengaruh Kebiasaan Belajar dan Self-Efficacy terhadap Hasil Belajar Geografi Di SMA. *Jurnal Pendidikan Geografi*. <https://doi.org/10.17977/um017v21i22016p017>
- [35] Sandhu S S 2014 Academic achievement of adolescents in relation to achievement motivation and study habits Inter. Multidisciplinary Research J. 11(1) 1-10
- [23] Saraih, U. N., Zin Aris, A. Z., Abdul Mutalib, S., Tunku Ahmad, T. S., Abdullah, S., & Harith Amlus, M. (2018). The Influence of Self-Efficacy on Entrepreneurial Intention among Engineering Students. *MATEC Web of Conferences*. <https://doi.org/10.1051/mateconf/201815005051>
- [24] Sardiman, A. (2014). Interaksi Dan Motivasi Belajar Mengajar. In *Interaksi & Motivasi Belajar Mengajar*.
- [25] Sukmawati N P F, Suarni N K and Renda N T 2013 Hubungan antara efikasi diri dan kebiasaan belajar terhadap prestasi belajar siswa kelas V SDN di Kelurahan Kaliuntu Singaraja *Online Article* (Available At <http://download.portalgaruda.org/article.php?article=105368&val=1342>)
- [26] Suresh K 2015 A study on study habits, achievement motivation and academic achievement of high school student EPRA Inter. J. Economic and Business Review 3(10) 138-41
- [27] Taran H, Kalantari S, Dahaghin F and Abhari Z S 2015 The relationship among parenting styles, self-efficacy, and academic achievement among students Inter J. Academic Research in Progressive Education and Development 4(1) 219-22
- [28] Yazdani, K., Godbole, V. S., & Pradesh-india, A. (2014). Studying the role of habits and achievement motivation in improving students ' academic performance. *European Online Journal of Natural and Social Science*.
- [29] Yuliati, Y. (2017). LITERASI SAINS DALAM PEMBELAJARAN IPA. *Jurnal Cakrawala Pendas*. <https://doi.org/10.31949/jcp.v3i2.592>
- [30] Yusuf, M. (2011). The impact of self-efficacy, achievement motivation, and self-regulated learning strategies on students' academic achievement. *Procedia - Social and Behavioral Sciences*. <https://doi.org/10.1016/j.sbspro.2011.04.158>

The Academic Supervision Process by Principal in Science Learning at SMPN Satap 1 Tembuku

I W Winarsa, I W Subagia, and N L P M Widayanti

Post Graduate of Science Education Departmen, Mathematic and Science Faculty,
Ganesha University Department, Bali-Indonesia, 81116

E-mail: winarsa18@gmail.com, aigabus@yahoo.co.id, manikwidiyanti@gmail.com

Abstract. The main purpose of this research was to explain and described the supervision by principal towards the learning process in science learning at SMPN Satap (Satu Atap) 1 Tembuku. This research is a descriptive qualitative research that reveals the supervision process by principal. Data was taken by interview technique. The source triangulation technique is carried out to obtain the validity of data. Interviews were conducted with principals and science teacher. The results showed that the supervision by principal towards the learning planning process was carried out by observing and assessing the administrative completeness and also organize a workshop. Supervision of learning process is done by visiting class to observe the learning activities. Supervision of the assessment process is carried out by confirmation and guiding the determination of minimum completeness criteria for science learning. Principal supervision has been optimally. The kind of supporting factor for supervision is an agreement for documents plan are legalize by one basic competence. The different expertise between teacher and principal in terms of subjects are the kind of barrier factor in the supervision.

1. Introduction

Education has a very big impact to improving the quality of human resources. Good quality of education will impact the quality of humanc resources. The government should maintain and continue to develop the quality of education in order to maintain the quality of human resources. The development of education quality in Indonesia starts at the school level that must be done with equal distribution in all sectors.

Ironically, the distribution of quality education in each region. The opportunity to have an education cannot be felt in some areas. This problem is certainly one of the barrier factors to create the qualified of human resources. The government is trying to fix these problems to make the equitable education in Indonesia. The educational equalization program in Indonesia has been planned by the government through 12-year education program. Based on [8], efforts to achieve the program are by expanding and increasing access to quality secondary education to accelerate the availability of educated people. The government establishing a Satap school (2 or more different level of education located in 1 area) in sub-districts that do not yet have a secondary education unit. The 12-year education program needs to be realized in all area of the country to improve the quality of human resources as one of the assets and the main potential of national development.

The implementation of that program is expected to be able to fix the problems of equal distribution services and improve the quality of education that has not been realized optimally. There are still a big gaps of the education quality between urban and rural areas, especially in isolated areas. In accordance with [8], the government made an effort by establishing integrated schools or commonly called Satap. Satap school is a model of education that differs between elementary and secondary schools but the learning activities take place in one location. This model is intended to bring educational institutions closer to the community, especially in isolated areas, to create an equal distribution of education. Elementary school integrated junior high school program or commonly known as Satap. Satap is an education organization that includes elementary and junior high schools whose location or management are integrated.

The establishment of a Satap school aims to accelerate the completion of the 12-year education program and improve the quality of education, especially in isolated areas. The establishment of a

Satap is also expected to open access to education, so the human resources can be created even in isolated areas. The establishment of a Satap school was carried out because the secondary schools is unavailable in that area. The Satap management generally has a low economy, located in rural areas, hills. The majority of residents are usually farmers or ranchers so the economic level of the area is still low.

Bangli Regency is one of the regions has a Satap in Bali. Bangli regency consists of 4 sub-districts namely, Bangli, Susut, Kintamani and Tembuku. Three of each sub-district has schools that are still in the same status. Specifically for Kintamani Subdistrict, there are 4 of Satap, SMPN Satap 1 Kintamani located in Kayu Selem Village and SMPN 2 Kintamani Satap in Gunungbau Village, SMPN Satap 3 Kintamani located in Songan Village, and SMPN Satap 4 Kintamani located in Pinggan Village. SMPN Satap 1 Tembuku is located in Yangapi Village, Tembuku District, meanwhile SMPN Satap 1 Susut located in Susut District. Bangli sub-district did not establish a single school because there were already many regular schools.

Mostly Satap has so much problem. Based on [10] found that learning management of Satap school in Karangasem District had constraints such as bad quality of facilities and infrastructure, unuseable computer, as well as academic and non-academic achievements needs to be improved. A similar result was also found by [11] who found that SMPN Satap 4 in Pongkar Village, Tebing District, Karimun Regency, Riau Islands has obstacles in the management of learning like supporting facilities and infrastructure, the number of educators and education staff is still low and the motivation of the community to send their children to school is still low. The results of the preliminary study indicated some obstacles found, especially in the supervision of the learning process at SMPN Satap 2 Kintamani. The learning process is not optimal, including the attendance and motivation of students are still low. Supervision of teachers and employees is also not optimal. Supervision activities undertaken by the principal have not been implemented regularly. The presence of a few minimal teachers is also one of the obstacles in the learning process. This certainly has a major impact on the quality of education, especially in SMPN 2 Kintamani.

Following on these problems, the authors conducted a further study at SMPN Satap 1 Tembuku. The geographical and social conditions almost similar, so the study was conducted at that school. Unically, the quality of education in SMPN Satap 1 Tembuku are special. Initial findings indicate the learning process carried out very well. The motivation and attendance of students are good. SMPN Satap 1 Tembuku also has a lot of achievement in academic and non academic programs. It shows that the quality of education in SMPN Satap 1 Tembuku is already good than the other Satap in another area in Bangli. Based on the above findings, it can be concluded that the quality of learning in Satap 1 Tembuku is unic. This certainly has an impact on the quality of education in the same school. The quality of education must be maintained by providing systematic supervision [3]. [15] also revealed that supervisors or education supervisors must understand the problem so that it can help and improve the quality of learning. The empirical data shows that there is a link between supervision and quality of education.

The quality of education in schools can be started by providing good supervision. The school is one of the agencies that desire every employee and teacher work optimally in order to achieve the educational goals that have been stated in the school's vision. Supervision is certainly needed as a function of coaching and supervising the school. Teacher competency needs to be maintained because teachers are the frontline in improving the quality of learning in schools. Coaching is very necessary to maintain the main goal. Teachers need to be nurtured or supervised through supervision or supervision by supervisors who are usually called supervisors [8]. Supervisors have the duty to guide and supervise teachers and staff in a school.

Supervisors are usually principals and senior teachers. The principal or senior teacher supervises the staff and the teacher. Supervision or supervision is a coaching activity that is planned to help teachers and staff so that the main tasks can be done effectively. Supervision will create schools of good quality. Supervision creates a school that is conducive and in accordance with government expectations. According to [2], supervision has the following objectives: 1) increasing the effectiveness and efficiency of learning, 2) controlling the implementation of educational technical fields in schools in accordance with the provisions and policies set, 3) ensuring that school activities take place in accordance with applicable regulations, 4) assessing the schools in carrying out their duties, and 5) providing guidance to correct existing deficiencies.

Supervision has a big impact to the school. Good supervision of schools will contribute actively in the formation of increasingly advanced schools. Supervision does not only supervise, but also provide input and guidance to the existing shortcomings. Input should be used as a reference for creating better academic activities. Supervision activities can be interpreted as a process that requires students and supervisors to consciously engage with each other in a spirit of professionalism, respect, togetherness and an open mind [1]. This can be interpreted that the principal as a supervisor and teacher or employee as students, have an attachment to each other in forming a maximum educational situation.

Based on [6] concerning standar process for primary and secondary education units, it states that: 1) supervision of the learning process is carried out at the planning, implementation, and assessment of learning outcomes, 2) supervision of learning is carried out by providing examples, discussion, training and consultations, and 3) supervision is carried out by the principal or senior teacher and supervisor of the education unit. This shows that there is no single stage in the school especially in the academic field that is independent of supervision activities, in other words supervision has a strategic role in efforts to improve the quality of education.

[6] revealed that supervision consists of two aspects, namely managerial and academic. Academic supervision is an oversight activity that is shown to improve the quality of students through efforts to motivate, guide, foster and direct people related to academic activities. Managerial supervision is oversight in the administrative field related to school administration. Supervision in this study focuses on the academic supervision process carried out at SMPN Satap 1 Tembuku, particularly on planning, implementing, and evaluating science learning. Academic supervision directly influences teacher behavior, especially in academic process. It show that academic supervision will create better quality of learning. Implementation of academic supervision that is routinely carried out by the principal can improve the quality of learning if done in accordance with applicable principles. Principals are required to supervise with the maximum so that the quality of learning is getting better.

Based on the explanation above, the author conducted a study entitled "The Academic Supervision Process by Principal in Science Learning at SMPN Satap 1 Tembuku". The objectives of this study are as follows: 1) Explain and describe the process of supervision of learning planning in SMPN Satap 1 Tembuku. 2) Explain and describe the process of supervision of the implementation of learning in SMPN Satap 1 Tembuku. 3) Explain and describe the process of supervision of learning assessment in SMPN Satap 1 Tembuku. The following is a further explanation related to the process of academic supervision in learning science learning at SMPN Satap 1 Tembuku in 2018/2019 academic year.

2. Research Method

This research uses descriptive method with a qualitative approaches. [13] revealed that qualitative research is used to examine the condition of objects in a natural and researchers as the main instrument. Data collected by interview, observation, and documentation techniques. The informants in this study were the principal, one science teacher at SMPN Satap 1 Tembuku, and one o external supervisor of Bangli Regency. The credibility of this data is carried out with triangulation techniques, discussions with peers, and member checks. This research was conducted for 2 months, from June to August 2019.

3. Result and Discussion

Based on the data obtained the following is a presentation related to the results and discussion of this study.

3.1. Supervision Process of Learning Plan

The learning plan preparation process carried out at SMPN Satap Tembuku is prepared in the workshop period which is held every early semester before effective learning activities. The workshop discussed related to teacher administration preparations that will be used in the whole fo next semester in the form of lesson plan, syllabus, annual programs, semester programs, effective weeks and other administrations. Through the workshop also seen the preparation of teacher learning plan.

The syllabus used by the teacher refers to the government. Through these activities the teacher designs a learning plan which is adopted from science teacher association and will be used in each school.

The planning activities carried out by science teachers at SMPN Satap 1 Tembuku, based on [6], learning planning activities carried out by science teachers already going well. The learning process planning of a lesson plan containing subject identity, competency standards, basic competencies, indicators of competency achievement, learning objectives, teaching materials, time allocation, learning methods, learning activities, assessment learning outcomes, and learning resources [7]. [5] revealed that planning is one of the important aspects that must be considered in curriculum implementation. Planning will determine the overall quality of learning.

Supervision of the planning process by the teacher is needed by the supervisor, in this case the principal is an internal supervisor. Based on the results of interviews conducted, the teacher carried out administrative in order. Teachers who have not yet completed the administration of learning are usually given a penalty through teacher evaluation. The assessment of science teacher is done by the Principal. The teacher evaluation is carried out continuously by the school principal. Teacher evaluation scores can indicate the level of work of teacher. The results of the teacher evaluation can have an impact on teacher certified. This triggers professional teacher to work with discipline so that they get good grades when the teacher assessment is conducted.

Completeness of teacher administration will always be controlled by the Principal. The teacher who wants to do the learning process checks the administration in the principal's office. The check is through the authorization of administration which will be used when learning later. The assignments of learning plan document is conducted step by step. The validation of the document is only for the 1 week period. The document was not validated in its entirety (for example directly 6 month) but by one week, or by one basic competency.

According to [6], the supervisory process standards are as follows. Supervision of the learning process includes observation, supervision, evaluation, reporting, and follow-up activities. The observation of learning process is conducted from planning, implementation, and evaluation stages of learning outcomes. Observation carried out by means of focus group discussions, observations, recording, interviews, and documentation. Observation activities are carried out by the headmaster and supervisor of the education unit. Supervision of the learning process is carried out at the planning, implementation and evaluation stages of learning outcomes. Supervision of learning is conducted by providing examples, discussion, training, and consultation.

Supervision activities conducted by principals and senior teacher as internal supervisors and supervisors of education units as external supervisors. The school principal is given the authority to supervise a maximum of 12 teachers. Senior teachers can be vice-principals or teachers who already have more experience compared to other teachers. Evaluation of the learning process is carried out to determine the overall quality of learning, including the planning stages of the learning process, the implementation of the learning process, and the assessment of learning outcomes. Evaluation of the learning process is carried out by (a) comparing the learning process implemented by the teacher with the standard process, (b) identifying the teacher's performance in the learning process in accordance with the teacher's competence. Evaluation of the learning process focuses on the overall performance of the teacher in the learning process.

Supervision of the planning process is important to do. [4] revealed that the making of lesson plans has an important role in the learning process. The lesson plan is a point for the teacher in implementing the learning process. [12] revealed that a lot of teachers did not make learning plan documents, but only download the documents from the internet. Surely its impact on implementation of learning, besides the procession of the teacher as a planner of the learning process is not in accordance with the expectations or ideas of the teacher. Making a design document can also change the teacher's perspective in its application. Planning oversight also needs to be done by school principals and supervisors of learning by improving the quality of teachers and learning [15].

3.2. The Supervision Process of Learning Implementation

Supervision of the implementation of learning at SMPN Satap 1 Tembuku was carried out by the Principal and one of the senior teachers. Supervision is carried out to provide input when constraints occur in learning in class. Supervision of the implementation process is carried out by visiting class to observe the learning activities. Supervision takes place continuously to keep the consistency in

implementing the learning process properly. Based on the results of interviews conducted, it shows that the supervisor has carried out the provisions of the supervision process in accordance with [6].

3.3. The Supervision Process of Learning Assessment

The minimum criteria is determined by each teacher in each subject. The establishment of minimum criteria is done during the workshop periods together with other administrative collections. That because the establishment of the minimum criteria is one of the administrative documents that must be collected together with the learning plan, syllabus and etc. Stages of assessment usually refer to summative and formative tests. The test is carried out in stages of daily tests, midterms, and end of semester exams. During daily tests and midterm exams, questions are made by the teacher, while in the final semester exams the questions are made from the service through teacher association. These activities are closely monitored, so as to create pure results from the abilities of students.

4. Conclusion

The supervision process carried out at SMPN Satap 1 Tembuku, namely; first for supervision of the planning process conducted by carrying out the rules so the teacher prepare the learning plan regularly. Administration in the form of lesson plans and syllabus and other documents are collected in early of the semester. The process of making these documents is usually through workshops conducted at the beginning of the semester. Teachers who do not perform administrative according to the rules will be given a warning based on teacher evaluation value conducted by the Principal. The interesting thing about the preparation supervision process is carried out by principal. The assignment of learning plan is done by 1 basic competence. This supervision will impact the teacher to make learning plan regularly and implemented in class.

Second, the process of supervision of the implementation of learning. The supervision process is carried out by the school principal in the context of supervision which is carried out routinely by the school. Supervision begins with an examination of planning documents that will be carried out by the teacher in the learning process. Examination of these documents refers to [7]. Inspection of the document is carried out to check whether there is a deficiency or input that must be given by the Principal in this matter as a supervisor in the activity. Furthermore, activities will be carried out in the classroom. The school principal observes the learning process conducted by the teacher. The teacher brings the lesson plans into class which can be used as a reference in carrying out the learning stages. These activities usually refer to three stages, namely introduction, core and closing activities. The next stage is, giving input to the teacher if there are deficiencies that occur during the learning process in class. The input is certainly a reference for learning activities that will take place during the next semester to be better.

Third, the process of the assessment supervision at SMPN Satap 1 Tembuku was carried out well done. Assessment documents in the form of minimum criteria provisions are collected by the teacher at the beginning of the semester. The minimum criteria determination refers to three main components, namely, the complexity of the material, the absorption of students, and supporting facilities/infrastructure in the school. Assessment at SMPN Satap 1 Tembuku refers to three aspects, namely psychomotor, cognitive and affective students. Supervision of the assessment is also carried out on summative and formative tests carried out. The supervision is in the form of forming a committee and conducting tests conducted with high integrity. This is evident from the ministry's award won by the school as a school with high integrity in the implementation of the National Examination in 2015.

Based on the explanation above, the supervision aspect is one of the most important aspects in the management of learning. Supervision that is done regularly will create a systematic planning, implementation and assessment process. Supervision in of a planning process is carried out by principal with a validation of learning plan and syllabus only for a few basic competencies. This causes the teacher to be more disciplined and prepare planning documents as well. A good planning process will have an impact on the implementation process. Supervision by the principal is usually done by visiting the class. The visitation is carried out at the supervision stage which is carried out routinely every semester. The activity was conducted as a reflection to carry out the learning process going forward. Stages of assessment are also done well. This stage is done to maintain the purity of student

learning outcomes in school. Assessment is carried out with high integrity so that it is able to maintain the credibility of the school as a good nationality examination implementation.

There are supporting and barriers factors in the supervision process at SMPN Satap 1 Tembuku. This is a description of the supporting factors of the supervision process at SMPN Satap 1 Tembuku; 1) The supervision conducted intensively at the planning stage. The headmaster validate only a few basic competencies so that supervision is more stringent and maintained so that teachers are more disciplined in completing administration, 2) supervision is carried out continuously at the beginning of each semester in accordance with [6], 3) the exercise of workshops so the teachers are given the opportunity to have more concept to prepared the learning plan, and 4) giving a warning and sanctions if the teacher makes a mistake and giving rewards to teachers who have good performance. The barriers factors of supervision in SMPN Satap 1 Tembuku are follows; 1) Teacher's with undisciplined behavior in collecting administration so that supervision of planning is not fulfilled, 2) Limited expertise of supervisors because of the different basics knowledge between supervisors and supervised teachers.

References

- [1]. Abiddin N Z, Ismail A and Ismail A 2011 Effective Supervisory Approach in Enhancing Postgraduate Research Studies. *International Journal of Humanities and Social Science* vol 1 (2). 206-217
- [2]. Burhanuddin 2007 *Supervisi Pendidikan dan Pengajaran* (Malang: Rosindo)
- [3]. Iskandar D and Wibowo U B 2016 Peran Pengawas Pendidikan dalam Peningkatan Mutu Pendidikan SMP di Kabupaten Bima Provinsi Nusa Tenggara Barat. *Jurnal Penelitian Ilmu Pendidikan* vol 9 (2) pp 179-195
- [4]. Kanellopoulou E M and Darra M 2018 The Planning of Teaching in The Context of Lesson Study: Research Findings. *International Education Studies* Vol 11 (2) pp 67-82
- [5]. Mulyasa E 2008 *Menjadi Guru Profesional* (Bandung: PT Remaja Rosdakarya)
- [6]. Permendikbud 2013 *Nomor 65 Tahun 2013 tentang Standar Proses Pendidikan Menengah* (Jakarta: Kementerian Pendidikan dan Kebudayaan)
- [7]. Permendikbud 2014 *Nomor 103 tahun 2014 tentang Pembelajaran pada Pendidikan Dasar dan Pendidikan Menengah* (Jakarta: Kementrian Pendidikan dan Kebudayaan)
- [8]. Permendikbud 2015 *Nomor 22 tahun 2015 tentang Rencana Strategis: Kementrian Pendidikan dan Kebudayaan* (Jakarta: Kementrian Pendidikan dan Kebudayaan)
- [9]. Sahertian 2008 *Konsep Dasar & Teknik Supervisi Pendidikan* (Jakarta: PT Rineka Cipta)
- [10]. Sanjaya I K A, Marhaeni A A I N, and Suarni N K 2013 Studi Evaluasi Tingkat Efektifitas Pelaksanaan Pengembangan SD-SMP Satu Atap di Kabupaten Karangasem *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha* vol 2(1) pp 1-11
- [11]. Sawirdi 2016 Implementasi Kebijakan SD-SMP Negeri 4 Satu Atap di Desa Pongkar Kecamatan Tebing Kabupaten Karimun *Jurnal Pendidikan* vol 17(2) pp 114-120
- [12]. Sudjito D N, Keliat N R and Hastuti P S 2018 Integrated Science Learning Using Scientific Apporach in Junior High Schools in Semarang Regency *Indonesian Journal of Science and Education* vol 2(1) pp 69-74
- [13]. Sugiyono 2013 *Metode Penelitian Kuantitatif, Kualitatif, dan R & D* (Jakarta: Alfabeta)
- [14]. Wiles J & Bondi J 1986 *Supervision: A Guide to Practice. Second Edition* (Columbus: Charles E. Merrill Publishing Company)
- [15]. Yummeti Y 2018 Implementation of Lesson Study in Physich Teaching by Group of Teacher in Solok West Sumatera *Journal of Physics: Conference Series*. Article

Levels of serum glutamate oxaloacetate transaminase (sgot) white rat (*Rattus norvegicus*) wistar strain after administration *Katsuwonus pelamis* L. which has been soaked using the leaf extract of *Moringa oleifera* L.

N L P M Widiyanti^{1,2,3}, N P Ristiati^{1,2,3}, D M Citrawathi^{1,2,3}, D W Wahyuni¹

¹Department of Biology and Marine Fisheries, Faculty of Mathematics and Science, Universitas Pendidikan Ganesha, Bali-Indonesia, 81116

²Postgraduate Natural Science Department of Education, Faculty of Mathematics and Science, Universitas Pendidikan Ganesha, Bali-Indonesia, 81116

³Department Biology of Education, Faculty of Mathematics and Science, Universitas Pendidikan Ganesha, Bali-Indonesia, 81116

e-mail: manikwidiyanti@gmail.com/putu.manik@undiksha.ac.id,
puturistiati@gmail.com, dskcitra@gmail.com

Abstract. The purpose of this research were: to know levels of Serum Glutamate Oxosaloacetate Transaminase (SGOT) *Rattus norvegicus* wistar strain after administration cakalang (*Katsuwonus pelamis* L) which has been soaked using formalin and various concentrations moringa leaf extract and to analyze the concentration of moringa leaf extract is best used as a natural preservative of skipjack. This research design is post test only control group design. Levels of SGOT were analyzed using anova one way. The results of this study showed that levels of significance different of SGOT, then H_0 rejected and H_1 accepted so there was a difference in SGOT levels of male white rat (*Rattus norvegicus*) wistar strain after administration of cakalang which has been soaked using various concentrations moringa leaf extract. The concentration of moringa leaf extract most effectively used as a natural preservative of cakalang is the concentration of 25%.

Key words : moringa or merunggai leaf extract, *Katsuwonus pelamis* L, *Rattus norvegicus* wistar strain, SGOT levels

1. Introduction

Indonesia is an archipelago is the largest island country in the world. The breadth of the sea water area is owned, causing Indonesia to be dubbed as maritime country. The production of fish caught 4.72% to 5.03% million tons (especially tuna fish), while the resulting fish production rose 3.98% to 10.07% million tons until the third quarter of the year 2015.

One of the waters in Indonesia that has increased production of fish catches and cultivation is the waters of North Bali with an area of $\pm 3,850.03$ km² that includes coastal waters along Regency of Buleleng [1]. Based on this great potential, the sea of Buleleng has long been utilized by coastal communities as a source of livelihood, especially in the field of capture fisheries. The potential of sustainable fisheries in the marine waters of Buleleng based on the data of the Marine and Fisheries Service Bali Province in year 2015 is 3,196.5 tons in year 2015, consisting of pelagic fish large and small, demersal fish, and coral fishes. The dominant type of fish caught by fishermen one of them is skipjack fish or cakalang (*Katsuwonus pelamis* L).

Based on the results that have been observed in some traditional markets in Buleleng and the results of interviews with some fish traders, it is known that Skipjack is one of the fish that consumers are interested in buying. This is because skipjack fish has a high nutrient content and is complete

especially the protein and tender meat. But in reality in the field there is an inequality between consumer demand with the least availability of skipjack sold by merchants who do not dare to provide too much tuna. This is because the cakalang is a large pelagic fish that is prone to decay. Generally, the decomposition of fish is caused by the activity of microorganisms, both inside and outside of fish.

The use of formalin is widely abused and often used as a preservative for food such as fish that can cause liver damage. [2] has conducted tests on the influence of fish exposure to formalin and its influence in rats occurred functional hepar disorder. Based on the problem, it can be solved by utilizing natural preservatives. One is the moringa (*Moringa oleifera* L.). The research conducted by [3] by testing the moringa leaf extract as a natural preservative of skipjack fish (*Katsuwonus pelamis* L.) has been observed that the results of moringa leaf extract can cause a barrier zone on bacterial growth. To observe the potential of moringa leaf extract as a natural preservative in skipjack fish and its impact for consumers, then this research is done by determining the serum levels of glutamate oxaloacetate in liver transaminases (sgot). This test was done on the animal model namely male white rats (*Rattus norvegicus*) wistar strains by giving feed in the form of cakalang fish pellets. Skipjack fish have been soaked in moringa leaf extract for further made pellets.

2. Methods

2.1 Research design

The research design used in this study is true experimental with a complete randomized design (CRD) with the design of the randomized post test only control group design. The population in this study was the male white mouse (*Rattus norvegicus*) wistar strain with a body weight is 150 – 200 grams, aged 2-3 months. The research samples was 24 male white mouse (*Rattus norvegicus*) wistar strain have been randomized selected and have been divided into 3 treatment groups and 1 control group. Repetition has been done 6 times, according to the formula of Federer $(t - 1)(n - 1) \geq 15$ [4]. There are three types of sample criteria are :

1. Inclusion criteria are : male white mouse (*Rattus norvegicus*) wistar strain, age 2-3 months, weight 150-200 grams, healthy.
2. Drop out criteria : visible physical defects, death during research.
3. Exclusion criteria : female white mouse, the other species and strain.

2.2 Research variables

2.2.1. Independent Variable

The independent variable in the study is administration feeding pellet of skipjack fish which has been soaked with formalin and moringa leaf extract with various concentrations (25%, 50%, 75%) on mice

2.2.2. Dependent variable

Dependent variable in this study were SGOT levels in male white rats (*Rattus norvegicus*) wistar strain.

2.3 Data Collection Techniques

The Data needed in this research have been gathered through three phases namely the preparation stage, implementation stage and observation stage.

2.3.1. Preparation phase and preliminary test

1. Preparing tools and research materials
2. The manufacture of moringa leaf extract (*Moringa oleifera* L.)
3. Make cakalang fish pellets
4. Animal preparation test

2.3.2 Implementation stage

1. Feeding pellet from cakalang fish
2. Collection of blood

2.3.2. Observation Stage

1. Observation of SGOT levels. Measurement of SGOT levels is measured with Evogen brand SGOT Kit reagent. Measurement of SGOT activity is conducted on each treat group. SGOT examination, as follows:

A. Provide SGOT kit (Evogen volume 100 ml).

B. Create a working reagent by mixing 4 ml of reagent 1 (R1) + 1 ml of reagent 2 (R2) into the test tube then in homogenization.

C. To inject work reagents, samples, and controls at working temperature (30°C).

D. Regulate spectrophotometer on absorbance 0 with aquadest at 340 nm wavelength.

E. To enter work reagents as much as 1 ml and the sample (blood serum) of 100 ml into the cuvet was then homogenized and incubated for 1 minute at working temperature (30°C).

F. Insert the cuvet into a spectrophotometry cell holder.

G. Read the absorption in minutes 1, 2, and 3.

H. Calculate differences between absorbance

I. Calculate the previous average absorbancy difference to obtain a value of absorbance per minute ($\delta a/\text{min}$).

J. Multiply the value of absorbance per minute ($\delta a/\text{min}$) with the SGOT factor (1746) so that the value of SGOT rate is in μL .

2.4. Technic of data analysis

2.4.1. Hypotesis

The hypothesis test was conducted using the analysis of variance test (ANOVA) one way with the equivalent significance (α) = 0.05.

3. Results and Discussion

3.1. Results

The male white mouse (*Rattus norvegicus*) wistar strains have been given 30-days treatment with the feeding pellet of skipjack fish. The end of the treatment has been surgically performed in rats to take the blood serum, and an average levels of SGOT measured using a spectrophotometer with a wavelength 340 nm.

3.1.1 Descriptive analysis results

Data on the measurement result has been done by measuring the average SGOT rats can be seen in Table 1.

Table 1. The average SGOT of rats

Variabels	Average (μL)	Standard deviation
Levels of SGOT positive control (μL)	95.39	4.541
Levels of SGOT Treatment1 (μL)	77.843	5.828
Levels of SGOT Treatment2 (μL)	62.274	4.044
Levels of SGOT Treatment3(μL)	45.833	5.888

Based on Table 2 obtained that control criteria has increased SGOT with average SGOT level of 95.73 μL , while for treatment1 (moringa leaf extract 25%) has decreased SGOT average with an average of 77.84 μL . Treatment 2 (moringa leaf extract 50%) with an average SGOT 62.27 μL tends to have decreased and has undergone a decline in the treatment. Treatment 3 (moringa leaf extract 75%) with average SGOT is 45.83 μL .

3.1.2 The normality analysis result

The test results of normality that has been done by measuring the SGOT level of male white mouse (*Rattus norvegicus*) wistar strain can be presented in Table 2.

Table 2. The results of the test for normality of SGOT levels

Variable	Mean (μ /l)	Standard Deviation	p Value	Explanation
SGOT levels (PC +)	95.739	4.541	0.605	Normal
SGOT levels (T1)	77.843	5.828	0.151	Normal
SGOT levels (T2)	62.274	4.044	0.801	Normal
SGOT levels (T3)	45.833	5.888	0.675	Normal

3.1.3 The homogeneity analysis result

The results of homogeneity test that has been done by measuring SGOT levels of white rats are presented in table 3.

Table 3. The results of the test for homogeneity of SGOT levels

Variable	Levene test value	p value	Explanation
SGOT levels	0.489	0.694	Homogen

Based on Table 3, the results of homogeneity test that has been done by measuring the level of SGOT White mouse has gained significance value of 0.694. This shows the variant of the SGOT Data group of male white rats is homogeneous because of the level of significance obtained $p > 0.05$.

3.1.4 One way anova test result

The results of hypothesis test that has been done by measuring SGOT rat levels are presented in Table 4.

Table 4. The results of one way anova test

Variable	F value	p value	Explanation
SGOT levels	103.534	0.0001	Significance difference

According to Table 4, the results of the hypothesis test that was done using the statistical test of Anova One Way has shown the significance value of SGOT rats, i.e. $p = 0.0001$, meaning the value of $p < 0.05$ so that there has been a significant difference SGOT of white rat wistar strain, then H_0 has been rejected and H_1 has been accepted that the meaning the treatment with fish-feeding that has been soaked with leaf extract of merunggai with different concentrations affecting SGOT rat levels.

3.1.5 Least Significance Difference analysis result

Advanced test results that have been done by calculating the least significance difference test (LSD) of SGOT mouse with post hoc test can be seen in Table 5.

Treatments		Difference Average	p value	Explanation
Control	Treatment 1 (25%)	17.896	0.0001	Significance difference
	Treatment 2 (50%)	33.465	0.0001	Significance difference
	Treatment 3 (75%)	49.906	0.0001	Significance difference

Treatment 1 (25%)	Treatment 2 (50%)	15.568	0.0001	Significance difference
	Treatment 3 (75%)	32.010	0.0001	Significance difference
Treatment 2 (50%)	Treatment 3 (75%)	16.441	0.0001	Significance difference

The average of SGOT rat levels are presented in figure 1.

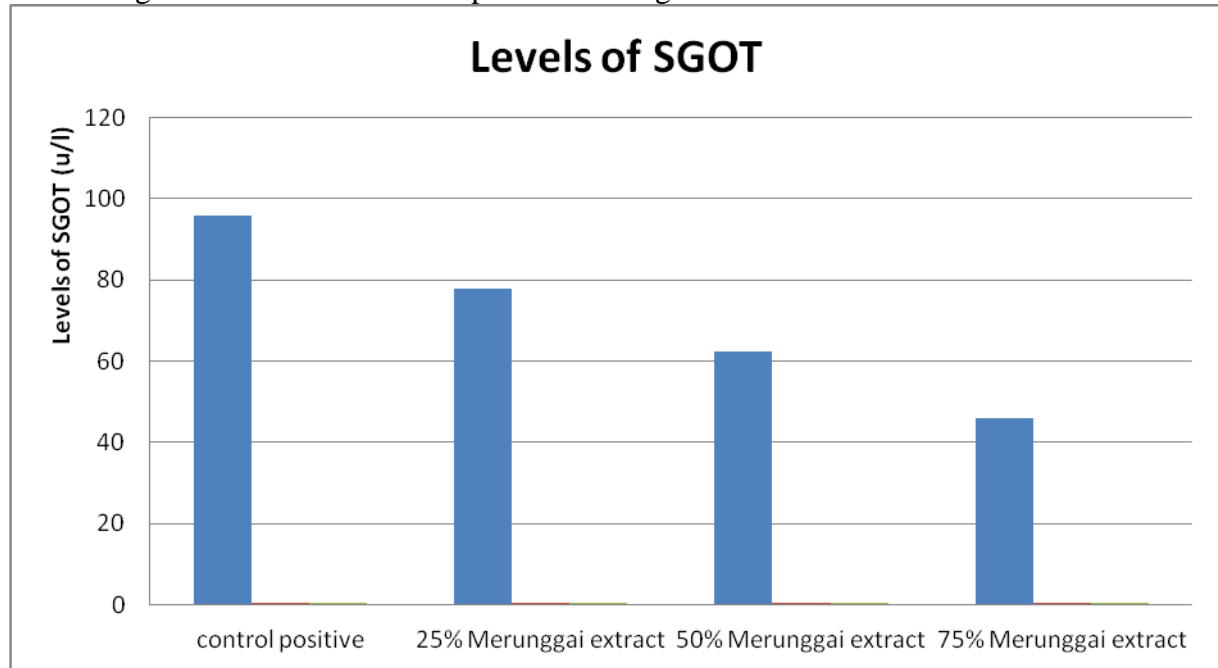


Figure 1. SGOT levels of male white rats

3.2 Discussion

This study has used male rats as a test animal as it has a more stable biological condition compared to female rats. The 2-3-month-old male mouse is a young adult rat with optimal physiological conditions. The mouse was adapted for 14 days in order to adapt to the environment during study.

Based on the results of the research done and the results of data analysis that has been done using ANOVA one way indicates that the value $p = 0.0001$ which means there is a meaningful difference between the experiment group and the control group. SGOT level activities were measured using a spectrophotometer with a wavelength of 340 nm. The results of measurements have shown that in the control group using formalin as a preservative of skipjack fish obtained level SGOT is 95.739 μL which has meant that SGOT has been measured to exceed the level limit of normal SGOT white rats as already stated by Mangkoewidjoyo, 1988 (in [5]), that SGOT level in normal white mouse is 45.7-80.8 μL .

SGOT level mice in control groups that have been given skipjack that has been soaked with formalin tend to increase from the treatment group which has been given a various of the concentration of moringa leaf extract. The skipjack feed that has been preserved by using formalin causes increased levels of SGOT compared to the use of moringa leaf extract (*Moringa oleifera*). This research has been in line with the results of research conducted by [2] which has stated that the results of data analysis showed that formaldehyde treatment in fish can increase the level of SGOT compared to the group control (fish without formalin).

In this research that has been done, there has been increased levels of SGOT *Rattus norvegicus* which has been caused due to exposure to fish against formalin chemicals that

have been administered for 30 days at a dose of 0.25%. According to [6] that formalin is an irritant substance, in which the formalin compound enters into the body will be detoxifying and metabolized by hepar, as well as producing xenobiotic substances that can damage liver function. Damage to hepar structure due to exposure to xenobiotic material will cause impaired liver function. Formalin that has entered into the body will be metabolized into a format acid compound. The acid format in the body will circulate through the port vein thereby entering the hepar tissue. In the hepar tissue there are the kuppfer cells that will directly activate reactive oxygen species (ROS) which are toxic compounds. ROS production has resulted in damage to fatty tissues that can cause damage to the cell structure, i.e. in the mitochondrial membrane. Formite acid that has been produced in the metabolic process of formalin in the body will inhibit the metabolic activity process of mitochondrial oxidase of cytochrome P450 thereby resulting in tissue hypoxia in hepar cells. Prolonged hypoxia will result in damage to the hepar tissues. Damage can result in a hepar injury so that an increase in SGOT levels. Increased levels of SGOT occur due to the output of glutamate oxaloacetate into the serum when the tissue suffered damage. [7] stated that SGOT limit that indicates liver damage can reach 20-100 times the highest normal limit.

Based on the results of [2] research, has reported that formaldehyde treatment in fish has been able to increase SGOT levels. Damage to cell structures has led to functional enzymes such as SGOT detected in the cytosol as well as mitochondria to enter into the blood circulation system. Therefore, high levels of SGOT contained in the blood can indicate the occurrence of damage to the hepatic cells. Similarly [6] has stated that the SGOT level of *Rattus norvegicus* that has been given a formalin through the mouth has been expressed higher SGOT rate than placebo control

The results of SGOT mouse measurements that have been done in this research with the treatment of skipjack pellets that have been preserved with moringa leaf extract with various concentrations, have shown different SGOT levels with the control group. The difference is seen in the results of SGOT measurement group treatment with control group, indicating that the treatment group that has been given skipjack that has been soaked with leaf extract moringa 25%, 50%, and 75% has shown SGOT level lower than the positive control group (soaking the skipjack using formalin).

SGOT activities in all treatment groups during the treatment period show that it is still included in the normal range, normal SGOT level in rats is 45.7 – 80.8 μ /l. SGOT level on moringa leaf extract 25%, 50%, and 75% have shown that concentrations of these moringa leaf extracts are concentrations that can be exposed to the rat body on a daily basis, as they have high anti-bacterial and anti-oxidant doses to ward off free radicals that can be accepted by body.

One of the food sources that serves as hepatoprotector is moringa leaf are plants that contain beneficial chemical compounds, among which are flavonoids compounds that can capture free radicals that cause damage to the hepar [8].

Based on the results of the phytochemical studies, the moringa leaf contains metabolic compounds of secondary flavonoids, alkaloids, phenols, quercetin and may also inhibit bacterial activity [9]. [10] stated the phytochemical compounds of saponin, and tannins have also been found on the moringa leaf extract..

The usefulness of moringa leaves as a natural preservative to inhibit microbial growth has been extensively researched, some of which are [11] has stated that merunggai leaf extract can be used as a *Pseudomonas aeruginosa* antibacterial is one of the bacteria that causes decay to fish. The active ingredient contained in the leaves of the merunggai n are flavonoids, phenols, quercetin, and alkaloids are the active ingredients of the antimicrobial compound [9]. The research that has been done by [3] has stated that the coarse extract of the moringa leaves (*Moringa oleifera* L.) as a natural preservative of skipjack fish (*Katsuwonus Pelamis*

L.) has been able to cause a diameter zone barrier in bacterial growth with the concentration used is 25%, 50%, and 75% and the freshness level of skipjack fish that has been soaked with moringa leaf extract can last up to 12 hours with the freshest quality at a concentration of 75%.

Quercetin has antioxidant activity that allows flavonoids to capture or neutralize free radicals associated with the OH phenolic group to improve the state of the damaged tissues and the inflammatory process can be obstructed [12]. [13] stated Silymarin has a hepatotherapy effect because it can increase the speed of protein synthesis that stimulates cells to regenerate faster, namely by replacing old or damaged cells with new cells.

Increased serum in the enzyme liver transaminases consisting of aspartate amino transaminases/glutamate oxaloacetate transaminase (AST/GOT) is a more specific initial marker for the detection of the damage of hepar [14]. One mechanism that contributes to the damage of hepar is the buildup of free radicals. Excessive free radicals will cause oxidative stress that triggers the peroxidation process against lipids, thereby causing cancer, inflammation, atherolerosis, and accelerating the aging process [15].

From the results of studies that have been conducted, has shown that the level of SGOT in rats that had been feed fish that had been preserved with moringa leaf extract with concentrations of 25%, 50%, and 75% had shown that the extract had been able to inhibit increased levels of SGOT at normal levels, where normal SGOT in rats is 45.7 – 80.8 μ /L. When the liver cells do not suffer damage, the SGOT enzyme does not enter the blood circulation in large quantities. Thus, it has been demonstrated that the use of moringa leaf extracts with concentrations of 25%, 50%, and 75% in this experiment did not cause impaired liver function in test animals.

Based on the data on the level of SGOT *Rattus norvegicus* which has been obtained in Table 1 shows the average level of SGOT *Rattus norvegicus* after given the feeding of skipjack fish that has been preserved with moringa leaf extract has obtained a treatment that most effective at a concentration of 25% which can be seen in the LSD test which at a concentration of 25% has shown differences and decreased levels of SGOT *Rattus norvegicus* compared with the positive control group (using formalin). In research conducted by [3] about moringai leaf extract as a natural preservative skipjack fish has been known that moringa leaf extract at a concentration of 25% is anti-bacterial because of its concentration antibacterial compounds have been optimally diffused into the body of bacteria. The concentration of moringa leaf extract of 25% contains an active antibacterial compound that has been able to damage the consortium's defense system test bacteria. It has also been reported by [16], that moringa leaf extracts with a concentration of 25% have been able to inhibit *E. coli* pathogenic bacteria.

The results of studies that have been conducted, has shown declining levels of SGOT white rats at a concentration of 25% which is the lowest concentration that has been used in this study, has shown that the active compounds in the leaf extract of the moringa in a dose of 25% has been able to lower SGOT levels compared to positive control (soaked using formalin).

4. Conclusion

Based on the research that has been done, the conclusion in this study is as follows.

1. There is a difference in the level of SGOT white mouse (*Rattus norvegicus*) strains wistar the male after eating skipjack fish that has been preserved with merunggai leaf extract as a natural preservative with varying concentrations.
2. The most effective concentration of merunggai leaf extract used as a natural preservative of skipjack fish is the concentration of 25%.

5. Recommendation

For the community especially fish traders, it is advisable to use natural ingredients for the purpose of food preservation, especially in this case to maintain the freshness of fish. This is done considering that natural ingredients are more effective and do not give a bad effect on the body when compared to synthetic preservatives.

6. Acknowledgments

Authors wishing to acknowledge assistance or encouragement from colleagues :who have helped directly or indirectly, so that this research can be resolved.

References

- [36] Dinas Kelautan dan Perikanan Provinsi Bali 2008 *Potensi Perikanan Bali* (Bali : Dinas Kelautan dan Perikanan Provinsi Bali)
- [37] Maramis A A, Mohamad A, Sumarno S dan Aloysius D C 2010 Pengaruh Paparan Berulang Ikan Berformalin Terhadap Gangguan Fungsional Hepar Mencit *Seminas Pend Biol FKIP UNS*
- [38] Wulandari N K M 2017 Ekstrak Kasar Daun Kelor (*Moringa oleifera*) Sebagai Pengawet Alami Ikan Cakalang (*Katsuwonus pelamis* L.) *Skripsi* (Bali : Jur Pend Biol Univ Pendidikan Ganesha).
- [39] Federer W 1963 *Experimental Design Theory and Application* (Oxford : Oxford and Lbh Publish Hincó).
- [40] Wahyuni S 2005 Pengaruh Daun Sambiloto (*Andrographis paniculata*) Terhadap Kadar SGPT dan SGOT Tikus Putih *GAMMA* vol 1 num 1 pp 45-53
- [41] Peanasari A R I, Djamil S L and Rohmani A 2015 Pengaruh Formalin Peroral Terhadap Kadar SGOT dan SGPT Tikus Wistar *J KedokMuhammadiyah* vol 2 number 1 pp 36-37
- [42] Sadikin M 2002 *Biokimia Enzim* (Jakarta:WidyaMedika)
- [43] Caceres A and Saravia A 1992 Pharmacologic Properties of *Moringa Oleifera*. 2: Screening for Antispasmodik, antiinflammatory and Diuretic Activity *J Ethnopharmacol* vol 36 pp 233-237.
- [44] Pandey A, Pandey R D, Tripathi P, Gupta P P, Haider J, Bhatt S, and Singh A V 2012 *Moringa oleifera* Lam (Sahijan) – A Plant With a Plethora Diverse Theraupic Benefits: An Update *Retropectio Medicinal & Aromatic Plants* vol 1 p 101
- Bukar A, Uba A, and Oyeyi TI 2010 Antimicrobial Profile of *Moringa oleifera* Lam Extracts Against Some Food – Borne Microorganisme *Bajopas* vol 3 num 1 pp 43-48.
- Widowati I, Siti E, dan Sari W 2014 Uji Aktivitas Antibakteri Ekstrak Daun Kelor (*Moringa oleifera*) Terhadap Bakteri Pembusuk Ikan Segar (*Pseudomonas Aeruginosa*) *Jurnal Penelitian Sains & Teknologi Universitas Negeri Yogyakarta* vol 9 num 2.
- [45] Ikalinus R, Widyastuti S K, Setiasih N E 2015 Skrining fitokimia ekstrak etanol kulit batang kelor (*Moringa oleifera*) *Indonesia Mediacus Veterinus* vol 4 num 1 pp 71-79
- Krisnadi D A 2014 *Kelor Super Nutrisi* Pusat Informasi dan Pengembangan Tanaman Kelor Indonesia, Lembaga Swadaya Masyarakat – Media Peduli Lingkungan (LSM-MEPELING).
- [46] Koh D dan Jeratnam 2009. *Buku Ajar dan Praktik Kedokteran Kerja* (Jakarta:EGC)
- [47] Ramatina 2011 Efektifitas Berbagai Suplemen Antioksidan Terhadap Penurunan Status Oksidatif Malondialdehyd (MDA Plasma) Pada Mahasiswa Alih jenis IPB *Skripsi* (Bogor : Institut Pertanian Bogor)
- [48] Nugraha A 2013 Bioaktivitas Ekstrak Daun Kelor (*Moringa oleifera*) Terhadap *Escherichia coli* Penyebab Kolibasilosis Pada Babi *Tesis* (Denpasar : Program Studi Kedokteran Hewan Program Pascasarjana Universitas Udayana).

The implementation of flipped learning model in classroom: literature review

L P R Ukirsari¹, I W Subagia² and N P Ristiati³

^{1,2,3} Science Education Master Study Program, Departement of Physics and Science Teaching, Faculty of Mathematics and Natural Sciences, Ganesha University of Education

putureniz@gmail.com

Abstract. This paper aims to described and explain the implementation of flipped learning model in classroom. Literature review was used for developing this paper involving 22 international articles. Those articles then categorized based on the research objectives, research method, and the factors affecting flipped learning model implementation. Based on the objectives of the study, 40.9% of the research were compared the use of flipped learning models and traditional learning models. There were 59% of articles that aim to find out students' perceptions and motivations in participating in learning. The result revealed that there were 22.7% of researchers used qualitative methods and 77.3% of studies using mixed methods. Factors affecting flipped learning model implementation were student, teacher, school, and parents. Overall, the results of the study shows that the implementation of the flipped learning model has a positive impact on the learning process.

Keyword: flipped learning model, classroom, literature review

1. Introduction

The development of science and technology in the form of internet, computers/laptops, handphones, etc., must be used in a good way. This development must be used in education field. At present, learning tends to use traditional methods where instruction is given by teaching and students are given assignments to do at home without being guided. Students will tend to be trapped and unable to complete these tasks [1]. Although there are some teachers use a learning model with scientific approach, but lack of time is one of the problems. Teaching and learning process in schools must started to apply technology. Utilization of the internet to find various information needed in the learning process is one of the goals of technology implementation. The flipped learning model is one of learning models that can be used in applying internet technology. Flipped learning model is very different from the traditional learning model in various aspects. In the traditional learning model, students in class tend to record the material delivered by teacher and then do the work given by teacher at home. Unlike the flipped learning model, before students enter the classroom they are equipped with sufficient information to answer various problems regarding learning to be carried out. Information is given to students by utilizing internet facilities, such as by using google classroom, group chat, Facebook, or etc. When students enter the classroom, the student already has information about the material to be studied. Activities in class are answering questions that cannot be understood by students. Educators are no longer as information providers, instead they share the responsibility of learning procedures with students [2].

Teachers in educating students must utilize various ways and techniques in improving the quality of knowledge obtained by students. The flipped learning model not only emphasizes how students watch videos at home, but how students gain learning experiences in meeting their needs [3]. In the flipped learning model, the teacher gives a video, text or phenomenon that will be read or watched at home. Students are also allowed to find other learning resources related to the material being discussed. At school, students only discuss material that is not yet understood and work on questions related to the material. The teacher usually gives lectures in the form of videos as homework, and uses the time in class to practice active learning and direct involvement with students. There are seven steps in applying the flipped learning model, which are as follows [4].

- a. Determine learning outcomes and main concepts
- b. Planning an implementation strategy
- c. Develop pre-class learning activities and checkpoints

- d. Develop and connect class activities
- e. Delivering class
- f. Link with advanced class activities and assessments
- g. Class evaluations

Theoretically, flipped learning model implementation will produce good learning outcomes. But practical evidence is needed, so that it can be stated literally about the effectiveness of flipped learning model. Currently, research on the flipped learning model implementation has been carried out in various educational circles in the world, from elementary to university level. Various methods and approaches are used to achieve the research objectives. Many researchers compare the effectiveness of implementing the flipped learning model with other learning models [5,6,7,8,9,10,11,12,13]. There are also studies using questionnaires and interviews to find out students' perceptions about the flipped learning model [8,14,15,16]. The result of the studies showed varies result according to their objectives. There needs a literature review to find out all the information from a collection of articles that research about flipped learning model. The results of the literature review will showed the objective and method used in the research being studied. The factors affecting flipped learning model will also be seen. This literature review can be used as a reference or guideline in implementing flipped learning model or as input if need to do a research about flipped learning model.

2. Method

This literature review was made by systematic searching of related articles in five websites, namely AJET, ERIC, Free Full PDF, Google Scholar, and Science Direct. The keyword used in finding the article was flipped learning. Articles were reduced in such a way, adjusting to the purpose of making this literature review. Articles used were published in 2008 - September 2018. The search results returned 66 articles. Furthermore, the abstracts from the 66 articles were read and resulted 22 articles. The criteria used in determining the article used were contain flipped learning, how the model influences the learning process, as well as the perceptions of educators or students about the application of this model. The articles used is only focused on research objectives, research methods, and factors affecting flipped learning model implementation. The research places and subjects used by researchers were not taken into account.

The 22 articles then categorized based on research objectives, research methods, and factors affecting flipped learning model implementation. The research objectives of the articles were collected and divided based on similar objectives. It is also done in research method and the factor affecting flipped learning model implementation. The group of each similar criteria then analyzed. From that data, the reasons of choosing research objectives and research methods will be known. Factors affecting of flipped learning model will be analyzed from all the articles.

3. Results

Based on the results of the literature review, it can be categorized as follows (Figure 1.).

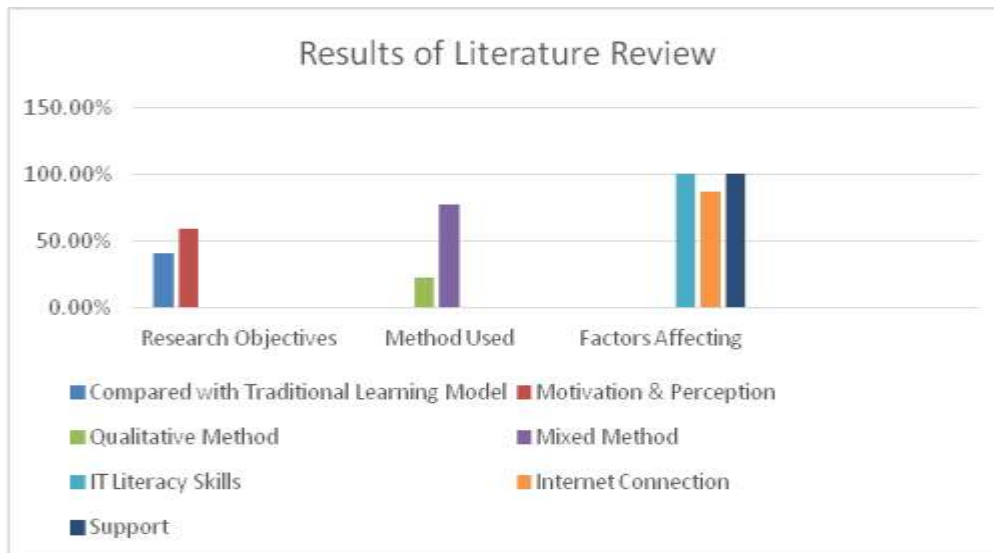


Figure 1. Results of Literature Review

3.1. Research objectives

The 22 articles are further categorized based on the purpose of the research conducted. There are 40.9% of research articles used traditional learning as a control group and flipped learning models as an experimental group. This study aims to determine the effectiveness of flipped learning model compared with traditional learning models in the learning process. The results showed that the use of flipped learning model was more effective than the traditional learning model [5,6,7,8,9,10,11,12]. This is evident by the level of student achievement in learning material higher than using traditional learning model. Only 11.1% said that there was no significant difference between the use of the flipped learning model and the traditional learning model [13].

Furthermore, there are 59% of research articles that examine the motivation and perceptions of students towards the flipped learning model. This information was obtained through the use of questionnaires and interviews with research samples. The results showed that the use of flipped learning model can increase student motivation in learning participation [17,18,19,20,21,22].

3.2. The research method used

The 22 articles were categorized based on the method used by the researchers. There are two types of research methods used in research on flipped learning, namely qualitative methods and mixed methods. The qualitative method is carried out by giving questionnaires, observations or interviews with informants. There are 22.7% of articles that use qualitative methods, namely [15,23,24,25,26]. The instruments used are observation, interview and document collection. Observations done to know the student motivation in learning participation by applying the flipped learning model. The involvement and interest of students in participating in learning is also observed. Information about students' perspectives, interests and perceptions is collected through semi-structured interviews. Documents, in the form of student attendance, shows the interest and motivation of students in learning participation. Furthermore, there were 77.3% of studies that used mixed methods and 35.3% of them used quasi-experimental research designs. Pre-test and post-test was conducted to determine the increase in student knowledge after using flipped learning model.

3.3. Factors affecting flipped learning model implementation

The factors affecting flipped learning model implementation are as follows.

- 3.3.1. Teachers and students must have adequate IT literacy skills. Based on the results of the study, 100% of the research conducted revealed that teachers must be active and can use computers to make or search for online videos. Students must also be able to use computer/laptop and the internet properly. It will easier to watch videos or read the learning material provided.
- 3.3.2. An internet connection. Students are expected to have internet facilities besides computer at home. This can be seen from 86.4% of research using internet facilities to provide video or

learning material to students. Based on these results, 5.26% of them use social media (facebook) in providing material, and some also create a special website to provide material (5.26%).

3.3.3. There are support from the school (university), parents, environment, students and teachers themselves.

4. Discussion

4.1. Research objectives

Based on the research objectives, out of 22 articles, 40.9% of research articles use traditional learning as a control group and the flipped learning model as an experimental group. Lubbe [5] analyzes the application of flipped learning model to accounting subjects at North West University. In the research conducted, Lubbe [5] provides learning with traditional methods in semester 1 and flipped learning models in semester 2. The results of the study showed that the flipped learning model implementation is better than using traditional learning methods. This is evident from the higher survey percentage after using flipped learning model. Furthermore, Paristiowati [6] examined the use of flipped learning model. Paristiowati [6] used the inquiry-flipped learning group as an experimental group and the guided inquiry group as a control group. The results showed that student achievement using flipped learning model was higher than using guided inquiry. This shows that, a comparison of two teaching methods is carried out to put more emphasis on measuring student learning outcomes towards the flipped learning model implementation. Comparison used by researchers to find out the position of flipped learning model towards other learning model.

Other research was conducted to determine students' perceptions and motivations. Based on the 22 articles reviewed, there were 59% of researchers whose studies aimed to find out the opinions of the research objects. D'addato and Miller [24] conducted a study of 4th grade mathematics students. This study aimed to determine the impact of using the flipped learning model. The instruments used were observation sheets, teacher reflection sheets, and survey sheets for students and parents. The results showed that flipped learning model had a positive impact on the learning process. The teacher feels that flipped learning model provides a higher advantage when compared to conventional learning models. In addition, the implementation of this model is felt to be a challenge for teachers themselves. Smallhorn [15] conducted research on second-year students taking Genetics, Evolution and Biodiversity courses. The teacher applies the flipped learning model in teaching to find out his involvement in the learning process. Students are given a reflection questionnaire to determine the effectiveness of the learning model applied. The results showed that student involvement in learning increased as evidenced by their presence during the learning process.

Other research that also examines students' motivation towards the application of the flipped learning model is research conducted by Akbel [25]. This study aims to determine the opinions of students and instructors on the flipped learning model implementation in Cello Education Turkish Music. Semi-structured interviews are used to find out the opinions of students and instructors. The results showed that students and instructors were motivated by the use of the flipped learning model. This kind of objectives used to know the student's views on the flipped learning model implementation. Opinions from students, teachers, and parents are needed to know the effectiveness of this model.

4.2. The research method used

In general, there are two research methods namely qualitative and quantitative. However, it is not uncommon for researchers to use both methods in one study. The results showed that, from 22 articles examined, there were 22.7% of articles used qualitative methods. It means that only a few researchers who wants to know the perception or motivation of students. They only wants the data about effectiveness of flipped learning model using observation or interviews. They don't care about the score of students who used flipped learning model, or the position of flipped learning model towards other learning model in the form of numbers. Qualitative methods are widely used to find out opinions or perceptions of research objects about an issue. Qualitative research is a study that aims to describe a situation, phenomenon, problem or activity [27]. This research is a research in which data in the form of words from interviews or questionnaires and will later form a new theory. Through

qualitative research, various subjects can be explored including the understanding, experience, and imagination of research participants, the ways in which social processes, institutions, work relationships, and meanings are produced [28]. The characteristic of qualitative research is its purpose which is related to understanding several aspects of social life, and its methods which (in general) produce words, not numbers, as data for analysis [29].

Besides, there are 77.3% of studies used mixed methods and 35.3% of them used quasi-experimental research designs. Pretest and posttest were conducted to find out the increase in students' knowledge after using the flipped learning model. The quantitative method used aims to measure the effectiveness of the model implementation while the qualitative method is used to determine student' perceptions and motivation in learning participation. The combination of the two methods is carried out in order to find out more closely about the impact of using the model. Based on this result, it is showed that more researchers want to know the position of flipped learning model towards other learning model as well as the perception of student about this model. The data carried out by the researchers in the form of numbers and words. This data then can be generated to get the conclusion of the study. This kind of data is more complex, valid, and comprehensive.

4.3. Factors affecting flipped learning model implementation

The flipped learning model implementation is influenced by several factors as follows.

- 4.3.1. Based on the literature review conducted, there is 100% research that requires teachers to have adequate IT literacy. There are 22.7% of articles mentioning that researchers make their own videos that are used to provide material to their students [5,7,8,9,25]. Sojayapan and Khlaisang [8] created a special website to provide learning material to students. Lin and Hwang [19] use social media facilities such as Facebook to provide learning videos for students. Teachers who cannot make videos (59%) used internet facilities to find videos that are suitable with the learning material. The skills of a teacher and students in using computer technology and the internet become one of the important factors in the flipped learning model implementation. Without this skill, the implementation of this model will not do well. Flipped learning model as a technology learning model need a technology to do it. Computer skill as one of the basic skill that required by the teachers.
- 4.3.2. In addition to IT literacy capabilities, internet connection is another factor that must be present. Providing videos or learning materials from teachers to students requires an internet connection. This can be seen from 86.4% of research using internet facilities to provide video or learning material to students. Based on these data, 5.26% of them use social media (facebook) in giving out material, and there are also those who create special websites to provide material (5.26%). Students must have an internet connection in watching or reading material provided by the teacher.
- 4.3.3. The flipped learning model will not be implemented properly if there is no support, from the school (university), parents, the surrounding environment, students and the teacher itself. Overall articles (100%) showed that the flipped learning model implementation is strongly influenced by the students' own will. If students do not want to read or watch videos provided by the teacher, then the application of this model cannot be optimally implemented. The teacher is also very influential in the application of this model. Teacher readiness in preparing material for students at home becomes a very important supporting factor in the implementation of the model. The teacher must also be prepared to provide answers to questions raised by students in online discussions. Shih and Tsai [19] provide online discussions in their research in addition to providing learning material. Besides the willingness of students and teachers, support from schools (universities) and parents in setting up facilities is very much needed. The intended facilities are computer / laptop, good internet connection and training for teachers to be able to apply the flipped learning model properly.

5. Conclusion

- 5.1 The objectives of the researches was categorized into two, namely determining the effectiveness of flipped learning model compared with traditional learning models and the motivation and perceptions of students towards flipped learning model.

5.2 Method used by researchers were qualitative method and mixed method.

5.3 Factors that affecting the flipped learning model implementation were IT literacy skill, internet connection and support from student, teacher, school, environment and parents.

6. Acknowledgement

We thank to the article's authors used in this literature review. Thanks also to the family, colleagues, and mentors who always support and motivate in developing this paper.

References

- [1] Bergmann J and Sams A 2014 *The flipped classroom* **17**
- [2] Uguten S D and Balci O 2017 *Flipped learning* (University Institute of Social Sciences: Article of Suleyman Demirel
- [3] Bray B, Cradler J, Craven, R R M, Day K, Deets D, Landeck T, and Thornburg D 2013 *On CUE flipped teaching & learning*. First Edition. (CUE: Spring)
- [4] Karanicolas S, Snelling C, and Winning T 2015 *7 Steps to Flipping: With A Framework* (The University of Adelaide)
- [5] Lubbe E 2016 *Innovative teaching in accounting subjects: analysis of the flipped classroom* **8** 63-74
- [6] Paristiowati M, Fitriani E, and Aldi N H 2017 *The effect of inquiry-flipped classroom model toward students' achievement on chemical reaction rate* (Indonesia: American Institute of Physics)
- [7] Sojayapan C and Khlaisang J 2018 *The effect of a flipped classroom with online group investigation on students' team learning ability* **5** 1-6
- [8] Unal Z and Unal A 2017. *Comparison of student performance, student perception, and teacher satisfaction with traditional versus flipped classroom models* **10** 145-164
- [9] Camilin M K 2017 *The flipped classroom: teaching the basic science process skills to high-performing 2nd grade students of Miriam college lower school* **5** 213-230
- [10] Elian S A and Hamaidi D A 2018 *The effect of using flipped classroom strategy on the academic achievement of fourth grade students in Jordan* **13** 110-125
- [11] Qiang J 2017 *Effects of digital flipped classroom teaching method integrated cooperative learning model on learning motivation and outcome* **6** 2213-2220
- [12] Abdelshaheed B S M 2017 *Using flipped learning model in teaching english language among female english majors in Majmaah University* **10** 96-110
- [13] Cabi E 2018 *The impact of the flipped classroom model on students' academic achievement* **19** 202-221
- [14] McCubbins O, Paulsen T H, and Anderson R G 2016 *Student perceptions concerning their experience in a flipped undergraduate capstone course* **57** 70-86
- [15] Smallhorn M 2017 *The flipping classroom: a learning model to increase student engagement not academic achievement* **8** 43-53
- [16] Chen L, Chen T L, and Chen N S 2015 *Students' perspectives of using cooperative learning in a flipped statistics classroom* 621-640
- [17] Osterlie O *Can flipped learning enhance adolescents' motivation in physical education? An intervention study* (Norway: Creative Common Attribution)
- [18] Lin C J and Hwang G J 2018 *A learning analytics approach to investigating factors affecting efl students' oral performance in a flipped classroom* **21** 205-219
- [19] Shih W L and Tsai C Y 2017 *Students' perception of a flipped classroom approach to facilitating online project-based learning in marketing research courses* **33** 32-49
- [20] Katsa M, Sergis S, and Sampson D G 2016 *Investigating the potential of the flipped classroom model in k-12 mathematics teaching and learning* (Australia: 13th International Conference on Cognition and Exploratory Learning in Digital Age)
- [21] Deng L 2018 *The project-based flipped learning model in business english translation course: learning, teaching and assessment* **11** 118-128
- [22] Akkaraju S 2016 *The role of flipped learning in managing the cognitive load of a threshold concept in physiology* **16** 28-43

- [23] Fatima S S, Arain F M, and Enam A 2017 *Flipped classroom instructional approach in undergraduate medical education* **33** 1424-1428
- [24] D'addato T and Miller L R 2016 *An inquiry into flipped learning in fourth grade math instruction* **17** 33-55
- [25] Akbel B A 2018 *Students' and instructors' opinions on the implementation of flipped learning model for cello education in Turkish music* **6** 1-11
- [26] Yamashita K and Yasueda H 2017 *Project-based learning in out-of-class activities: flipped learning based on communities created in real and virtual spaces* **5** 1044-1053
- [27] Kumar R 2011 *Research methodology: A step – by – step guide for beginners 3rd Edition* (Singapore: SAGE Publications Asia-Pasific Pte. Ltd)
- [28] Mason J 2002 *Qualitative researching: second edition* (London: SAGE Publications Ltd.)
- [29] Patton M Q and Cochran M 2002 *A guide to using qualitative research methodology* (Medecins Sans Frontieres, <https://cloudfront.ualberta.ca/>)

The effect of science environment technological and society learning model (SETS) on the students' critical thinking skill and learning achievement

D A P D O Lestari¹, K Suma² and I W Suja³

^{1,2,3} Faculty of Mathematics and Natural Sciences, Ganesha University of Education

wayudiahlestari@yahoo.com

Abstract. The purpose of this study is to find out and describe the differences in critical thinking skills and student learning outcomes between study with the SETS model compared to study with the DI model. This type of research is a pretest-posttest nonequivalent control group design. The population in this study were all class VIII students of SMPN 1 Banjarangkan. Samples were taken using simple random sampling technique to the class so that two experimental classes and two control classes were obtained. Data was collected using instruments in the form of tests of critical thinking skills and learning outcomes. Data were analyzed by hypothesis was tested by the Manova technique. The normalized gain score results of critical thinking skills and the learning outcomes of students. The results showed that: (1) There were differences in critical thinking skills and student learning outcomes between studied with the SETS model compared to the DI model ($F=49.78$; $p<0.05$). (2) There were differences in critical thinking skills between studying with the SETS model compared to the DI model ($F=45.31$; $p<0.05$; $LSD=0.08$). (3) There were differences in student learning outcomes between studying with the SETS model compared to the DI model ($F=55.28$; $p < 0.05$; $LSD=0.06$).

1. Introduction

In the current 4.0 industrial revolution, the development of science and technology has become a fundamental foundation in determining the quality of life of a nation. This era is marked by the occurrence of unlimited communication that impacts on the dissemination of information that is not necessarily true. In this condition, the community as recipients of information must be able to think critically to sort and select information that is reliable truth. The ability to think critically in responding to information is not innate so it must be learned early on [1].

As part of high-level thinking, critical thinking ability is also a way of thinking is reflective and reasoned that focused on decision-making to solve the problem [2]. Critical thinking allows the child to understand the problem and determine the selection and draw conclusions with smart. For this reason, if children are accustomed to using learning that hones their ability to think at a higher level, they will eventually get used to and be able to distinguish truth from lies, facts and opinions, knowledge and beliefs.

To train students to think critically, learning the industrial revolution era 4.0 requires that teachers as educators are able to keep abreast of fast-growing science and technology. The teacher needs to look for issues or problems that develop in daily life related to the technology that is around him, or that are related to the needs of students, then students can creatively solve problems by using relevant concepts either independently or with teacher guidance [3]. If the teacher is able to follow the development of science and technology, then students will be able to learn all the facts and concepts of science and be able to apply in their lives.

Components of critical thinking skills students need to have include: interpretation, analysis, evaluation, inference, and ekplanasi [4].

The reality found in the field is very much different. The learning applied by the teacher is still more dominant in the introduction of aspects of knowledge and understanding of concepts, not yet requiring students to be active in thinking and discovering their own concepts. Students tend to memorize concepts without knowing how to find the concepts. conditions that result in a lack of students' ability to think for problem solving [5]. The most dominant learning model used is the direct learning model that emphasizes lecture, discussion and question and answer activities that are directly conducted by the teacher [6]. The application of the learning model directly impacts the low critical thinking skills of students due to the absence of skills training processes such as the link between lessons and the real world and the process of problem solving in daily life.

The low scientific literacy and high-level thinking skills of Indonesian students are recorded through research conducted by international institutions. *The me for International Student Assessment* (PISA) program in 2015 stipulates that Indonesia is ranked 62 out of 70 participating countries in terms of scientific literacy skills, which includes readiness for student involvement in learning, readiness in problem solving, and student self-confidence.

Gaps occur between the 2013 curriculum targets which require students to think critically in solving problems with the reality that occurs in learning in school. One effort that can be done is to vary the application of learning models to make students comfortable in learning. The influence of ICT (*Information, Communication, and Technology*) in education requires students to be creative, innovative and think critically in the hope that knowledge can be applied in the community environment. One learning model that can be applied is the community and environmental technology (SETS) learning model. This learning model answers the problems experienced by the government. This learning model causes students to pay more attention to the surrounding environment as a medium of learning and pay attention to the technology developing in today's society. Students are also able to develop critical thinking skills in sorting information and using appropriate technology in accordance with their functions.

The results also showed that there were significant differences in the understanding of concepts and attitudes to care for the environment between students who took part in learning with *Science, Environment, Technology And Society* (SETS) learning devices and those who did not use these learning tools [7]. The results of other studies show that applying the SETS splitting model can attract students' interest in learning compared to classes that do not apply the model. All students said that they enjoyed the SETS learning method and hoped to continue learning according to the same methods in their school [8].

The application of the SETS learning model is a fun and meaningful learning model for students and can improve understanding of concepts and attitudes of caring for the environment [9]. Distinctive Approach SETS is learning that the link between science and technology, environment and society, as well as provide learning experiences for students to identify problems, collect data, consider alternative solutions, and to consider based mindset for certain decisions [10]. The learning model *Science Environment Technology and Society* (SETS) is a learning model that me Mandang forward against the notion that everything that is faced in life contain aspects of science, environment, technology, and society which is a unity and mutual influence reciprocally [11].

The fundamental difference between the above research with the research that I will do is, seeing from the SETS learning model which is a learning model that suppresses learning in solving problems that occur in the community related to technology. In resolving problems that occur require high thinking to solve. Therefore I associate SETS learning models with critical thinking skills possessed by students. With students improving critical thinking skills it will be able to improve learning outcomes.

2. Method

This type of research is quasi-experimental. This study uses a Pretest-Posttest Non Equivalent Control Group Design research design. The total population studied was 307 students. The sample selection was used by Simple Random Sampling technique. The research sample used was 124 students. Data collection for critical thinking skills variables and student learning outcomes using objective tests. The value of the reliability of the critical thinking skills test and the test of learning outcomes respectively: 0.89 and 0.83. The figure also shows the degree of reliability of the test is at a very high level.

Data were analyzed by descriptive analysis, analysis prerequisite test, hypothesis testing. To describe the data used descriptive statistics and to test the hypothesis multivariant analysis techniques (MANOVA) are used. As a further test of MANOVA is the significance test of the average value between groups using Least Significant Difference (LSD). The results of the study were analyzed in stages, namely data description, analysis prerequisite tests, and hypothesis testing. The prerequisite tests conducted were the test data normality test, the variance homogeneity test, the intercorrelation test.

3. Results and discussion

Differences in Critical Thinking Skills and Student Learning Outcomes between the SETS Learning Model and the DI Learning Model. Based on the analysis results obtained a significant value of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Large Root showed a value ($F = 49.777$; $p < 0.05$). So it can be concluded that H_0 is rejected and H_1 is accepted, in other words there are differences in critical thinking skills and student learning outcomes between groups of students learning with SETS learning models and groups of students learning with DI learning models.

Based on the results and application of learning in the classroom, the SETS model starts learning by linking events in the surrounding environment to the material being taught. With this students pay more attention to the environment around them. With this learning model, the teaching of science will be more meaningful if the principles, concepts and theories of science are designed to relate to society and technology. During the learning process students are emphasized to analyze and find themselves the problems experienced in order to improve higher order thinking skills. Enhancing higher order thinking skills can be done by linking science, technology, society and the environment.

The findings of this study are in line with the results of the study. His research shows that the SETS learning model successfully stimulates the development of productive learning activities. Productivity of learning outcomes in question is an increase in student learning outcomes and an increase in the level of student activity in the learning process. There is a significant difference between understanding biological concepts and critical thinking skills between students who take learning with the SETS model and conventional learning models [12].

The same opinion, teachers and students gave positive responses both regarding the application of science learning that was developed with the SETS vision. Application of SETS-based learning makes students accustomed to having a comprehensive mindset (comprehensive) in viewing material in Biology as a science integrated with the environment, technology and society [13].

Differences in Critical Thinking Skills between SETS Learning Models and DI Learning Models. Based on the analysis results obtained values ($F = 45.307$; $p < 0.05$; $LSD = 0.0841$). So it can be concluded that H_0 is rejected and H_2 is accepted, in other words there are differences in students' critical thinking skills between groups of students learning with SETS learning models and groups of students learning with DI learning models. With a total influence of 0.265 or 26.5%.

The results of the descriptive analysis of the average value of critical thinking skills dimensions indicated the lowest value was in the evaluation dimension in the control class with an average of 60.94 with moderate qualifications and the interpretation dimension in the experimental class had an average of 66.45 with moderate qualifications. The highest value is in the dimensions of analysis in the experimental class has an average of 74.68 with high qualifications and in the control class the analysis dimension is 66.45 with medium qualifications.

Judging from the mean gain score, the dimensions of interpretation of critical thinking skills in the experimental class have an average gain score of 0.12 with low qualifications, while in the control class it has an average gain score of 0.05 with low qualifications. the interpretation dimension has the lowest qualifications compared to other dimensions. This is because because some students are still confused when connecting new learning with previous learning, students are still confused linking the experiences they have experienced to the concept of learning science they learn.

This is not too much of an obstacle, because most students have been able to identify the relationship of questions, concepts, descriptions, and various models used to reflect their thoughts, views, beliefs, decisions, reasons, information and opinions. During the learning process students discuss the opinions raised by their friends and analyze the truths found this is in line with the results of the average gain score dimensions of critical thinking skills analysis of the experimental class that

is 0.56 with moderate qualifications, while the average gain score of the control class is 0.31 with moderate qualifications.

The average gain score of the evaluation dimensions of the experimental class is 0.32 with moderate qualifications, while the average gain score of the control class is -0.04 with low qualifications. In this phase, students in the experimental class develop their own concepts, students discuss and provide solutions to problems found related to the material being studied and other learning materials used in reflecting student thinking.

In the dimension of inference the average gain score of the experimental class was 0.39 with moderate qualifications, while the control class model was 0.23 with low qualifications. In this phase students in the ekeprimen class are able to find information for the preparation of conclusions. In the explanatory dimension in the experimental class, the average gain score is 0.30 with moderate qualifications, while in the control class the average gain score is 0.25 with low qualifications, this shows that in the STML learning model students have dared to state the results of thought, explain reasons based on consideration of available evidence.

The presentation of discrimination in critical thinking skills applied with the SETS learning model is better than the DI teaching model because the SETS learning model emphasizes the active participation of students in constructing knowledge with a comfortable and pleasant environment. This learning model can increase student involvement in learning. In this method students are given the freedom to express their ideas and ideas. This situation requires students to be active, explore information from various supporting sources. In contrast, the DI learning model emphasizes the function of the teacher as a source of information. Students only listen to the teacher's explanation without being actively involved. Explanation of the concept of Science has been set up in such a way by the teacher, starting with an explanation of the theory, giving examples, then given a question exercise on the worksheet. In this case, students only learn to complete the assignment given by the teacher.

[14] shows that the illumination of the SETS learning model in the experimental class has a very good category. It was seen that there was a positive response from students at 85.70%. Thus it can be concluded that the inquiry learning model with the SETS approach can be applied in physics learning to improve students' critical thinking skills.

Differences in Student Learning Outcomes between the SETS Learning Model and the DI Learning Model. Based on the analysis results obtained values ($F = 55.28$; $p < 0.05$; $LSD = 0.06$). So it can be concluded that H_0 is rejected and H_3 is accepted, in other words, there are differences in student learning outcomes between groups of students learning with the SETS learning model and groups of students learning with the DI learning model. With a total effect of 0.306 or 30.6%.

Based on the descriptive results of student learning outcomes have increased both in the control class and experimental class. Learning outcomes in the control class with high qualifications has a percentage of 41.9% while in the experimental class 54.8%. Seen in the experimental class has a higher value. The same thing is also seen in the very high qualifications of learning outcomes in the control class with a percentage of 1.6% while in the experimental class 14.5%. Based on the percentage of very high ability students in the experimental class have higher grades than those in the control class.

This shows learning outcomes in the application of the SETS learning model are superior to the DI learning model. In the classroom experiment learning that is implemented is directly related to daily life which results in a deeper understanding of students. Students discover their own concepts and understanding in this learning. While on direct learning the teacher gives a theoretical explanation including practice questions so that students' understanding is not exhaustive of the material being taught.

The findings of this study are in line with the results of study which states the SETS learning model can improve student learning outcomes. The results showed the average learning outcomes in the experimental group were 78.33 with an increase of 15.73 (25.12%), while the average learning value of the control group was 70.10 with an increase of 6.87 (10.86 %). This shows SETS learning model is able to improve student learning outcomes [15].

In addition to these things that affect student learning outcomes, namely motivation in receiving and understanding the material being studied. When students have motivation in learning to eat will affect the results obtained. In addition to motivation there are also other factors that can affect student

learning outcomes, namely the teacher as a supporting facilitator must be able to find interest and know the student's learning style in understanding the material [16].

4. Conclusions

Based on the results of hypothesis testing and discussion of research results, the following conclusions can be drawn.

First, there are differences in critical thinking skills and student learning outcomes between groups of students learning with the SETS learning model compared to groups of students learning with a direct learning model (Direct Instruction). This can be seen from the MANOVA test results that were obtained ($F = 49.777$; $p < 0.05$).

Second, there is a difference in the critical thinking skills of groups of students who learn with the SETS learning model compared to groups of students who learn by direct learning models. This can be seen from the MANOVA test results obtained ($F = 45.307$; $p < 0.05$; $LSD = 0.0841$).

Third, there are differences in student learning outcomes of groups of students who learn with the SETS learning model compared to groups of students who study with a direct learning model (Direct Instruction). This can be seen from the MANOVA test results that ($F = 55.285$; $p < 0.05$; $LSD = 0.05841$).

5. Acknowledgments

Acknowledgments are addressed to: the supervisors for advice and input provided during the study, the head of SMPN 1 Banjarangkan for permission so that this study could be carried out properly, the teachers who had helped in collecting data about this study, extended families who have provided support, advice and input during the study, and colleagues who have provided assistance so that study can run smoothly.

6. References

- [1] Imbriale P and Zapalska A 2019 *European Journal of Education Studies* 6 1
- [2] Enis R H 1993 Critical Thinking Assessment Theory into practice. 32 3
- [3] Afni N Kharitil & Abdullah 2014 *biotic journal* 2 2
- [4] Facione P A 2011 *Critical Thinking: What it is and Why it Counts* Millbrae CA Measured Reasons and The California Academic Press
- [5] Ristiasari T Priyono B 2012 *Unnes Journal of Biology Education* 1 3
- [6] Sadia I W 2008 *Undiksha Education and Teaching Journal* 41 2
- [7] Mahlianurrahman 2017 Development of *Science, Environment, Technology and Society* (SETS) Learning Tools to Improve Understanding of the Concepts and Attitudes of Environmental Care of Primary School Students 6 2
- [8] Bar V Azaiza E Azaiza D Shirtz A S 2016 Teaching Electrolysis Using STSE Method, Multidisciplinary Approach. 3 2
- [9] Stephen A M & Megan D 2012 The Impact of an STS Approach on the Development of Aspects of Scientific Literacy of Grade 10 Learners. *Paper presented at SAARMSTE Conference* 11
- [10] Bernadete I D R 2009 *Journal of Higher Education Research Science and Technology Section* 6 281
- [11] Zunicha Sunarno W & Suparmi 2017 *Inquiry journal* 6 3
- [12] Marliani N Hasanuddin & Nurmaliyah C 2017 *the EduBio Tropical journal* 5 1
- [13] Nygren T Haglund J Samuelsson C R Geijerstam A A and Prytz J 2019 *Education Inquiry* 10 1
- [14] Umami R and Jatmiko B 2013 *Journal of Physics Education Innovation* 2 3
- [15] Saputro D T 2016 Implementation of Learning Approaches *Sets (Science, Environment, Technology, Society)* In Learning Basic Automotive Engineering Work (Pto) To Improve Student Learning Outcomes. *Unnes Journal*
- [16] Piliang I R Rusdi and Miarsyah M 2018 *Indonesian Journal of Science and Education* 3 1

The Development of Local Wisdom-based Learning Material for Science Instruction in Junior High School

I Wayan Sukra Warpala

Biology Education Department of Universitas Pendidikan Ganesha
wayan.sukra@undiksha.ac.id

Abstract. This research aims to give contribution in improving education quality, especially for the science instruction in junior high school level through development of local wisdom-based learning material. The learning material that has been developed consists of content learning material, instructional procedure, and assessment method. Data have been collected by questioner, interview, observation, validation sheet, and documentations study. Data were analyzed descriptively and compared with the existing criteria. The result shows that the learning material has been developed gives positive contribution for improving concept understanding and students' scientific skill. Besides that, it has been obtained the contextual-based learning material that valid, practice, and effective to support the science teaching learning process.

Key words: science's learning material, science instruction, local wisdom

1. Introduction

Science instruction at junior high school level has undergone a fundamental change, namely the application of the idea of integrating biology and physics subjects into science subjects, as well as the introduction of some chemical material explicitly. Thus, the science subjects studied at the junior secondary level currently consist of three basic science fields, namely biology, physics, and chemistry. Changes in the content of these science subjects bring several consequences to the learning of science related to the existence of science teachers at junior high school level. The facts show that almost all of the science teachers have not a chemistry background at junior high school. Furthermore, this situation has an impact on the existence of science learning in schools.

The facts show that learning science at the junior secondary level is mostly done partially according to the mastery of the teacher. Other facts show that the chemistry aspect as one of the contents of the junior high school natural science material often escapes the teacher's emphasis because the teacher lacks mastery of the field of science. In line with changes in curriculum development, the orientation of science learning at the junior secondary level has also changed. At the junior high school level, science is recommended to be taught in an integrated manner. The integration of science learning in SMP is emphasized on the interdisciplinary integration model because science subjects in SMP cover the fields of biology, physics, and chemistry. Interdisciplinary integration of science learning requires the ability of teachers to develop teaching materials in an integrated manner. The issue of teaching materials is a crucial issue that is no less important in improving the quality of science learning.

One of the causes of the lack of success in implementing the curriculum in schools is the unavailability of teaching materials that are relevant to the demands of learning. One of the demands of learning is the use of diverse learning resources (multiple-learning resources). Particularly in natural science learning, the use of multi-site learning resources (diverse) has been shown to improve student learning processes and outcomes (Warpala, 2006; 2007a). The facts show, although the curriculum (Syllabus and RPP) has been developed by teachers in schools, but in implementing learning in the classroom teachers still use more single learning resources which are generally in the form of textbooks held by students. Another phenomenon, there are teachers who only use the worksheet that contains a set of questions (Warpala, 2006). Science learning is done from page to page in accordance with textbooks held by students is not the desired way of learning science in accordance with the applicable curriculum. This can be seen as one of the obstacles in the implementation of the science curriculum in schools.

The second crucial issue is the potential of local wisdom that is relevant for the development of SMP science teaching materials. Lately, the development of science learning that leads to the use of local wisdom, both the content of subject matter and pedagogy, has received high attention from researchers and educational developers. This is driven by the awareness that the development of learning cannot be separated from the role of the nearest environment, both the physical environment (natural) and the socio-cultural environment. According to Aikenhead & Jegede (1999), the cultural background students possess and are brought into the classroom during the learning process plays a very important role in the process of mastering subject matter. The same was expressed also by Wahyudi (2003) that the cultural background of students has a greater effect in the educational process than the effect contributed by the provision of subject matter.

In relation to the role of the environment in learning, it is realized that both the physical (natural) environment and the socio-cultural environment possessed by the Balinese people have various potentials that can be explored and developed as a supplement to teaching materials supporting science's learning in schools. In terms of the physical (natural) environment, in Bali there are a variety of flora, fauna, and the results of community technology that have not been identified and developed as teaching materials supporting science learning. In terms of the socio-cultural environment, the Balinese have various traditions, technologies, life habits, life values that have been used for generations as a guide in navigating their lives. Some of these life habits and values are almost always present in Balinese life and survive sustainably (sustainable). In this case the local wisdom of the Balinese is defined as the abilities (competencies) possessed by the Balinese that have been proven to be preserved to date. These abilities can be knowledge, skills, attitudes and values that are operationalized in daily life.

Based on the central issues above, the research development of science learning materials for junior high schools based on local wisdom is very urgent. In accordance with the will of the use of diverse learning resources it needs to be said that "learning material is not a textbook." Learning material is a set of various materials for learning that prepared by the teacher for students to learn in accordance with the lesson plans made by the teacher. In teaching materials there are two main components, namely learning material (content) that students will learn and learning procedures (pedagogy) that students must follow. Thus, the development of teaching materials based on local wisdom becomes very strategic in supporting the learning process to improve the quality of student learning.

2. Method

This research is a developmental research that developing a learning material for science instruction in junior high school. The development of the learning material used Kemp Model (1977) that was conducted by some procedures are as follows at Figure 1.

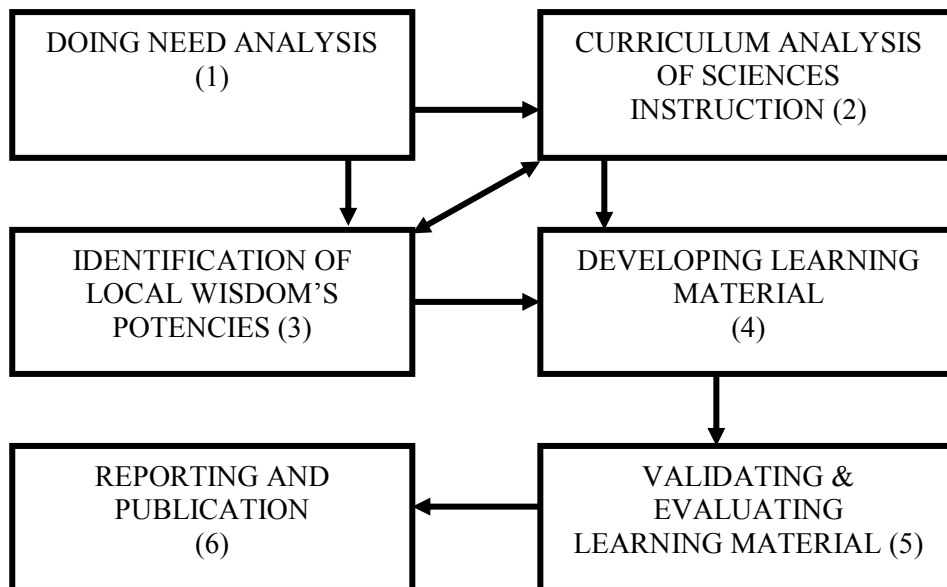


Figure 1. Schema flow of the learning material development

Based on Figure 1, the development process is preceded by analyzing the needs of the science curriculum implementation and identifying the potential of local wisdom in Bali. The needs analysis of the science curriculum implementation was carried out in several junior high schools in Badung, Tabanan, Bangli, and Buleleng Regencies. While the identification of the potentials of local wisdom was carried out through field studies in Sangeh Village, Alas Kedaton Forest, Penglipuran Village, Banjar District (Buleleng), and Lebih Village (Gianyar). After carrying out the needs analysis, proceed with the writing phase of teaching materials. Writing teaching materials are arranged with the draft content as follows: a) Identity of Subjects; b) Learning Objectives; c) Description of Material (concerning the description of the material in accordance with the subtitle of the topic of the lesson, which contains an introduction to local wisdom to reinforce facts, concepts, procedures, and / or new information); d) Learning Procedures (includes learning steps based on local wisdom and innovative learning); and e) Assessment of Learning Outcomes; and f) Bibliography. Furthermore, testing of teaching materials is done through three phases, namely testing by experts and users, testing small groups through focus group discussions, and testing in schools through CAR. Data collection uses the following instruments: a) questionnaire for the analysis of the curriculum of science lessons (availability of learning resources and analysis of learning problems faced by teachers and students); b) interview guidelines and field notes for identification of local wisdom; c) questionnaire for expert review; c) sheet/list suitable for conducting focus group discussions. Furthermore, the data are analyzed descriptively, which is then compared with existing criteria for the purpose of making decisions regarding the appropriateness of this development product.

3. Research Finding

3.1 Identification of local wisdom for supporting junior high school's science instruction

After conducting curriculum analysis and field observation, there was done an identification of local wisdom that can be integrated to support science instruction. The results were shown in Table 1.

Table 1. The potential of local wisdom to support sciences instruction

Subject Matter	Topics	Local Wisdom
Structure and function of living things Identifying structure and function of plant tissue	<ul style="list-style-type: none"> ▪ Root ▪ Stem ▪ Flower ▪ Fruit 	<ul style="list-style-type: none"> ▪ Living things and <i>Unsur Panca Maha Butha</i> ▪ <i>Tumpek kandang</i> ▪ Plant that used for Balinese ceremony
Nature conservation Defining ecosystem and relationship between its components Identifying the importance of living things diversity in teh preservation of ecosystem	<ul style="list-style-type: none"> • Ecosystem • Living things' interdependence • Biodiversity conservation 	<ul style="list-style-type: none"> • Customary village-based Environmental management. • <i>Konsep Rta</i> (natural law concept) • <i>Konsep Panca Maha Butha</i> (the five constituent element of living things) • <i>Tumpek kandang</i> and <i>tumpek bubuh</i> • <i>Alas duwe/alas angker</i> • Concept of <i>Tri Hita Karana</i>
Aproprate Technology Describing the concept of sound in everyday life	<ul style="list-style-type: none"> • Sound (Its properties, Marsenne's Law, Sound Tone, Resonance, and Sound Reflection) 	<ul style="list-style-type: none"> • Instruments of traditional music (<i>gamelan</i>), such as <i>gong gangsa</i>, <i>jegir</i>, <i>rebab</i>, and <i>kendang</i>. • <i>Keplug-keplugan</i> • Bamboo balinese tradisional music (<i>rindik</i>, <i>suling</i>)
Matter and Its Function Describing te concept of density in daily life	<ul style="list-style-type: none"> • Substance and its state (phase) • density of substance 	<ul style="list-style-type: none"> • <i>Nandusin</i> (making coconut oil traditionally in balinese people)
Food Technology Describing natural and artificial chemicals in packaging food and food ingredients	<ul style="list-style-type: none"> • Food processing • Food preservation 	<ul style="list-style-type: none"> • Making product of balinese traditional food (<i>tape ketan</i>, <i>sere colek</i>, <i>tempe</i>, <i>kepel</i>) • Activities of balinese traditional preservation (fermentation process used natural chemicals, <i>punapi</i>, <i>cacah</i>, <i>pindang</i>, and <i>telur asin</i>)

3.2 The development of science's learning material

a) *The result of learning material's validation by expert and user*

The result of learning material's review by two expert and two user can be reported in Table 2.

Table 2. The review result of expert and user

No	ASPECT/SUB ASPECT	Scored by Experts and Users			
		Exp-I	Exp-II	User-I	User-II
A	Aspect of Content				
1	Completeness of content (3 indicators)	21	21	21	21
2	Accuracy of content (3 indicators)	21	17	21	21
3	There are learning activities that support content (2 indicators)	12	12	12	14
4	There are effort to increase science's competencies (2	12	12	12	12

	indicators)				
5	There are content that stimulate students to conduct an inquiry relating to local wisdom (3 indicators)	17	15	17	17
Score total of validator (1st aspect)		83	77	83	85
Score mean (by score total = 91)		91,2	84,6	91,2	93,4
Judgement		Very Good	Very Good	Very Good	Very Good
B Aspect of presentation					
1	Organisation of general presentation (2 indicator)	14	12	14	14
2	General appearance of science's learning material (3 indicators)	17	13	17	17
3	Presentation organisation of science's learning material (2 indicators)	12	10	12	14
4	Presentation develops a process of knowledge construction (3 indicators)	15	15	19	17
Score total of validator (2st aspect)		58	50	62	62
Score mean (by score total = 70)		82,9	71,4	88,6	88,6
Judgement		Very Good	Good	Very Good	Very Good

Based on Table 3, it can be described that two experts and two users (teachers) stated that the sciences' learning material product was very good (feasible) in terms of material aspects. Meanwhile, in terms of presentation aspects, one expert and two teachers stated that it was very good, only one expert stated that it was good (worthy) for further testing.

b) The result of learning material's validation by small group through FGD

Validation of local wisdom-based learning material through Focus Group Discussions (FGD) is oriented to assess the learning materials in terms of practicality (possible level of performance in learning) and effectiveness (its support for increasing students' activity and students' learning outcomes). The results obtained in the implementation of the FGD are listed in Table 3.

Table 3 The result of practicality and effectiveness of science's learning material

INDICATORS	SCORE		4		3		2		1	
	T	S	T	S	T	S	T	S	T	S
A. The practicality of learning material										
1. Comformity to Standard of Competency	2	-	8	10	-	-	-	-	-	-
2. Comformity to Basic Competency	2	-	8	10	-	-	-	-	-	-
3. Comformity to Learning Objective	10	10	-	-	-	-	-	-	-	-
4. Supporting the Learning Resources	2	-	8	5	-	5	-	-	-	-
5. Comformity to Time Allocation	3	-	7	5	-	5	-	-	-	-
B. The effectiveness of learning material										
1. Increasing minds-on activities										
▪ Not available	-	-	-	-	-	-	-	-	-	-
▪ Available (score)	10	2	-	8	-	-	-	-	-	-
2. Increasing hands-on activities										
▪ Not available	-	-	-	-	-	-	-	-	-	-
▪ Available (score)	-	4	10	6	-	-	-	-	-	-
3. Increasing learning outcome			2	10	8	-	-	-	-	-
Teacher and student responses to implementation of instructional process	<i>Their opinion:</i> <ul style="list-style-type: none"> Teachers give a positive response to the 									

	implementation of local wisdom-based learning material
	<ul style="list-style-type: none"> ▪ Students give a positive response to the implementation of local wisdom-based learning material ▪ Students want their teacher to implement local wisdom-based learning material during science instruction

Note: T = teacher; S = student; 1 = very not supported; 2 = not supported; 3 = enough supported; 4 = very supported

By FGD, it can be stated that the sciences' learning materials is appropriate in instructional process. It can support to increase students' activity and learning outcomes. Thus, the sciences' learning materials that have been developed are categorized as good.

c) The result of learning material's testing through classroom action research

By classroom action research (CAR), it can be stated that (a) the science' learning material can improve the students' concept understanding (the average value of students' concept understanding was 69.87 in the first cycle and it was 76.11 in the second cycle); (b) the science' learning material can improve students' scientific performance (the average score of students' scientific performance was 11.37 in the first cycle and it was 14.16 in the second cycle); and (c) students' responses to the implementation of local wisdom-based learning material in science instruction are in the very positive category.

4. Discussion

Through the Classroom Action Research, it was found that teaching materials used to orient science learning could improve students' understanding of concepts and scientific performance. This finding relevant to the theoretical conceptually that the instructional process which is implemented using the student center learning paradigm. This means that students as subjects in conducting learning activities, students are taught according to their prior knowledge they have, and use an existing learning resources in their environment or socio-cultural background.

The local wisdom-based instruction also makes a process of learning is more interesting and enjoyable. It allows creation of meaning contextually based on students' prior knowledge wherein they are as a community in their own culture. The local wisdom-based instruction can also change the learning environment into a fun environment, which allows teachers and students to actively participate based on cultures that they already know. So, the optimal learning outcomes can be obtained.

The integration of Science knowledge content based on local wisdom (indigenous science) into science instruction provides opportunities for students to express their thoughts and to accommodate their concepts or beliefs which rooted on traditional science. Therefore, the its instruction can encourage students to be active in learning, increase student creativity, create effective learning, and the learning atmosphere becomes more conducive. These facts can be proved by analysis of the responses learning given by students, wherein it was found that the responses of students fall into very positive categorized. Students were agree and so happy with the implementation of local wisdom-based learning materials because the science instruction becomes not boring and every students' effort is made awarded.

Based on the results of focus group discussions, it was found that the teacher and students argued the local wisdom-based learning materials had an appropriate level of implementation and could support increased student activity and learning outcomes. The point of views that expressed by teachers and students have a conceptually reason. In general, according to Aikenhead & Jegede (1999), the influence of students' cultural backgrounds have two point of view on the learning process of science. Firstly, a positive influence will emerge if the science's learning material (which is being studied) is in harmony with the daily knowledge (culture) of students. In this situation the learning process supports the way students look at the natural surroundings. This learning process is called an enculturation process. Secondly, the science learning process in the classroom becomes a 'bully' when the science's learning material is not in harmony with the students' cultural background. It means that the teacher tries to impose the truth of the science content by marginalizing students' prior knowledge.

By empirically, it is also illustrated that the science instruction based on students' cultural background (or based on local wisdom) is very helpful in mastering concepts and skills. Therefore, it can be stated that the success of the science instructional process in schools is very much influenced by the cultural background of students or the community. If the science instruction is harmonious with students' daily lives, then science instruction will be more easily understood by students. This is because the science instruction is considered as a cultural transmission so that the instructional process in the classroom can be likened to the process of cultural acquisition by students from the learning resources.

Wahyudi (2003) states that students' cultural backgrounds have a greater effect than the effects of contributed by the provision of subject matter content in the educational process. In other words, the effects of the instructional process carried out in class by the teacher are 'lost' by the effects of the community culture that has been absorbed by students and brought into the instructional process. On the other hand, Suastra (2005; 2006) states that many of the local wisdoms of the Balinese people (in the form of documents or practices of daily community behavior) synergize with learning science in schools. The integration of Balinese local wisdom in learning science will be a source of inspiration and support the learning process of science in schools.

5. Conclusion

Based on the research finding and discussion, it can be concluded are as follows. Firstly, the development of local wisdom-based learning materials, that have been validated, contribute to the improvement of the students' concepts understanding and the scientific performance. Secondly, local wisdom-based learning materials have practicality and effectiveness that are appropriate and it can support the learning process of science (increased activity and learning outcomes). Thirdly, the integration of selected local wisdom concepts must consider to the diversity of students' cultural backgrounds. Fourthly, to optimize the scientific performance of each individual student, the teacher should accommodate individual patterns of interaction by giving unstructured independent assignments.

References

- Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching*, 36(3), 269-287.
- Anggreni. 2008. Identifikasi konsep-konsep IPA asli (*indigeneus chemistry*) yang relevan dengan konsep-konsep kimia dalam pembelajaran IPA di SMP. *Skripsi*. Karya Tidak Diterbitkan. Singaraja: Universitas Pendidikan Ganesha.

- Depdiknas. 2007. *Permendiknas Nomor 41 Tahun 2007 tentang Standar Proses Pembelajaran*. Jakarta: BSNP
- Suastra, I W. 2005. Merekonstruksi IPA Asli (Indigenius Science) dalam rangka Mengembangkan Pendidikan IPA Berbasis Budaya Lokal di Sekolah: Studi Etnogenis pada Masyarakat Penglipuran Bali. *Disertasi*. Karya Tidak Diterbitkan. Bandung: Program Pasca Sarjana Universitas Pendidikan Indonesia.
- Suastra, I W. 2006. Merekonstruksi IPA Asli (Indigenius Science) dalam rangka Mengembangkan Pendidikan IPA Berbasis Budaya Lokal di Sekolah: Studi Etnogenis pada Masyarakat Penglipuran Bali. *Jurnal Pendidikan dan Pengajaran IKIP Negeri Singaraja*, No. 3. Tahun XXXVIII.
- Wahyudi. 2003. Tinjauan Aspek Budaya Pada Pembelajaran IPA: Pentingnya Kurikulum IPA Berbasis Kebudayaan Lokal. *Jurnal Pendidikan dan Kebudayaan* No. 040, Tahun ke-9. Januari 2005.
- Warpala, I. W. S. 2006. Pengaruh Pendekatan Pembelajaran dan Strategi Belajar Kooperatif yang Berbeda terhadap Pemahaman dan Keterampilan Berpikir Kritis dalam Pembelajaran IPA SD. *Disertasi*. PSSJ Teknologi Pembelajaran, PPS Universitas Negeri Malang.
- Warpala, I. W. S. 2007(a). Pengaruh Pendekatan Pembelajaran dalam Seting Kooperatif STAD terhadap Keterampilan Berpikir pada Pembelajaran IPA. *Laporan Penelitian Mandiri*. Karya tidak diterbitkan. Singaraja: Lemlit Undiksha.
- Warpala, I. W. S., dkk. 2007(b). Pengembangan Desain Pembelajaran Biologi Bilingual untuk Sekolah Menengah Atas Bertaraf Internasional (SMA-BI). *Laporan Penelitian Hibah Research Grant*. Karya Tidak Diterbitkan. Singaraja: Program I-MHERE Universitas Pendidikan Ganesha.