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PROCEEDINGS OF THE 7th INTERNATIONAL CONFERENCE ON RESEARCH, IMPLEMENTATION AND EDUCATION OF MATHEMATICS AND SCIENCES (7th ICRIEMS)

Science, Technology, and Education in The Global Era for Virtuous and Competitive Generation

Yogyakarta, 25 – 26 September 2020

FMIPA UNIVERSITAS NEGERI YOGYAKARTA
INDONESIA

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Preface

This proceedings is the regular edition (non-Scopus-indexed) of the conference proceedings of the 7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS) held by the Faculty of Mathematics and Science, Yogyakarta State University, Indonesia on 25-26 September 2020 at Yogyakarta State Univesity . All papers in this proceeding were obtained from a selection process by a team of reviewers and had already been presented in the conference. Some selected papers from the conference were compiled under separate proceedings and published by Institute of Physics (IoP) which is Scopus-indexed. This proceedings comprises 9 fields, they are mathematics, mathematics education, physics, physics education, chemistry, chemistry education, biology, biology education, and science education.

The theme of this 7th ICRIEMS is '*Science, Technology, and Education in The Global Era for Virtuous and Competitive Generation*. This conference presented five keynote speakers, which were Martianus Frederic Ezerman, Ph. D (School of Physical and Mathematical, Sciences, NTU, Singapore), Prof. Dwikorita Karnawati, Ph.D (BMKG, Jakarta), Prof . Dr. Gultekin Cakmakci (Hacettepe University, Turkey), Prof. Wing Mui Winnie So (University of Hong Kong), and Dr. Insih Wilujeng (Universitas Negeri Yogyakarta). Besides the keynote speakers, there were also parallel articles that present the latest research results in the field of mathematics, sciences, and education. These parallel session speakers came from researchers from Indonesia and abroad.

Hopefully, this proceeding may contribute in disseminating research results and studies in the field of mathematics, sciences and education such that they are accessible by many people and useful for the development of our civilization.

Yogyakarta, October 2020

Editorial Team

Forewords From The Head of Committee 2020

Assalamu'alaikum warahmatullahi wabarakatuh
May peace and God's blessings be upon you all

Dear our respected speakers and participants on behalf of the 7th ICRIEMS 2020 Organizing Committee, we would like to extend our warmest welcome to the Yogyakarta.

The 6th International Conference on Research, Implementation, and Education of Mathematics and Science (ICRIEMS) which is organized by Faculty of Mathematics and Science, Universitas Negeri Yogyakarta, Indonesia held today on September, 25-26 2020. The theme of the 7th ICRIEMS is "Integrating Science, Technology, Engineering, & Mathematics (STEM) and Education for Disaster Risk Reduction and Mitigation". We certainly hope that the theme will covers the field of mathematics, chemistry, physics, biology, mathematics education, chemistry education, physics education, biology education, and science education to enhance society knowledge on natural phenomena and geographical position of countries in the ring of fire pathway that have the potential for natural disasters. The knowledge could help people and government agencies to reduce and prevent the emergence of a larger disaster impact.

The conference is an event where prominent practitioners, researchers, students and educators from all around the world are joining together to share their latest research and exchange their ideas. The conference will be a good place to promote or maintain not only national but also international collaboration and networking among academics, researchers and educators. The conference has accepted 210 papers from six countries, i.e. Turkey, Indonesia, Hongkong, Singapore, Malaysia, and Thailand. There are more or less 140 selected papers will be published by AIP Publisher under Scopus Index and Journal of Physics: Conference Series by IOP Publishing also under Scopus Index. The rest of the papers will be published on DOAJ Journals and Regular ICRIEMS Proceeding.

Last but not least, We address very big appreciation and many thanks to all presenters and participants who have been actively involved in this conference. We also wish to thank to our reviewers for invaluable comments and suggestions. We wish you a productive conference and hope you enjoy your time in Yogyakarta and at 6th ICRIEMS 2019!

Wassalamu'alaikum warahmatullahi wabarakatuh.

Yogyakarta, November 2020

Dr. Supardi, M.Si

Forewords From the Dean of Faculty of Mathematics and Sciences, Universitas Negeri Yogyakarta

May peace and God's blessings be upon you all.

On behalf of the Committee, first of all allow me to extend my warmest greeting and welcome to the 7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS) 2020, organized by Faculty of Mathematics and Natural Sciences (FMNS) Universitas Negeri Yogyakarta.

The readiness of human resources is required to face up the new era of industrial revolution which demands people to be actively involved in communication system, to think critically, and to have good skills including adaptability, social-emotional learning, growth mindset, and cultural awareness. The challenge for us is getting bigger with the Covid-19 pandemic around the world which changes the order of human life. Mastery and self-readiness are very important to face the world today. This condition could be achieved if it is supported by the empowerment of individuals and scientific and technological innovations in order to adapt to global change which encompasses technological, social, cultural, economic changes and natural events.

With the theme of "Science, Technology, and Education in The Global Era for Virtuous and Competitive Generation", this conference is aimed to pull together researchers, educators, policymakers, and practitioners to share their critical thinking and research outcomes. Therefore, we can understand and examine the development of fundamental principles, knowledge, and technology to adapt to global changes and to prepare the qualified generations. The scope of this conference covers all topics but is not limited to in the field of mathematics, chemistry, physics, biology, mathematics education, chemistry education, physics education, biology education, and science education.

Distinguished guest, ladies, and gentlemen,

This conference will be far from success and we could not accomplish what we do without the support from various parties. So let me extend my deepest gratitude and highest appreciation to all committee members. I would also like to thank each of participants for attending our virtual conference and bringing your expertise to our gathering. Should you find any inconveniences and shortcomings, please accept my sincere apologies.

To conclude, let me wish you a fruitful discussion and an impressive virtual conference.

Yogyakarta, September 2020

Prof. Dr. Ariswan

PROGRAM OUTLINE

VIRTUAL CONFERENCE PROGRAM
THE 7th INTERNATIONAL CONFERENCE ON RESEARCH, IMPLEMENTATION & EDUCATION OF MATHEMATICS AND SCIENCES (ICRIEMS) 2020
25-26 September 2020, DIGITAL LIBRARY, UNIVERSITAS NEGERI YOGYAKARTA, INDONESIA
Friday, Sept 25, 2020

No	Time	Programs
1	07.30 - 08.00	Registrasi
2	08.00 - 08.30	Pembukaan
		1. Menyanyikan Lagu Indonesia Raya
		2. Laporan oleh Ketua Panitia
		3. Sambutan dan Pembukaan oleh Rektor UNY
3	08.30 - 09.30	Keynote Speech #1 : Prof. Dr. Lee Ching Kuo (Taipei Medical University, Taiwan) Bidang Kimia
4	09.30 - 10.30	Keynote Speech #2 : Prof. Peter Charles Taylor (Murdorch University Australia, Australia) Bidang IPA
5	10.30 - 11.30	Keynote Speech #3 : Prof. Dr. Suriani Abu Bakar (UPSI, Malaysia) Bidang Fisika
6	11.30 - 13.00	Break
7	13.00 - 16.00	Sesi Paralel I
8	16.00 - 16.15	Penutup

VIRTUAL CONFERENCE PROGRAM
THE 7th INTERNATIONAL CONFERENCE ON RESEARCH, IMPLEMENTATION & EDUCATION OF MATHEMATICS AND SCIENCES (ICRIEMS) 2020
25-26 September 2020, DIGITAL LIBRARY, UNIVERSITAS NEGERI YOGYAKARTA, INDONESIA

Saturday, Sept 26, 2020

No	Time	Programs
1	08.00 - 08.15	Pembukaan
2	08.15 - 09.15	Keynote Speech #4 Dr. Ariyadi Wijaya (Mathematic, Universitas Negeri Yogyakarta)
3	09.15 - 10.15	Keynote Speech #5: Assoc. Prof. Chatree Faikhamta (Kasetsart University, Thailand) Bidang Kimia/IPA
4	10.15 - 11.15	Keynote Speech #6 : Dr. Agus Purwanto (Institut Teknologi Indonesia) Bidang Fisika
5	11.15 - 12.00	Invited Speakers #1: Assoc. Prof. Vichit Rangpan (Yala Rajabhat University, Thailand) Bidang Biologi
6	12.00 - 12.15	Break
7	12.15 - 13.00	Invited Speakers #2 Dr. Retno Arianingrum (Chemistry, Universitas Negeri Yogyakarta)
8	13.00 - 16.00	Sesi Paralel I
9	16.00 - 16.15	Penutup

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PHYSICS EDUCATION

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PHYSICS

The Effect of PjBL Models and Discovery Learning on Student Cognitive Learning Outcomes in the Momentum and Impulse Subjects

R S Sakbana[1*], W Sunarno[2], S Budiawanti[2], W M Maubana[3] and D A Gebze[3]

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Abstract. This study aims to determine the effect of project-based learning (PjBL) and discovery learning models toward students' cognitive learning outcomes on momentum and impulse materials. This is an experimental study using simple random sampling as a sample selection technique. The sample is the two classes of Xth grade students of SMA Negeri 1 Amarasi Timur which is divided into two parts, namely X1 which employs the PjBL model, and X2 which uses the discovery learning model. The valid and reliable test instrument is an objective test with 22 questions. The variable is the students' cognitive learning outcomes obtained from the post-test data. This research employs one way ANOVA analysis of variance for the normality and homogeneity test in both normal and homogeneous classes. The results of the analysis reveal that there is an increase in the learning process with discovery learning and PjBL models toward students' learning outcomes. However, discovery learning has better improvement than PjBl model. It can be concluded that there is an influence of the learning model toward students' cognitive learning outcomes.

Keywords: *Project-Based Learning, Discovery Learning, Cognitive Learning Outcomes, Momentum, Impulse*

1. Introduction

Law No. 20 of 2003 concerning the National Education System states that education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious-spiritual strength, self-control, personality, intelligence, noble morals, and necessary skills which required by himself, society, nation, and country [1]. The learning system in the 21st century demands a change in the educational paradigm from a teacher-centered to student-centered learning. In implementing quality education, the government has set a 2013 Curriculum to be applied to schools.

In general, education problems in Indonesia also occur at the senior high school level, one of them is a decrease in the graduation rate. Based on the assessment center of Education and Culture Ministry

(Kemendikbud), the average National Exam score at the senior high school level majoring in Science shows a decrease in the graduation rate from 2011 and continues every year until 2018. The problems faced in the world of education need to be overcome. Teachers as the main actors in the field of education are certainly one of the factors that influence the success of students in taking education so that teachers are required to improve the quality of learning. Teacher quality can be viewed from two aspects, namely in terms of results and process [2].

The observation results in class X SMA Negeri 1 Amarasi Timur shows that teaching and learning activities are generally teacher-centered. It means the teacher's role in learning activities is still dominant. Besides, the results of interviews with the teachers show that physics teaching and learning activities are still dominated by the use of lectures and assignments, although in practice it is supported by group discussions and questions and answers session, overall teacher learning activities are still the most dominant so that students are less engaged and passive in the classroom. [3] said that one of the supporting factors of the learning process is the learning model.

One of the learning that can be implemented in the 2013 curriculum is project-based learning. Project-Based Learning is an approach that aims to help students become actively involved in the learning process and educate them so that they can search, collect data, make analysis, and draw conclusions based on the analysis [4]. Project-Based Learning is a learning method that uses problems as a first step in collecting and integrating new knowledge based on experiences with activities [5]. It can be concluded that Project Based Learning is a learning method that uses problems as a first step that can help students collect data, make analyzes, and draw conclusions.

Discovery learning is a learning model that allows students to find and get information on their own. Discovery learning includes the development of knowledge-based on the students' own experiences [6]. Data or knowledge information obtained by students is collected directly through observation or experiments. So it can be interpreted that discovery learning is a learning model that requires students to discover and investigate concepts by themselves through observation and experimentation so that they can develop students' active thinking.

Based on the above explanation, this study is intended to determine the differential influence of project-based learning (PjBL) model and discovery learning toward students' cognitive learning outcomes on the momentum and impulse materials.

2. Research Methods

2.1. Place and Time of the Research

This research is conducted at SMA Negeri 1 Amarasi Timur which is located at Jln. Pakubaun Department, Amarasi Timur sub-district, Kupang Regency, East Nusa Tenggara on January 9th, 2020 to January 30th, 2020.

2.2. The subject of the research

The sampling technique in this study is simple random sampling. It is a simple technique because the sampling members of the population are chosen randomly without paying attention to the strata in the population. The sample is the students of class X1 and X2 of SMA Negeri 1 Amarasi Timur in the School year of 2019-2020.

2.3. Data Analysis

This is an experimental research method. This study involves two classes which are used as experimental classes. The first experimental class is treated using the PjBL model, while the second experimental class employs the Discovery Learning model. The test instrument is intended to determine students' cognitive learning outcomes is an objective test instrument. Before the test instrument is used in this study, it is first validated by an expert and then tested to obtain valid and reliable questions. The research stage begins by giving a pretest to determine the students' initial abilities. The pretest results are analyzed quantitatively to provide information about students' grades.

The second stage applies to learn in class X1 and class X2 using the PjBL model and discovery learning. After that, the posttest is given to find out how the students' cognitive learning outcomes, then the results are analyzed quantitatively. Before testing the hypothesis, a prerequisite test is carried out, namely the normality and homogeneity test. Then to test the hypothesis, the data analysis is one way ANOVA analysis of variance. It is employed to see whether the increase in cognitive abilities is significant or not.

The form of the test is an objective test with a multiple choice which is arranged based on instruments consisting of C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating) with a level of difficulty ranging from easy, medium, and difficult [7]. There are 22 questions related to momentum and impulse materials. Furthermore, the interpretation of the percentage of cognitive abilities in each domain is carried out based on the interpretation of Arikunto [8] presented in Table 1. The obtained data for each cognitive domain is processed with the following calculations:

$$\frac{average\ number\ of\ students\ who\ answer\ correctly}{total\ number\ of\ students}\ x\ 100\% \qquad (1)$$

Table 1. Interpretation of Cognitive Abilities

No	Percentage %	Interpretation
1.	0	Nothing
2.	1-25	Small portion
3.	26-49	Almost a half
4.	50	A half
5.	51-75	Most of it
6.	76-99	Most of all
7.	100	In all

3. Results and Discussion

Nanawi in K. Brahim states that learning outcomes can be interpreted as the level of students' success in learning subject matter at school which is expressed in scores obtained from test results regarding a certain number of subject matter [9]. Data on cognitive learning outcomes after being given treatment obtained through the posttest are presented in Table 2.

Table 2. Posttest of cognitive learning outcomes

Learning Model	Total	Min. Value	Max. Value	Average	Std.Dev
PjBL	31	55	86	73	10.23
Discovery Learning	31	64	86	76	6.67

The following is the prerequisite test table, namely the normality test and the homogeneity test. The normality test is carried out to determine that the data is normally distributed. Data are in the normal category if the probability is greater than 0.05 ("ρ> 0.05"). The results of the normality test are presented in Table 3.

Table 3. Normality Test

Learning Model	Kolmogorof Smirnov			Conclusion
	Statistic	Df	Sig.	
PjBL	0.295	31	0.177	Normal Data
Discovery Learning	0.243	31	0.200	Normal Data

The homogeneity test is conducted to determine the sample came from a homogeneous population. The data is categorized as homogeneous if the probability is greater than 0.05 ("ρ> 0.05"). The results of the homogeneity calculation are presented in Table 4.

Table 4. Test of Homogeneity of Variances

Cognitive learning outcomes

Levene Statistic	df1	df2	Sig.	Conclusion
3.999	1	60	.050	Homogen

Source: SPSS 18

Furthermore, the analysis of variance for students' cognitive learning outcomes is presented in the table with the hypothesis,

if sig. ≥ 0.05 then the null hypothesis is rejected, which means there is influence

if Sig. <0.05 then the null hypothesis is accepted, meaning there is no influence.

Table 5. The result of ANOVA

Cognitive learning outcomes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	142.516	1	142.516	1.939	.169
Within Groups	4409.355	60	73.489		
Total	4551.871	61			

Source: SPSS 18

Based on table 5, it can be seen that the significance value for students' cognitive learning outcomes is 0.169. because of the value of sig.> 0.05, the null hypothesis is rejected, so it can be summarized that there is an influence on the use of learning models toward students' cognitive learning outcomes. This is in line with [10] who concluded that the use of learning models has a significant effect on students' competence.

The following is the percentage of students' cognitive learning outcomes for each domain, after being given the treatment which is presented in the form of a histogram in Figure 1.

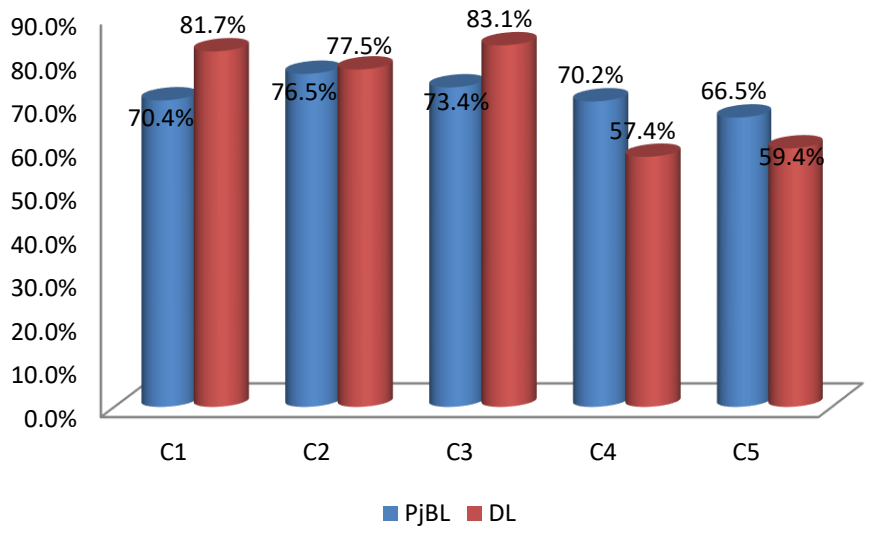

Figure 1. Achievement of Students' Cognitive Learning Outcomes

Figure 1 shows that in the experimental class I, as many as 70.4% of students can do questions for C1, for C2 up to 76.5%, C3 up to 73.4%, C4 for 70.2%, and C5 for 66.5%. Based on this data, it shows that the lowest category is in the C5. Then in the learning outcomes of the discovery learning model, it shows that the highest percentage is in the C1 cognitive domain category of 81.7% and the lowest percentage is in the C4 cognitive domain, which is 57.4%. The results of this study indicate that the cognitive learning outcomes in the experimental class II increase greater than those in the experimental class I.

Besides, figure 1 also reveals that there are differences in cognitive learning outcomes of students who are treated with the PjBL model and discovery learning, where the discovery learning model gets higher results than the PjBL model. The same thing is stated by [11] that one way to improve students' cognitive ability mastery is to use discovery learning models. Another factor that influences this increase is [12] because the discovery learning model allows students to get active and real learning experiences so that they are trained to solve problems. This reveals that students can make decisions based on the criteria. The criteria used are quality, effectiveness, efficiency, and consistency [13].

4. Conclusion

Based on the description of the results and discussion, it can be concluded that there is an influence on the use of the learning model. Then the use of the discovery learning model has higher improvement toward cognitive learning outcomes than the PjBL model. It means that the discovery learning model gets better cognitive learning outcomes than the PjBL model.

References

[1] Sanjaya, W. (2013). *Penelitian Pendidikan, Jenis, Metode dan Prosedur*. Jakarta: Kencana Prenada Media Group.

[2] Mulyasa. (2013). *Pengembangan dan Implementasi*. Bandung: PT. Remaja Rosdakarya.

[3] Wijayanti, E., Ashadi, & Sunarno, W. (2018). Effect of Guided Inquiry Learning Model with Virtual and Real Learning Media on the Improvement of Learning Result Viewed from Cooperation Skills of the Students. *AIP Conference Proceedings*, *2014*, 163–170. https://doi.org/10.1063/1.5054430

[4] Baran, S. J. (2010). *Pengantar Komunikasi Massa: Literasi Media dan Budaya*. Jakarta: Salemba Humanika.

[5] Hosnan. (2014). *Pendekatan Saintifik dan Kontekstual dalam Pembelajaran Abad 21*. Bogor: Ghalia Indonesia.

[6] Saab, N., Joolingen, W. R. Van, & Hout-Wolters, B. H. A. M. Van. (2005). Saab, N., et al. "Communications in Collaborative Discovery Learning. *British Journal of Educational Psycology*, (75), 603–621.

[7] Krathwohl, L. W. A. dan D. R. (2010). *Kerangka Landasan untuk Pembelajaran, Pengajaran, dan Asesmen*. Yogyakarta: Pustaka Pelajar.

[8] Arikunto, S. (2012). *Dasar-Dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara.

[9] Brahim, K. . (2007). *Peningkatan Hasil Belajar Sains Siswa Kelas IV SD Melalui Pendekatan Penempatan Sumber Daya Alam Hayati Di Lingkungan Sekitar.*

[10] Pratiwi, E. (2019). *Effect of Discovery Learning Model Assisted by Scientific Competence in SMAN 2 Padang Panjang*. 290–295.

[11] Gholamian, A. (2013). Studying the Effect of Guided Discovery Learning on Reinforcing the Creative Thinking of Sixth Grade Girl Students in Qom during 2012-2013 Academic Year. *Journal of Applied Science and Agriculture*, *8*(5), 576–584. Retrieved from http://www.aensiweb.com/old/jasa/rjfh/2013/576-584.pdf

[12] Castronova, J. A. (2002). Discovery Learning for the 21st Century: Article Manuscript. *Odum Library*, *1*(1), 1–9. Retrieved from http://hdl.handle.net/10428/1257

The Effectiveness of the Utilization of Kahoot Platform as Interactive Media in Physics Learning at SMA N 1 Pengasih

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Abstract. In this study, the researcher aims to (1) determine the appropriateness of instruments used in learning physics to increase the achievement motivation and mastery of students' material, (2) assess the effectiveness of the Kahoot platform in physics teaching in terms of improving student achievement motivation and knowledge of material and also the value of Partial Eta Square, and (3) describe the ability profile of students in SMA Negeri 1 Pengasih on sound wave material. This research is experimental research with pre-post test design. The results showed that: (1) The instrument used in this study was declared feasible because it obtained the Aiken V index with a value range of 0.83 to 1.00. (2) The effectiveness of using the Kahoot platform in terms of achievement motivation, the results show that the experimental class is higher than the control class. (3) The mastery of the material percentage in the experimental classes were higher at 58.62% and 76.67%, while in the control class, it was only 9.375%.

1. Introduction

Learning in school is the interaction between students and educators both in the classroom and outside the classroom with the aim of increasing the abilities and knowledge of students about a branch of science or subject. One of the subjects in the High School majoring in Mathematics and Natural Sciences is physics, in this case it is one branch of science that studies about natural phenomena. [1] explains, Physics is the science that deals with the discovery and fundamental understanding of the laws that drive it. Meanwhile, [2] stated nature of physics are: (1) physics as a product aspect or a body of knowledge, (2) physics as an attitude aspect or a way of thinking, and (3) physics as a process aspect or a way of investigation.

The ability of students to master the material can be seen from the cognitive learning outcomes. [3] explains, cognitive learning outcomes are abilities that students have after receiving their learning experiences. Learning outcomes at SMA N 1 Pengasih according to the odd semester final assessment in class XI MIPA obtained an average of only 65.66 with the lowest score of 50, the highest score of 80, and the minimum completeness criteria of 65. These results indicate that the students' mastery of material in physics lessons is still very low. The factors that influence the students' low mastery of the material are low achievement motivation, less varied learning, and not using the media effectively. This is in line with the opinion of [4] regarding the factors influencing the low mastery of students' material, the teacher only explains the material and gives exercises, the learning model is not varied, the availability of learning facilities and facilities are lacking, and if there are facilities available at

school but it is not functioning properly. Motivation can also affect students' mastery of material. [5] explains, students who have high motivation will get better learning outcomes than students who have low motivation. Meanwhile, [6] explains that achievement motivation means that students learn to achieve the achievements or successes they have set. However, in fact the achievement motivation of students in learning physics is still very low. This is evidenced by the low choice of physics as a national exam subject, which is only 25 out of 134 students majoring in Mathematics and Natural Sciences at SMA N 1 Pengasih.

Based on [7], the learning process in educational units is conducted interactively, inspiratively, fun, challenging, motivating students to actively participate and provide sufficient space for creativity and independence initiatives according to their talents, interests, and the psychological physical development of students. Media is a very important instrument to achieve learning objectives. As research conducted by [8] explains the learning media is in asoftwareform that could be operated by using an Android device, it is able to support SMA-level physics learning of the material about elasticity, it could be used in or outside physics learning at school. Another case with research conducted by [9] regarding the impact of pocket mobile learning to improve critical thinking skills in physics learning, based on analysis and research results can be concluded that pocket mobile learning media of specifically physics material about dynamics of motion could improve students' critical thinking skills show that the students average score with learning use pocket mobile learning is higher than learning use powerpoint. From some of these studies, it can be said that there are various media that can be used in learning to improve the abilities of students. [10] explains, game education is a game that is used in the learning process and in this game it contains elements of education or educational values. One of the interactive learning content is Kahoot. Research conducted by [11] Kahoot! It: Gamification in Higher Education explains if Kahoot! is effective in terms of its ability to foster and reinforce learning, especially with regards to theoretical frameworks, analysis models, media concepts, media language features or devices, and media writing techniques. This is in line with research conducted by [12] the students consider that they have been able to self-evaluate their learning process, which has been more active and experiential and they have had the possibility to better show what they have learnt, which is very interesting from the point of view of the metacognitive process. In another study conducted by [13] regarding Using Kahoot as a formative assessment toll in medical education: a phenomenoblogical study got the results that Kahoot! sessions motivate students to study, to determine the subject matter that needs to be studied and to be aware of what they have learned. Thus, the platform is a promising tool for formative assessment in medical education. As well as research from [14] the results showed that kahoot could be an alternative interactive learning media in higher education because it was proven to significantly improve student learning outcomes. Based on the research that has been done, it can be concluded that the use of Kahoot is effective in learning. Therefore, this study raises the topic of the effectiveness of using the kahoot platform in learning physics to increase achievement motivation and mastery of the material for high school students.

2. Research Methods

2.1. Types of Research

This type of research is an experimental research with a pretest-posttest control group design [15].

2.2. Time and Place of Research

This research was conducted at SMA Negeri 1 Pengasih which is located at Jalan KRT Kertodiningrat 41 Margosari, Pengasih, Kulon Progo, DI Yogyakarta. This research was conducted in the even semester of January - July 2020.

2.3. Research Subject

Table 1. Research Subject

Empirical Test (class XII)	Research at SMA N 1 Pengasih
• SMA N 1 Sedayu 36 students • SMA N 1 Sentolo 36 students • SMA N 1 Pengasih 36 students	• XI MIPA 2 (29 students) as experimental class • XI MIPA 3 (30 students) as experimental class • XI MIPA 4 (29 students) as control class

2.4. Data, Instruments, and Data Collections Techiques

This study uses two instruments in the form of a learning instrument and a data collection instrument. Learning instruments in the form of RPP, LKPD, and Kahoot Platform. The data collection instruments were in the form of instrument validation sheets, observation sheets of lesson plan implementation, achievement motivation questionnaires, pretest and posttest.

Data collection techniques were carried out through observation, tests, and questionnaires. Validation techniques are carried out to assess whether the instruments that have been made are suitable for use or not. The observation technique was carried out to measure the implementation of the lesson plan in learning activities. Data collection techniques with this questionnaire were given before and after the learning was carried out, aiming to find out the increase in students' achievement motivation. The test was conducted to determine the increase in students' mastery of material before and after learning activities.

The types of data obtained in this study are qualitative and quantitative data. Qualitative data were obtained from suggestions and comments on the instrument validation sheet by the validator, as well as suggestions and comments on student response questionnaires. The quantitative data obtained in this study include, among others, the results of filling in the instrument validation sheet, observation sheet of RPP implementation, achievement motivation questionnaire, and pretest-posttest results.

2.5. Data Analysis Technique

The data analysis technique consisted of the feasibility analysis of the research instrument, the analysis of the items, the implementation of the lesson plans, the analysis of the ability profile of students, and the analysis of the results. Analysis of the RPP feasibility sheet using SBi. Analysis of the eligibility results of the achievement motivation questionnaire, pretest-posttest items, Kahoot items used Aiken's V analysis, [16] and [17] as follows:

$$V = \sum_{i=1}^{c-1} \frac{in_1}{N(c-1)} \tag{1}$$

Analysis of the items used the Rasch Model with the Quest program. The analysis of the implementation of the RPP uses the equation:

$$\text{persentase (\%)} = \frac{\text{Total score in learning}}{\text{total score}} x\ 100\% \tag{2}$$

Analysis of the profile of the distribution of student achievement motivation based on the following table.

Table 2. Achievement Motivation Questionnaire Results Criteria

***Range* Skor**	**Categori**
25 – 40	Very Low
41 – 55	Low
56 – 70	Medium
71 – 85	High
86 – 100	Very High

As for the completeness of the students' mastery of material, it can be seen whether they have exceeded the Mininal Completeness Criteria in physics subjects, namely 65.

The data analysis technique uses mixed anava with the help of the SPSS 26 application. Anava is a General Linear Model (GLM) menu [18]. This analysis combines two sub-analyzes, namely the Within Subject Test (testing the difference in scores in one group) and the Between Subject Test (differences in scores between groups). Anava mixed design is appropriate to use in this study because there are two dependent variables and three observation classes (two experimental classes and one control class).

3. Research Result and Discussion

3.1. Description of Research Result

3.1.1. Validation. The validation of research and learning instruments was carried out by three practitioners, namely Siti Muryani, S.Pd (Validator 1), Sutarsih, S.Pd (Validator 2), and Pipit Daristasari S.Si (Validator 3). Validation is used to determine the feasibility of an instrument. The following is a summary of the validation results:

Table 3. Summary of RPP Validation Results

RPP Kelas	**Rata-rata**	**Kategori**
Control	3,80	Very Good
Experimen	3,77	Very Good

Item validation is used to determine whether the items made are feasible or not. This validation uses the Aiken's V. Index V on each item, are:

Table 4. Instrument Validation Result

Item Number of pre-post test	**Index V Aiken**	**Decision**	**Item Number Questionnaire**	**Index V Aiken**	**Decision**	**Item Number of Kahoot**	**Index V Aiken**	**Decision**
1	1,00	Valid	1	1,00	Valid	1	1,00	Valid
2	1,00	Valid	2	1,00	Valid	2	0,83	Valid
3	1,00	Valid	3	0,83	Valid	3	1,00	Valid
4	1,00	Valid	4	1,00	Valid	4	1,00	Valid
5	0,83	Valid	5	1,00	Valid	5	1,00	Valid
6	1,00	Valid	6	1,00	Valid	6	1,00	Valid
7	1,00	Valid	7	0,83	Valid	7	1,00	Valid
8	0,83	Valid	8	1,00	Valid	8	1,00	Valid
9	1,00	Valid	9	1,00	Valid	9	1,00	Valid
10	1,00	Valid	10	1,00	Valid	10	1,00	Valid
11	1,00	Valid	11	1,00	Valid	11	1,00	Valid

Item Number of pre-post test	Index V Aiken	Decision	Item Number Questionnaire	Index V Aiken	Decision	Item Number of Kahoot	Index V Aiken	Decision
12	1,00	Valid	12	1,00	Valid	12	1,00	Valid
13	1,00	Valid	13	0,83	Valid	13	1,00	Valid
14	1,00	Valid	14	1,00	Valid	14	1,00	Valid
15	0,83	Valid	15	1,00	Valid	15	1,00	Valid
16	1,00	Valid	16	1,00	Valid			
17	0,83	Valid	17	1,00	Valid			
18	1,00	Valid	18	1,00	Valid			
19	1,00	Valid	19	1,00	Valid			
20	1,00	Valid	20	1,00	Valid			
21	1,00	Valid	21	1,00	Valid			
22	1,00	Valid	22	1,00	Valid			
23	1,00	Valid	23	1,00	Valid			
24	1,00	Valid	24	1,00	Valid			
25	1,00	Valid	25	0,83	Valid			

Based on this table, it can be stated that the instrument used in the study is feasible because it gets an Aiken V index score of more than 0.8.

3.1.2. Empirical Test. The instrument being tested was 25 items. Each student worked on 10 items with ± 30 minutes. The test results of this instrument were analyzed using the Quest program to see the feasibility of each of these items. The appropriateness of the item instrument was seen from the item difficulty level, the MNSQ infit value and the infit-t in the Rasch Model.

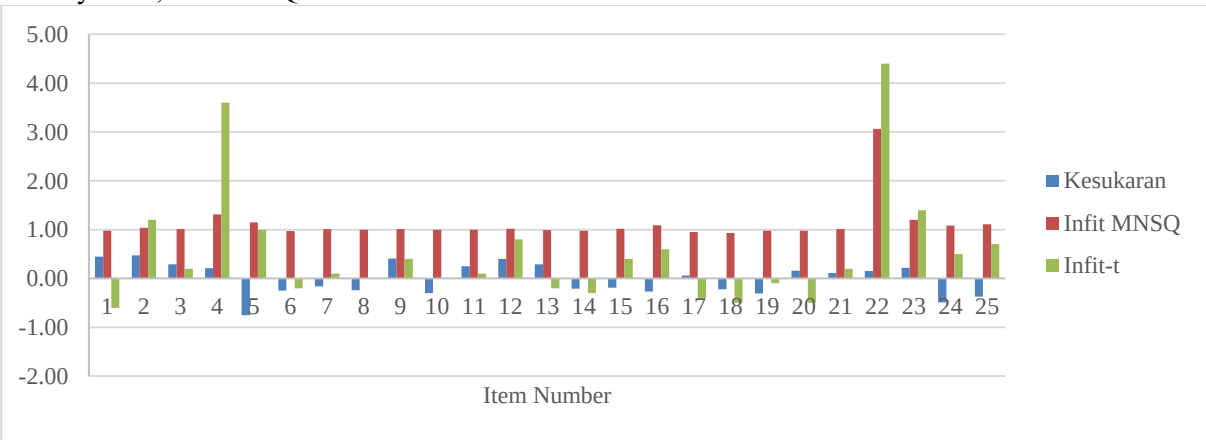

Figure 1. Results of Instrument Test Analysis

Based on this graph, it can be seen that there are two items that are not suitable for research, namely items 4 and 22 because they do not meet the criteria of the Rasch Model. The difficulty level of a good item is between -2 to 2, then the item fit with the Rasch Model if the MNSQ infit value is between -0.77 to 1.33 and the infit-t value is between -2 to 2.

The reliability value of this question can be seen in the Reliability of estimate in the Quest, which gets the result of 0.64. This means that the problem is reliable so that it can be used as a question instrument.

```
Summary of item Estimates
=========================

Mean                          .02
SD                            .67
SD (adjusted)                 .54
Reliability of estimate       .64
```

Figure 2. Reliability of estimate

3.1.3. Implementation of RPP. The implementation of the learning implementation plan was obtained from the lesson plan observation sheet which was observed by two observers in each meeting. The results of the implementation of the RPP are as follows.

Table 5. Implementation of RPP

Meeting To	Class (in %)		
	XI MIPA 2 (Experimen)	XI MIPA 3 (Experimen)	XI MIPA 4 (Control)
1	93,57	92,86	92,15
2	90,59	80,59	91,18
3	92,78	91,11	90,00
4	92,94	94,12	90,59
5	91,76	94,71	92,85
6	93,00	92,50	93,16
7	95,84	94,17	95,84
Average	92,92	91,44	92,25

3.1.4. Data Analysis

Multiple Comparisons

LSD

Measure	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
MEASURE_1	1	2	.06232	.070466	.379	-.07772	.20236
		3	.11864	.069376	.091	-.01923	.25651
	2	1	-.06232	.070466	.379	-.20236	.07772
		3	.05632	.068766	.415	-.08034	.19298
	3	1	-.11864	.069376	.091	-.25651	.01923
		2	-.05632	.068766	.415	-.19298	.08034
MEASURE_2	1	2	-1.25*	.571	.031	-2.39	-.12
		3	2.32*	.562	.000	1.21	3.44
	2	1	1.25*	.571	.031	.12	2.39
		3	3.58*	.557	.000	2.47	4.68
	3	1	-2.32*	.562	.000	-3.44	-1.21
		2	-3.58*	.557	.000	-4.68	-2.47

Based on observed means.
The error term is Mean Square(Error) = 4,812.

*. The mean difference is significant at the ,05 level.

Figure 3. Multiple Comparisons

In the results of the Multiple Comparisons output, look at (I) Group 3, because Group 3 is a control class that is the comparison between the two experimental classes, namely Group 1 and Group 2. If the MD (Mean Difference) results are negative, then the subject has increased. In MEASURE_1 and MEASURE_2 MD between group 3 with groups 1 and 2 got negative results, this means that the

experimental class experienced a higher improvement than the control class. However, the results of the increase in achievement motivation were not significant because p> 0.05.

Multivariate Tests

Group		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
1	Pillai's trace	.769	145.160[a]	2.000	87.000	.000	.769
	Wilks' lambda	.231	145.160[a]	2.000	87.000	.000	.769
	Hotelling's trace	3.337	145.160[a]	2.000	87.000	.000	.769
	Roy's largest root	3.337	145.160[a]	2.000	87.000	.000	.769
2	Pillai's trace	.800	174.287[a]	2.000	87.000	.000	.800
	Wilks' lambda	.200	174.287[a]	2.000	87.000	.000	.800
	Hotelling's trace	4.007	174.287[a]	2.000	87.000	.000	.800
	Roy's largest root	4.007	174.287[a]	2.000	87.000	.000	.800
3	Pillai's trace	.584	61.037[a]	2.000	87.000	.000	.584
	Wilks' lambda	.416	61.037[a]	2.000	87.000	.000	.584
	Hotelling's trace	1.403	61.037[a]	2.000	87.000	.000	.584
	Roy's largest root	1.403	61.037[a]	2.000	87.000	.000	.584

Each F tests the multivariate simple effects of time within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

Figure 4. Multivariate Test

In the Multivariate Test table, look at the partial Eta Squared to see the effective contribution of the learning process. The effective contribution to learning using the Kahoot platform in Group 1 was 76.9% while for Group 2 it was 80.0%. The result was greater than the untreated control class, which was only 58.4%.

3.2. Discussion

3.2.1. Student Achievment Motivation. Based on the analysis of the data obtained, it can be seen in the Pairwise Comparisons table that for each class there is an increase in achievement motivation because MD is negative, for group 1 MD = -0.186; group 2 MD = -0,314; and group 3 MD = -0,248. In this result, it can be seen that the smallest increase was experienced by the experimental class 1 (group 1). However, this smaller increase from the control class does not mean that the students' achievement motivation in the experimental class is the lowest. This can be seen in the following graph of increasing achievement motivation.

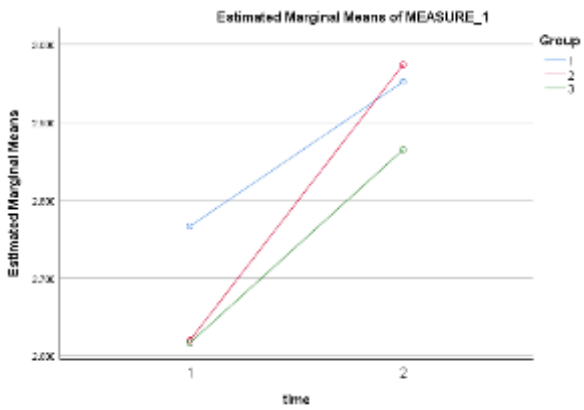

Figure 5. Graph of Achievement Motivation Improvement

In general, all classes (groups 1, 2, and 3) experienced an increase, but the most significant increase in motivation was group 2.Each class experienced an increase in achievement motivation because in this study using STAD type cooperative learning model which can make students feel that Learning is

more interactive than usual learning, but it is different from groups 1 and 2 which are the experimental class which experience higher final motivation than group 3.Then the results of the distribution of achievement motivation profiles of students are also obtained, is:

Table 6. Profile of Student Motivation Distribution

***Range* Skor**	**Experimen 1**	**Experimen 2**	**Control**	**Categori**
25-40	3,45%	0%	0%	Very Low
41-55	0%	3,33%	3,13%	Low
56-70	31,03%	73,33%	31,25%	Medium
71-85	55,17%	23,33%	62,50%	High
86-100	10,34%	0%	3,13%	Very High

The results obtained are in line with the demands of the 2013 curriculum which requires educators to use interactive media in learning to increase student activity so that achievement motivation increases.

3.2.2. Masteri of Student Material. From the results of data analysis, it can be seen in the Pairwise Comparisons table that for each class there is an increase in mastery of the material because MD is negative, for group 1 MD = -13.00; group 2 MD = -13,83; and group 3 MD = -7.84. In this result, it can be seen that the smallest increase was experienced by the control class (group 3). This can be seen in the graph of increasing mastery of the following material.

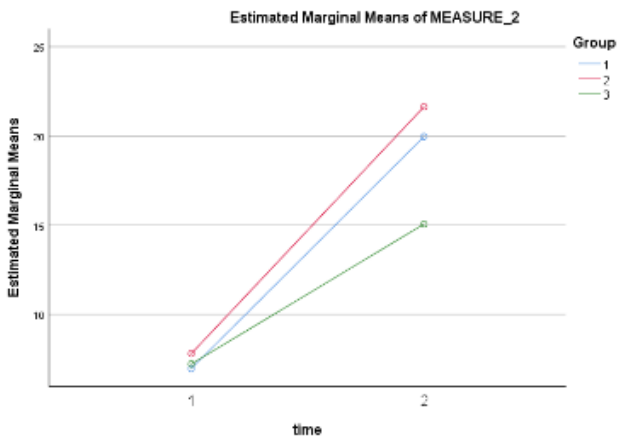

Figure 6. Graph of Increasing Students' Mastery of Material

From the graph, it was found that groups 1 and 2 (experimental class) experienced an increase that was almost the same as in group 3 (control class) with a more sloping graph, meaning that the increase was lower than the experimental class. While the effective contribution from learning using the Kahoot platform can be seen in the Multivariate Test image where the Partial Eta Sqare value for each class is different, for the experimental class 1 is 76.9%, for the experimental class 2 is 80.0%, and for the control class. only 58.4%. In addition, the percentage of completeness for each class is also different, the following is a graph of the scores for each class.

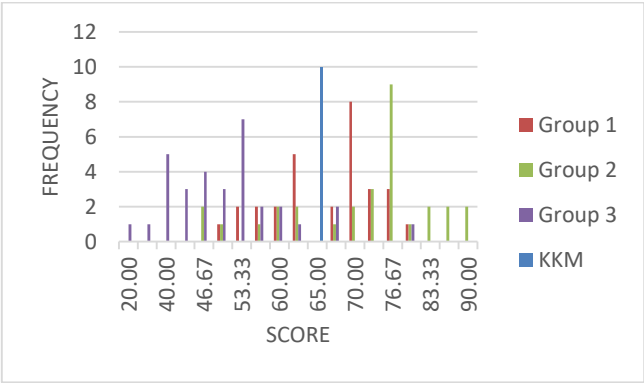

Figure 7. Acquisition of Student Value

Based on the graph, it can be seen that only a few of the control class (group 3) have more than the KKM. The details are as follows, for the experimental class 1 (group 1) there were 17 out of 29 (58.62%) students who got more than the KKM score, for the experimental class 2 (group 2) there were 23 out of 30 (76.67%) students who get more scores than the KKM, while for the control class (group 3) there are only 3 out of 32 (9.375%) students who get more than the KKM. This is because in the experimental class the achievement motivation of students is higher than the control class, so that each student will study more actively and diligently. This is in line with the research conducted by Irwan (in the introduction) and the opinion of Maryam Muhammad regarding the relationship between motivation and mastery of the material, where if the students 'motivation is higher, the students' mastery of the material is also high.

Based on the discussion, it can be concluded that the students 'mastery of the material will increase if the students' achievement motivation increases.

4. Conclusion

Based on the results of research and discussion, the following conclusions are obtained.

1. The instrument used in this study was declared feasible, because the results of the assessment by practitioners obtained the V Aiken index in the range 0.83 to 1.00 with very good criteria.
2. The effectiveness of using the Kahoot platform as an interactive medium in learning physics can be viewed from:
   a. The increase in achievement motivation is seen from the comparison between the control class and the experimental class 1, namely MD = -0.119 and between the control class and the experimental class 2 MD = -0.056.
   b. The increase in mastery of the material is seen from the comparison between the control class and the experimental class 1, namely MD = -2.32 and between the control class and the experimental class 2, namely MD = -3.58.
   c. The Partial Eta Square value is 76.9% for the experimental class 1 and 80.0% for the experimental class 2, while for the control class it is only 58.4%.
3. The profile of the ability of students can be seen from the percentage of completeness in each class, namely for the experimental class 1 as much as 58.62%, the experimental class 2 as much as 76.67%, and the control class only 9.375%.

5. References

[1] Istiyono, Edi. (2018). *Pengembangan Instrumen Penilaian dan Analisis Hasil Belajar Fisika dengan Teori Tes Klasik dan Modern.* Yogyakarta: UNY Press.

[2] Supahar. (2014). The Estimate of Inquiry Performance Test Item of High School Physics Subject with Quest Program. *Proceeding of International Conference on Research, Implementation and Education of Mathematics and Sciences 2014, Yogyakarta State University.* 137-146.

[3] Sudjana, Nana. (2010). *Penilaian Hasil Proses Belajar Mengajar*. Bandung: Remaja Rusdakarya.

[4] Ratih, Sunardi, dan Dafik. 2010. Identifikasi Faktor Penyebab Rendahnya Penguasaan Materi dalam Ujian Nasional Matematika SMA Program IPA Tahun Ajaran 2009/2010 Di Kabupaten Banyuwangi. *Pancaran*, Vol 2 (1), 185-196. https://jurnal.unej.ac.id on June 27, 2020.

[5] Muhammad, Maryam. 2016. Pengaruh Motivasi dalam Pembelajaran. *Lantanida Journal*, Vol. 4 No. 2, 2016.https://media.neliti.com on June 27, 2020.

[6] Sugihartono, dkk. (2013). *Psikologi Pendidikan*. Yogyakarta: UNY Press.

[7] PERMENDIKBUD NOMOR 22 TAHUN 2016 tentang STANDAR PROSES PENDIDIKAN DASAR DAN MENENGAH.

[8] Mardiana, Nana., Kuswanto, Heru. (2017). Android-Assited Physics Mobile Learning to Improve Sebior High School Students' Divergent Thingking Skills and Physics HOTS. *AIP Conference Proceedings*: **1868** 070005

[9] Astuti, I A D., et all. (2018). The impact of pocket mobile learning ti improve critical thingking skill in physics learning. *IOP Conf. Series: Journal of Physics*. *Conference series*: **1114** 012030

[10] Sutirna. (2018). Peran Teknologi Informasi dalam Mendukung Stabilitas Nasional. *Seminar Nasional Semnas Ristek*. 269 – 267.

[11] Lin, Debbita Tan Ai., Ganapathy, M., and Kaur, Manjet. (2018). Kahoot! It: Gamification in Higher Education. *Pertanika J. Soc. Sci. & Hum*. 26 (1): 565 – 582

[12] Prieto, Marta Curto., et all. (2019). Student Assessment of Use of Kahoot in the Learning Process of Science and Mathematics. *Journal Education* 9, 55; doi:10.3390

[13] Ismail, Muhd Al-Aarifin., et all. (2019). Using Kahoot! as a Formative Assessment Tool in Medical Education:a Phenomenological Study. *BMC Medical Education,* 19: 230

[14] Irwan, Irwan., Luthfi, Zaky Farid., & Waldi, Atri. (2019). Efektivitas Penggunaan Kahoot! Untuk Meningkatkan Hasil Belajar Siswa [Effectiveness of Using Kahoot! to Improve Student Learning Outcomes]. *Jurnal Pendidikan* Vol. 8 (1), 95-104.

[15] Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.

[16] Larasati, P E., Supahar., Yunanta, D R A. (2020). Validity and Reliability Estimation of Assesment Ability Instrument for Data Literacy on High School Physics Material. *Journal of Physics: Conference Series*. **1440** 012020

[17] Astuti, A T., Supahar, Mundilarto, and Istiyono, E. (2020). Development of Assesment Instrumen to Measure Problem Solving Skills in Senior High School. *Journal of Physics: Conference Series*. **1440** 012063

[18] Widhiarso, Wahyu. (2011). *Aplikasi Anava Campuran untuk Desain Eksperimen Pre-Post Test Design*. Fakultas Psikologi Universitas Gadjah Mada. http://widhiarso.staff.ugm.ac.id/ on April 7, 2020.

Developing the Teaching Material of the Wave Material Charged with Quran Values to Improve the Spiritual Competence and Metacognitive Knowledge

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Abstract. This research aims to: (1) develop a teaching material with the Alquran that deserves to improve knowledge and spiritual attitude of high school learners. (2) reveal the effectiveness of the developed teaching materials. This research is research and development using the 4D model, namely (1) defining learning needs; (2) designing product draft; (3) developing product assessed by experts and practitioners, product trials, and product revisions; (4) disseminating the final product. The developed teaching material contains the wave material with the Alquran value.The limited trial subjects are 10 learners. The subjects in the experimental class are 20 people and in the control class 21 people. The data collection instruments used include a teaching material assessment sheet, an assessment sheet of the knowledge ability and spiritual attitude, and a student response poll of the teaching materials. The data analysis technique utilizes the assumption test phase, N-gain, Hotelling's multivariate statistical test and the effect size analysis. This research resulted in (1) a learning material charged with the Alquran value that has fulfilled the eligibility criteria, based on the assessment by expert lecturers and practitioners. (2) The developed teaching materials get good responses from learners. (3) The developed teaching materials are effective in improving metacognitive knowledge ability and spiritual attitude.

Keywords: *metacognitive knowledge skills, spiritual attitude, teaching materials*

1. Introduction

The 21st century is the era of globalization or the open era that gave rise to many fundamental changes compared to the previous century. Changes that occur according to Fadel and Triling (2009), among others, in the field of technology, transportation, economics, resource management, as well as changes in the trend of job-based industry that used to be knowledge-based. The changes certainly have an effect on the culture and education so that required a thought which can produce good quality output (Tilaar, 1998) to the current society can live and work in a time of knowledge especially for field Education (Triling and Hood, 1999). Article 1 Act No. 20 Year 2003 of the national education system mention that sense education is planned and conscious effort to bring about an atmosphere of learning and the learning process so that learners actively develop the potential for him to have a religious spiritual strength, self-control, personality, intelligence, morals, as well as the necessary skills themselves, the community, the nation and the State. So in the process of education, at least there should

be teachers, students, educational purposes, materials, media education, and evaluation (Twyman and Heward, 2016).

In Indonesia, the evaluation is governed by Permendikbud No. 54 2013 in regard to the competency standards of graduates. It is explained about the criteria that learners need to achieve, such as knowledge, attitudes, and skills. The evaluation of student's learning outcomes requires some aspects to be done, among others, for mechanisms, learning assessment instruments and procedures. Evaluation of learner's learning results is the effort to collect and process the data obtained through learner's learning outcomes to measure the level of achievement of graduation criteria. The assessment for Student's learning outcomes has various types, such as written assessments, self-assessments, replay, and so on. Self-assessment is used for the competency assessment process (social and spiritual), while the written assessment is used to determine the outcome of student's knowledge competence (Permendikbud No. 66 year 2013).

In accordance with Permendikbud (2016) that the third competency (knowledge) is to understand, implement, analyse and evaluate factual knowledge, conceptual, procedural, and metacognitive (Bloom's Taxonomy of Krathwohl) by raising the curiosity of science, culture, arts, humanities, and technology using national insight, humanitarian state and also civilization related events and phenomena, as well as the knowledge that application of the study of the study and procedural according to the interests and talents of learners in solving a problem.Based on the description, which can be done to support the achievement of aspects of spiritual attitude and the knowledge aspect of learners, the need for the creation of teaching materials charged Quran values.

According to Prastowo (2012) materials is one of the ingredients of learning resources that can be used to help the teacher or instructor in carrying out the learning process in the classroom. Another explanation States that the materials can be used to implement the goals of learning standards, students, and teachers (Singer & Tuomi, 1999).

The teacher's teaching material development demonstrates a positive impact on learners ' learning activities (Aina, 2013) as well as making learning more effective (Oladejo, 2011). The development of teaching materials certainly affects learning achievement (Iji, 2014) and the Memory of learners (Mboto, 2011). For the preparation of the teaching materials according to the needs then it is necessary to understand some rules that should be observed in developing the teaching materials. Winkel (2014) explains that teaching materials should contain learning objectives, usage instruction sheets, reading materials for learners, examples of questions and evaluation tools. While according to Widodo & Jasmadi (2008), the teaching materials need to observe the following elements:

a) learning materials should be adapted to the conditions of the learner while carrying out the learning process
b) learning materials are expected to be able to change the behaviour of learners
c) the development of learning materials tailored to the needs and characteristics of the self
d) learning materials include objectives specific learning activities
e) learning materials contains a good learning material in the form of activity or exercise with detailed
f) learning materials include part of evaluation as a tool to measure the success of the learning learners (Jasmadi & Widodo, 2008).

Ministry of national education year 2008 considers vital to the existence of learning materials for learners because materials related to the availability of materials in accordance with the demands of the curriculum, the characteristics of the target, as well as the demands of the problem learn. The teaching and learning process that uses learning materials will affect the knowledge and attitudes of learners (Bozdogan, 2011). According to Ifeoma (2013) and Awolaju (2015), the use of teaching materials can reduce poor performance in learners so that students have a positive influence (the Power, 2011). According to Ballstaedt (1994), the print materials arranged in nice has several advantages, such as print materials easier to use because it can be moved freely, a good learning materials can motivate readers to do activities such as marking, noting, even sketching.

A school that has required the participants to study the Quran to understand the interpretation contained in the Quran can use the teaching materials. So that students can make the Quran as a

foundation in learning and understanding the wave material at once can add spiritual value. A narrated by Imam Nasai and Muslim.

فَإِنّ أَصْدَقَ الْحَدِيْثِ كِتَابُ اللهِ، وَخَيْرَ الْهَدْيِ هَدْىُ مُحَمّدٍ صَلّى الله عَلَيْهِ وَسَلّمَ، وَشَرّ اْلأُمُوْرِ مُحْدَثَاتُهَا، وَكُلّ مُحْدَثَةٍ بِدْعَةٌ وَكُلّ بِدْعَةٍ

ضَلاَلَةٌ، وَكُلّ ضَلاَلَةٍ فِي النّارِ

Indeed, the most correct words are the kitabullah, the good instruction is the instruction of the Prophet Muhammad, a bad thing is a new thing, every new thing heretics, every matter of heresy is misleading, and everything misleading will lead us to Hell (HR Imam Nasai and Muslim)
explaining that the best teaching material is Quran.

Learners are able to digest the material by wave analysis of events that exist because the search of knowledge through sight, hearing, and contemplation. Then the students are expected to develop metacognitive knowledge and spiritual attitude competence.

Research on the use of printed materials has been conducted by French, Taverna, Neumann, Kushnir, Harlow, Harrison, and Serbanescu (2015). They observed more than a thousand students on 12 undergraduate programs from the university in a large urban center and a university in a small urban center that uses textbooks. A total of 77 percent of students admitted often using textbooks and 25 percent of students read only textbooks at any given moment. As a result, those who often read textbooks have a better value at the end of the lecture. Research on the development of physics teaching materials with the values of the Quran was done by Neni Farkhianan Ulfa (2011) shows the validation results of the developed materials are worthy of use by learners and received a good response. Dini Maielfi (2012) has also developed a physics learning device with the CTL-based approach of faith and Taqwa aimed at the students of the MAN 2 Padang. His learning devices have been validated and are well-received by practitioners, experts, and learners. Learners who use these learning devices can improve their activities and outcomes.

2. Method

2.1Development model and procedure

This research uses research methods development or Research and Development (R&D) which is a research method to produce a specific product as well as test the effectiveness of products with quantitative analysis. The products are developed isteaching materials with the Quran values to improve the competence of spiritual attitudes (K1) and the competence of knowledge of students of high school learners on the subject of waves. As for the development of the following procedure:

2.1.1 Define stage (Definition) Stage define aims to establish and define the needs in the learning process.

2.1.2 Design stage (Design) The purpose of this stage is to prepare a prototype learning materials.

2.1.3 Develope Stage (Development) This stage aims to produce learning materials with Alquran values revised based on comments, suggestions, and the assessment of expert lecturers, physics teacher, field test, and the operational field test.

2.1.4 Deseminate stage (desemination) This stage aims to use teaching material of the wave material charged with Quran values that has been developed on a wider scale that is in 2 classes (limited test classes and operational field test classes).

2.2 Data analysis Techniques

The process of data processing using qualitative descriptive analysis technique, which is the technique to describe and use qualitative data. Qualitative Data obtained from material experts, media experts, physics teachers, peers, and learners is expertly quantized, for later analysis. But the analysis of the interviews and documentation is still using qualitative analysis.

2.2.1 Questioner instrument

2.2.2 Test instrument

2.2.3 analysis student's metacognitive knowledge and spiritual attitude differences to each group

2.2.4 Effectivity analysis Stages for conducting the effectiveness analysis of teaching materials are as follows bivariate normality test, homogeneity test, linierity and the sense of regression direction, autocorrelation test, multivariate *Hotelling's* T^2 test, calculate effect size.

3. Result and Discussion

The initial product development resulted in a rough draft of teaching material of the vave material charged with Quran values that has been assessed by experts and practitioners. The data descriptions of preliminary product development are explained in the following stages of development.

3.1.1. Define stage (definition) result

First, initial analysis aims to set a fundamental issue that emerged in the curriculum and the problem of field in the learning of physics in high school so that the teaching materials needed development. At this stage, observations and interviews. Through interviewing activities, it is known that the teaching materials are used to customize the direct instruction. The materials contain a summary of the materials and questions. The concept of the teaching material is too short that requires additional explanation on other teaching materials that support the learning process. The physics teacher has difficulty in explaining abstract materials such as waves. Learners are less able to imagine events about waves in everyday life. The results of the literature study present an alternate way as a solution to existing problems when learning in class. The alternative way of providing other teaching materials as a supporter of teaching materials that have been used is the teaching materials that are charged the Quran value. Learners are expected to improve the ability of metacognitive knowledge accompanied by increased spiritual attitude.

3.1.2. Design stage (design) result

The results at the design stage of teaching materials prototype. The selection of media is tailored to the easy delivery of basic materials so that learning objectives can be achieved. For the development of materials teaching using Microsoft Word. Designing the Teaching materials format in accordance with the analysis results of theory and analysis in the Define phase. Based on the design of the format, it can be designed early teaching materials. The learner's ability Format is about the description to assess the knowledge of metacognitive and self-assessment questions to determine the development of the spiritual attitude of learners. The Student ability Assessment sheet is given during posttest and pretest. The initial draft of the teaching materials and data collection instruments are further submitted to the guiding lecturers to be consulted. The guidance lecturers then provide correction and input to the teaching materials for further assessed by expert lecturers and practitioners

3.1.3. Develope stage (development) result

The validation process of data collection instruments aims to allow the instrument to measure the results of the actual research. The result of such validation is

No	Instrument	*Validity Coef.*	Interpretation	Reliability
1	Teaching materials assessment sheet	1,00	Valid	Reliable
2	Student response questionnaire	1,00	Valid	Reliable

Based on the results of input from FGD and expert lecturers, it can be revised against data collection instruments. Further revision results are consulted to the guidance lecturer. The process of content or

items assessment instrument's validation of metacognitive knowledge and spiritual attitude assessment is carried out by three expert lecturers and two physics teachers. The validity aspect is comprised of material, construction, and language aspects. The validity of the instrument content assessment of metacognitive knowledge and assessment of spiritual attitudes is calculated using validity coefficient. Here's more about validation results

No.	Instrument	Item number	*Validity Coef.*	Interpretation
1	Metacognitive Knowledge Assessment	1	1,00	Valid
		2	1,00	Valid
		3	1,00	Valid
		4	1,00	Valid
		5	1,00	Valid
		6	1,00	Valid
		7	1,00	Valid
		8	1,00	Valid
		9	1,00	Valid
		10	1,00	Valid
		11	1,00	Valid
		12	1,00	Valid
2	Spiritual attitude assessment	1	1,00	Valid
		2	1,00	Valid
		3	1,00	Valid
		4	1,00	Valid
		5	1,00	Valid
		6	1,00	Valid
		7	1,00	Valid
		8	1,00	Valid
		9	1,00	Valid
		10	1,00	Valid

At the development stage, there were wave materials that received improved assessment, suggestions and based on comments by expert lecturers and practitioners. Observation on material content of the materials is based on the concept of appropriate theory, while the use of procedures of writing materials adapted to Permendikbud number 50 year 2015 using simple language and easy to understand. Next 2 expert lecturers and 2 teachers validate the teaching materials. Data of the results obtained is the data in the form of scoring scores and data in the category of quality of teaching materials score.

No	**Aspects**	**Average scor**	**Category**
1	Content	3,83	Very good
2	Material layout	3,58	Very good
3	Linguistic	3,58	Very good
4	Graphics	3,83	Very good
Average		**3,70**	Very good

Comments and suggestions about the teaching materials are further provided by the expert lecturers and the further physics teachers are consulted with the Supervisor lecturer to get the input as revised material described in the product revision. After the results of the comments and suggestions by the physics teacher and expert lecturers have been revised, then will be generated teaching materials that are subsequently used in the limited trial. Limited trials are conducted to search for response data, comments and suggestions from users of developed materials. Afterwards the teaching materials were given to 10 students of the XI SMA class for testing. Developed teaching materials got 10% response with excellent categories, 70% with good categories, and 20% with enough categories. The total score value of all statements on a poll has a value of less than 0.05 and Cronbach's Alpha overall value is 0.844 (greater than 0.600). These results correspond to the hypothesis that the SPSS testing is a rejection of H0 which means the data shows valid and reliable (consistent) results.

The responses or suggestions provided by students to the teaching materials are consulted with the guidance lecturers to get improvement of the teaching materials that will be tested in the field. The validity and reliability knowledge assessment sheet and spiritual attitude assessment is conducted by 10 students of XI SMA class. The assessment results are further analysed using SPSS program. According to the empirical validity instrument's result the metacognitive knowledge assessment, all items can be said to be valid and reliable. The basic data is said to be valid is to have a total score of less than 0.05 so that the decision obtained rejection of H0 (according to hypotheses that lubricated SPSS). While the results of the assessment instrument is said to be reliable because it has a value of Cronbach's Alpha more than 0.600 which is 0.745 so that the decision obtained rejection H0 which means all the matter of reliability or consistent. According to the empirical validity instrument's result the spiritual attitude assessment, all items can be said to be valid and reliable. The basic data is said to be valid is to have a total score of less than 0.05 so that the decision obtained rejection of H0 (according to hypotheses that lubricated SPSS). While the results of the assessment instrument are said to be reliable because it has a value of Cronbach's Alpha more than 0.600 which is 0.806 so that the decision obtained rejection H0 which means all the matter of reliability or consistent.

A revised teaching and learner's ability to input and comment on the next limited trial in a different class is again tested as a field trial. On the field trials, the teaching materials received a student response of 45% with excellent categories and 55% with good categories. The experimental classes and the control class were used as field trials for Post-test and pre-test execution. The final results of the pre-tests and post-test in the experiment class and the control class are presented in the table below.

No	**Class**	**Average value of metacognitive knowledge**			**Average value of spiritual attitude**		
		Pretest	***Posttest***	***N-gain***	***Pretest***	***Posttest***	***N-gain***
1	experiment	40,6	85,65	0,78	75,5	92	0,67
2	control	40,76	76,05	0,59	75,24	87,14	0,48

The table shows the results of changing learners ' ability to be read through N-gain interpretation. In experimental classes, metacognitive knowledge n-Gain is 0.78 which is classified in high category while the spiritual attitude assessment N-Gain is 0.67 which is classified in medium category. While in the control class, metacognitive knowledge N-Gain is 0.59 which is a medium category and spiritual attitude N-gain is 0.48 with medium category.

Effectiveness testing to use teaching materials on metacognitive and spiritual attitude's ability enhancement is carried out using multivariate statistical tests because it has more than one dependent variables. A multivariate test can be performed after a test of assumptions, which should be done first is the assumption of the population variables that are both normal and homogeneous distributions (Stevens, 2009). The data used is increased capability or gain data.

After knowing there is a difference in the increasing metacognitive knowledge and spiritual attitude, it can be seen how much the influence of teaching materials to the metacognitive knowledge and spiritual attitude by using effect size. Effect Size is a measure magnitude of the variables effect in other variables, the magnitude of difference and the free relationship of the influence of the magnitude of the sample. Here are the calculation results in brief.

No	Variable	*Eta Squared*	*Cohen's f*	Interpretation
1	Metacognitive knowledge	0,372	0,40	*high effect size*
2	Spiritual attitude	0,148	0,165	*Medium effect size*

Based on the analysis, Cohen's f value with high effect size interpretation on both the metacognitive variable and the medium effect size in the spiritual variable. The results showed that the teaching materials charged the value of the Qur'an has a major influence on the enhancement of metacognitive knowledge and spiritual attitude. Therefore, it can be concluded that the use of teaching materials with the value of Qur'an is effective for use to increase learner's metacognitive knowledge and spiritual attitude.

3.1.4. Dissemination stage result (Dissemination)

The final product that has been through the revision stage and subsequent assessment can be carried out to the school that has been using the 2013 curriculum based on education Quran. Limited distribution to certain schools because the worry of understanding students who do not get the Quran education will have difficulty understanding materials materials. The teaching materials are given to the class teachers of XI SMA Ali Maksum and MA Almahali teacher by providing explanations on how to use. Advice given by the physics teacher is expected to be charged teaching materials the Quran value is able to be used by all high school.

4. Conclusion

This research results materials that have fulfilled the eligibility criteria. The eligibility criteria of the teaching materials are based on assessment by expert lecturers and practitioners. The application of teaching materials is effective to improve the ability of metacognitive knowledge and spiritual attitude. The effectiveness teaching materials is reviewed based on the implementation of field trials.

References

[1] Aina, K.J. (2013). *Instructional Materials and Improvisation in Physics Class: Implications for Teaching and Learning.* IOSR Journal of Research & Method in Education (IOSR-JRME) e-ISSN:2320-7388, p-ISSN:2320-737X vol 2, issue 5, pp 38-42

[2] Awolaju,B.A. (2015). *Instructional Materials as Correlates of Student' Academic Performance in Biology in Senior Secondary Schools in osun state.* International Journal of Information and Education Technology, vol 6 no 9, pp 705-708

[3] Bozdogan, A.E. (2011). *The Effects of Instruction with Visual Materials on the Development of Preservice Elementary Teachers' Knowledge and Attitude towards Global Warming.* The Turkish Online Journal of Educational Technology, vol 10 issue 2, pp 218-233, http://www.tojet.net/articles/v10i2/10222.pdf

[4] French, Michelle.,Taverna, Franco., Neumann Melody., Kushnir, Lena Paulo., Harlow, Jason., Harrison, David., &Serbanescu Ruxandra. (2015). *Textbook Use in the Sciences and Its Relation to Course Performance*. http://www.tandfonline.com/loi/vcol20, 63 (4), 171-177, http://dx.doi.org/10.1080/87567555.2015.1057099

[5] Ifeoma, M.M. (2013). *Use of Instructional Materials and Educational Performance of Students in Integrated Science (a case study of unity schools in Jalingo, Taraba state, Ngeria).* IOSR

Journal of Research and Method in Education (IOSR-JRME) e ISSN:2320-7388, p-ISSN:2320-737X Vol 3, issue 4, pp7-11

[6] Iji, C.O., Ogbole, P.O., & Uka, N.K. (2014). *Effect of Improvised Instructional Materials on Students' Achievment in Geometry at the upper Basic Education Level in Makurdi Metropolis, Benue State, Nigeria.* American Journal of Educational Research, 2014, vol 2, no 7, 538-542. http://pubs.sciepub.com/education/2/7/17/

[7] Mboto, F.A., Udo, N.N., & Stephen, U. (2011). *Effects of Improvised Materials on Students' Achievement and Retention of the Concept of Radioactivity.* An International Multi-Disciplinary Journal, vol 5 (1), no 18, pp 342-353

[8] Oladejo, M.A. (2011). *Instructional Materials and Students' Academic Achievment in Physics: some policy implications.* European Journal of Humanities and Social Sciences vol 2 no 1

[9] Prastowo, A. (2012). *Panduan Kreatif Membuat Bahan Ajar Inovatif*. Yogyakarta: Diva Press

[10] Singer, M & Tuomi, J. (Eds.). (1999). *Selecting Instructional Materials: A Guide for K-12 Science*. Washington, D.C.: National Academies Press

[11] Tilaar. (1998). *Paradigma Baru Pendidikan Nasional*. Jakarta: Rineka Cipta

[12] Trilling, Bernie dan Hood, Paul. (1999). *Learning, Technology, and Education Reform in the Knowledge Age*, (Online), (https://www.wested.org/online_pubs/learning_technology.pdf)

[13] Twyman, Janet S dan Heward, William L. (2016). *How to Improve Student Learning in Every Classroom Now*. International Journal of Educational Research, 1149, 13.http://dx.doi.org/10.1016/j.ijer.2016.05.007

[14] Ulfa, Neni Farkhiana. (2011). *Pengembangan Bahan Ajar Fisika Berkarakter Nilai-Nilai Alquran Pokok Bahasan Suhu dan Kalor bagi Siswa adrasah Aliyah kelas X semster 2.* Malang: Universitas Negeri Malang

[15] Winkel, W. S. (2014). *Psikologi Pengajaran.*Yogyakarta: Media Abadi

[16] Widodo, Chomsin S dan Jasmadi.(2008). *Panduan Menyusun Bahan Ajar Berbasis Kompetensi*. Jakarta: PT Elex Media Komputindo.

Improving problem-solving skill of prospective physics teachers based on their logical thinking ability through collaborative learning on electricity and magnetism topic

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Abstract. Problem-solving skills are one type of group thinking skills that need to be provided to prospective physics teacher students. Providing problem-solving skills can be done through the assessment process and the learning process. This study aims to improve the problem-solving skills of prospective physics teacher students based on the ability to think logically on the topic of electricity and magnetism through collaborative learning with IDEAL model problem-solving strategies. The research method used was pre-experiment with pre-test and post-test designs. The sample in this study was 30 prospective physics teacher students at universities in Makassar for the first year of the 2018/2019 academic year. Student problem-solving skills are measured by the Context Rich Problem (CRP) test in the form of descriptions related to electricity and magnetism topics. The level of students' logical thinking ability is divided into three categories, namely formal, transitional, and concrete which is measured using the standard test of Logical Thinking (TOLT). Based on the n-gain normality analysis, the results showed that students with the concrete and transitional logical thinking skills category had problem-solving skills in the moderate category with n-gain of 39% and 54%, respectively. Meanwhile, students with the category of formal logical thinking skills have problem-solving skills in the high category with n-gain = 74%.

1. Introduction

The science learning paradigm initiated in the National Science Teachers Association (1985) emphasizes that problem solving is an ability that must be developed in science learning [1,2]. The science learning paradigm has been adapted into the education curriculum in Indonesia related to the science curriculum starting in the 2004 Curriculum (KBK), the 2006 Curriculum to the 2013 Curriculum. One of the goals of learning science is to develop process skills for investigating the environment, solving problems, and making decisions. The importance of providing problem-solving skills in science learning is also explained in the structure of the 21st century skill framework which mentions that there are four skills groups that need to be mastered by humans in living life in the 21st century, namely ways of thinking, ways of working, tools for working, and living in the world [3, 4]. One such skill group is a skill group of ways of thinking, i.e. a group of thinking skills. Some of the

types included in the group of thinking Skills are 1) Creative and innovative; 2) Critical thinking, problem solving, decision making; and 3) Learn how to learn, and Metacognition [3–6].

The explanation above shows that one of the important thinking skills mastered in the 21st century is the problem solving skills. A number of studies related to the development of problem solving skills have been conducted in recent years in the world of science education [7–12]. Problem solving skills play an important role in science learning including physics. The basic component of a problem is based on the information received or the specific condition (conditions) (givens), a goal (goals), and the tool to obtain information from one particular state to another (operation). Problem solving aims not only to find the correct answer but also an action that covers the mental period and ability [9]. Therefore, problem solving skills need to be trained to learners at every level of education.

The essential meaning of thinking skills is a cognitive process, namely a mental activity through which knowledge is obtained. In particular, thinking skills focus primarily on reasoning as part of the cognitive process [6]. Logical thinking or reasoning is an integrated component in each stage of the thinking level after recalling the thinking level in a hierarchy of thinking levels [9]. This illustrates that the reasoning component plays an important role in every stage of complex thinking. The form of reasoning can be divided into two modes, namely thinking analogy and logical thinking [7,13]. Based on the hierarchy of thinking levels and their relation to reasoning, logical thinking contributes to each stage of student complex thinking as individual learners [8,10]. The position of logical thinking ability plays an important role in helping find truth based on certain rules, patterns, or logic needed to solve problems [9]. Thus, logical thinking ability is a cognitive variable that can affect the level of achievement of student problem-solving skills.

The results of preliminary observations on first-year prospective physics teachers at a university in Makassar in 2017/2018 academic year show that their problem-solving skills are still in the low category. Overall students have difficulty planning solutions and implementing problem-solving plans and have not been able to double-check solutions problem solving [14]. This shows the importance of being selective in choosing learning strategies that can optimize the problem-solving skills of prospective physics teachers.

Various research on how to improve students' problem solving skills has been done by providing innovations in learning [3–6]. One of the learning strategies that can optimize problem-solving skills in physics lectures is the IDEAL model of problem-solving learning strategies in the form of group physics problem-solving. This learning strategy is often termed as collaborative learning [15]. Collaborative learning in small groups has been a pedagogical tool in physics education for a long time in order to give opportunities for the students to express themselves with newly accessed knowledge in a relevant context. A meaning-making of concepts, their relations and also limitations of models used is facilitated if you are allowed to discuss them in a social context [15–18]. Research also shows that active learning, including collaborative learning, leads to improved results for several learning outcomes compared to passive learning, such as traditional lectures without interaction [15,19]. However, it is also demonstrated that it is not necessarily the case that the more collaborative learning there is the better. A combination of different methods might be the best [15,19]. Structured collaborative learning by Harskamp and Ding demonstrated how improves problem-solving in physics more than individual learning does [20]. In that comparative study, it is also proposed that the discussions of the students should be traced and explored in future studies. Studies have also been conducted on the question how the use of context affects the students' interest and how the use of context-rich problems (CRPs) [21] develops the discussion from talk based on everyday life experiences to a conversation based on physics reasoning [15, 22–24]. Based on this, the IDEAL stage model problem-solving learning strategy in collaborative form is expected to be able to help students build their knowledge based on a solid knowledge structure so that it can help improve analytical skills in solving contextual problems (CRPs).

Electrical and magnetics material is an important concept that must be taught to students in training their problem solving skills because the interaction of electrical material and the Magnetics plays a central coordination in determining the structure of life and become a foundation of important

technological developments in life [21,22]. Therefore, electrical and magnetic materials are important in developing the problem solving skills of prospective physics teacher students.

Based on the results of related research by previous researchers, the collaborative learning model in small groups was able to develop students' problem-solving skills in learning physics. The difference in this study with previous research is that this study focuses on improving student problem-solving skills which are reviewed based on the level of logical thinking skills (concrete, transitional, and abstract) through collaborative learning with IDEAL model problem- solving strategies. Furthermore, students are given a CRP test in the essay form to measure the level of achievement of problem-solving skills based on the logical thinking ability of prospective physics teachers.

2. Method

The research method which was used in this study is pre experiment with one group pre-test-post-test design with using 30 prospective physics teacher in 2018/2019 academic year as sample in this study. The data analysis technique used is quantitative based on problem-solving skill test result. Instruments used in this research are Context Rich Problem solving (CRPs) test and Test of Logical Thinking Ability (*TOLT*). CRPs test is used to measure problem solving skills of prospective physics teachers which consist of five question essay. Each question contains six indicators of problem solving skills. Indicators of problem-solving skills in this study are identify problem, define goal, represent problem, explore strategy, act strategy, and lock back and learn. Furthermore, *TOLT* test standardized is used to measure prospective physics teachers' logical thinking ability which was developed by Tobin and Capie version whose coefficient reliability (α) = 0.85, high significant level ($p < 0.0001$), mean value M = 2.94, and deviation standard = 2.94 [25]. *TOLT* measures five variables of logical thinking, namely proportional reasoning, controlling variable reasoning, correlational reasoning, probabilistic reasoning, and combinatorial reasoning. It consists of 10 items which requires participants to select a correct response and justification from a number of alternatives.

Analysis of problem-solving skills test result is start to 1) determining the value the test scoring of problem solving skills, 2) calculate the increase in students' problem-solving skills based on their logical thinking ability by using normalized gain $\langle g \rangle$, 3) interpret $\langle g \rangle$ value obtained used categories Hake [26] stating that $\langle g \rangle < 0.3$ low category, $0.3 \leq \langle g \rangle \leq 0.7$ category medium and high category $\langle g \rangle > 0.7$. Furthermore, inferential analysis with Kruskal Wallis test was used to know significant difference between formal, transitional, and concrete students to their problem-solving skills.

Analysis of TOLT test is quantitative description with determining test scoring of *TOLT*. The categorization of students' logical thinking ability is divided over three. There are concrete, transition, and formal operational categorize. Students whose score 0-1 were labelled concrete operational category, those with score 2-3 were called transition operational category, and they whose score above 4 were branded as formal operational category.

3. Results and Discussions

The results and discussions of this research consist of 1) description about prospective physics teachers' logical thinking ability and 2) description of prospective physics teachers' problem-solving skills based on logical thinking ability.

3.1. Description about prospective physics teachers' logical thinking ability

Logical thinking ability of prospective physics teachers was categorized into three types based on Tobin and Capie theory [25,27–29]. Result of study showed that there were 12 students who were formal reasoning category, 9 students who were transitional category, and 9 students who were concrete category.

Analysis result about obtaining test score of *TOLT* showed that the number of students who had logical thinking ability in formal category was more than the number of students who was in transitional and concrete category. Based on this result, we can conclude that every student has logical thinking ability to get and process more information in the class. Therefore, it is important to consider

the use of appropriate learning strategy with our student characteristic to improve problem solving skills of prospective physics teachers.

3.2. Description about problem-solving skills of prospective physics teachers based on their cognitive style.

Table 1 showed result of descriptive statistical analysis about average pre-post test score and normalized gain <g> for each indicator of problem-solving skills based on logical thinking ability of prospective physics teachers through collaborative learning with small-group in physics course.

Table 1. Descriptive statistic, and normalized gain <g> average for each indicator of problem-solving skills (PS) based on prospective physics teachers' logical thinking ability in basic physics course

Indicator Problem Solving Skill	Category of Logical thinking ability	*N*	Test	*Mean (μ)*	*Deviation Standard (S)*	N-*Gain (g)*	Category
Identify Problem (IP)	Concrete	9	U1	9,30	1,34	0,55	Middle
			U2	14,10	1,91		
	Transitional	9	U1	10,11	1,90	0,70	High
			U2	15,56	1,51		
	Formal	12	U1	10,55	0,52	0,98	High
			U2	17,82	0,60		
Define goal (DG)	Concrete	9	U1	4,40	1,84	0,64	Middle
			U2	13,10	1,45		
	Transitional	9	U1	8,00	2,65	0,61	Middle
			U2	14,22	1,48		
	Formal	12	U1	9,36	1,69	0,95	High
			U2	17,55	0,50		
Represent Problem (RP)	Concrete	9	U1	2,80	1,75	0,45	Middle
			U2	9,40	3,98		
	Transitional	9	U1	4,78	2,11	0,60	Middle
			U2	12,67	2,29		
	Formal	12	U1	6,73	2,53	0,93	High
			U2	17,18	1,25		
Explore Strategy (ES)	Concrete	9	U1	1,80	1,87	0,33	Middle
			U2	7,00	3,97		
	Transitional	9	U1	3,11	1,90	0,57	Middle
			U2	11,67	2,40		
	Formal	12	U1	4,09	1,51	0,82	High
			U2	15,36	3,01		
Act Strategy (AS)	Concrete	9	U1	0,50	0,97	0,29	Low
			U2	5,50	2,80		
	Transitional	9	U1	0,78	1,09	0,48	Middle
			U2	9,11	3,10		
	Formal	12	U1	0,82	0,87	0,64	Middle
			U2	11,73	0,94		
Look back and Learn (LBL)	Concrete	9	U1	0,00	0,00	0,22	Low
			U2	4,00	2,21		
	Transitional	9	U1	0,00	0,00	0,35	Middle
			U2	6,33	3,24		
	Formal	12	U1	0,55	0,52	0,42	Middle
			U2	7,91	2,43		
Problem	Concrete	9	U1	18,80	6,23	0,56	Middle

Indicator Problem Solving Skill	Category of Logical thinking ability	*N*	Test	*Mean (μ)*	*Deviation Standard (S)*	N-*Gain (g)*	Category
solving skill total			U2	53,10	13,27		
	Transitional	9	U1	26,78	8,44	0,57	Middle
			U2	69,56	12,54		
	Formal	12	U1	32,09	6,61	0,73	High
			U2	87,55	8,07		

Table 1 provides information that most students' problem-solving skills with the logical thinking ability at formal category have increased with an average n-gain value in the high category for problem identification indicators (0.98), goal setting (0.95), problem representation (0.93), and the strategy exploration indicator (0.82). Meanwhile, the indicator runs the strategy and looks back and learns it is in the medium category with an average n-gain value of 0.64 and 0.42, respectively.

Problem-solving skills for students with the transitional category of logical thinking ability mostly experienced an increase in the average n-gain score with the moderate category for goal setting indicators (0.61), problem representation (0.60), explore strategy (0.57), execute strategy (0.48), and look back and learn (0.35). There is only one indicator of problem-solving skill that is in the high category, namely the problem identification indicator with an n-gain value of 0.70.

Students with the logical thinking ability in the concrete category mostly experienced an increase in problem-solving skills with an average n-gain value in the middle category on the problem identification indicator (0.55), goal setting (0.64), problem representation (0.45), and exploring strategies (0.33). Meanwhile, the other two indicators, namely the indicator run strategy and look back and learn are in the low category with an average N-gain value of 0.29 and 0.22, respectively.

The analysis of the increase with the n-gain value was also carried out on part or all of problem-solving skills based on the level of logical thinking skills as shown in Table 1. Problem-solving skill tends to increase based on the level of logical thinking ability. The lowest average score on each indicator of problem-solving skills is students with a concrete category. Meanwhile, students with the level of the formal category have the highest average score.

The result of the n-gain analysis indicates that the implementation of collaborative learning in basic physics courses can contribute to improving the problem-solving skills of different students based on the level of logical thinking ability of students.

Kruskal Wallis difference test analysis was conducted to see the significance of differences in problem-solving skills between students in the concrete, transitional, and formal categories. The results of the Kruskal Wallis difference test analysis on the problem- solving skills test score are shown in Table 2.

Table 2. Descriptive Statistic and the different test of average score of problem-solving skills average score based on prospective physics teachers' logical thinking skills

Indicators of Problem-Solving Skill	Category of Logical Thinking Ability	*N*	*M*	*SD*	Kruskal Wallis test *(Asymp. Sig.)*	Description
Identify Problem (IP)	Concrete	9	14,10	1,91	0,000	Significant
	Transitional	9	15,56	1,51		
	Formal	12	17,82	0,60		
Define goal (DG)	Concrete	9	13,10	1,45	0,000	Significant
	Transitional	9	14,22	1,48		
	Formal	12	17,55	0,82		
Represent	Concrete	9	9,40	3,98	0,000	Significant

Indicators of Problem-Solving Skill	Category of Logical Thinking Ability	*N*	*M*	*SD*	Kruskal Wallis test *(Asymp. Sig.)*	Description
Problem (RP)	Transitional	9	12,67	2,29		
	Formal	12	17,18	1,25		
Explore Strategy (ES)	Concrete	9	7,00	3,97	0,000	Significant
	Transitional	9	11,67	2,40		
	Formal	12	15,36	3,01		
Act Strategy (AS)	Concrete	9	5,50	2,80	0,002	Significant
	Transitional	9	9,11	3,10		
	Formal	12	11,73	2,94		
Look back and Learn (LBL)	Concrete	9	4,00	2,21	0,009	Significant
	Transitional	9	6,33	3,24		
	Formal	12	7,91	2,43		
Problem solving skill total	Concrete	9	53,10	13,27	0,000	Significant
	Transitional	9	69,56	13,27		
	Formal	12	87,55	8,07		

The results of Kruskal Wallis different test (Table 2) for problem-solving skills show that there are significant differences based on differences in the level of logical thinking skills, namely concrete, transitional, and formal. Significant differences were found in each indicator of problem-solving skills, for example problem identification (p = 0,000), goal setting (p = 0,000), problem representation (p = 0,000), strategic exploration (p = 0.000), run the strategy (p = 0.002), and look back and learn (p = 0.009). Likewise, with overall problem-solving skills, there were significant differences between concrete, transitional, and formal student groups (p = 0.000).

The results of the different test analysis of problem-solving skills based on the level of students' logical thinking abilities showed that the percentage of the contribution of implementing collaborative learning in improving the problem-solving skills of prospective physics teacher students was different between the three groups of logical thinking ability categories. The formal student group experienced the highest and lowest increase in problem-solving skills in students with concrete logical thinking skills. Indirectly, the logical thinking ability variable becomes one of the factors that influence the improvement of problem-solving skills of prospective physics teacher students. Similar findings from Atay's research show that the ability to think logically has a fundamental role in student academic achievement, especially in constructing logical relationships between concepts to solve problems encountered [30].

4. Conclusions

Based on the result of study above, it can be concluded that 1) collaborative learning can improve problem solving skill of prospective physics teachers based on their logical thinking ability; 2) the logical thinking ability variable contributes to prospective physics teachers' problem–solving skills. Furthermore, students with formal category have improve their problem-solving skills higher than students with concrete and transitional category on electricity and magnetism topic.

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References

[1] NRC 1996 *National Science Education Standars* (Washington, DC: National Academy Press)

[2] NRC 2001 *Knowing What Student Know: The Science and Design of Educational* (Washington D.C: National Academy Press)

[3] Binkley M, Erstad O, Joan H, Raizen S, Ripley M, Miller-Ricci M, Rumble M 2012 *Assessment and Teaching of 21st Century Skills* **(**New York: Springer)

[4] Costa A.L 1985 *Developing Minds: A Resource Book for Teaching Thinking* (Alexandria, Virginia: Association for Supervision and Curriculum Development)

[5] Koenig J.A, Elliott S, Hilton M, and Iverson K 2011 *Assessing 21st Century Skills Summary of a Workshop* (Washington D.C: The National Academies Press)

[6] McGregor D 2007 *Developing Thinking Developing Learning: A Guided to Thinking Skills in Education* (USA: Education Press)

[7] Dossey J.A and Funke J 2016 Canadian and United States Students' Performances on the OECD's PISA 2012 Problem-Solving Assessment *Can. J. Sci. Math. Technol. Educ.* **16**, 1 p. 92–108.

[8] Freitas I M Jimenez R and Mellado V 2004 Solving physics problems: The conceptions and practice of an experienced teacher and an inexperienced teacher *Res. Sci. Educ.* **34**, 1 p. 113–133.

[9] Gok T 2012 The Impact of Peer Instruction on College Students' *Int. J. Sci. Math. Educ.* **10**, June 2011 p. 417–436.

[10] Gok T 2010 The General Assessment of Problem Solving Processes and Metacognition in Physics Education *Eurasian Journla Phys. Chem. Educ.* **2**, 2 p. 110–122.

[11] Krulik S and Rudnick J 1995 *The New Sourcebook for Teaching Reasoning and Problem Solving in Elementary School* United State of America: Allyn and Bacon

[12] Pólya G 1957 *How To Solve It* (New York: *Qucosa.De*)

[13] National Science Teachers Association 1985 *Science-Technology-Society: Science Education for the 1980's," in NSTA Handbook* Wasington, DC: National Science Teachers Association.

[14] Rahmawati R, Rustaman N Y, Hamidah I, and Rusdiana D 2017 The Use of Classroom Assessment to Explore Problem Solving Skills Based on Pre- Service Teachers' Cognitive Style Dimension in Basic Physics Course in *IOP Conf. Series: Journal of Physics: Conf. Series 812 (2017) 012047* p. 012047.

[15] Gustafsson P, Jonsson G, and Enghag M 2015 The Problem-Solving Process in Physics as observed when Engineering Students at University Level Work in Groups *Eur. J. Eng. Educ.* **40**, 4 p. 380–399.

[16] Gänswein W 2011 *Effectiveness of Information Use for Strategic Decision Making* (Netherlands: Gabler)

[17] Leach J and Scott P 2003 Individual and Sociocultural Views of Learning in Science Education *Sci. Educ.* **12**, 1 p. 91–113.

[18] Redish E F 1994 Implications of Cognitive Studies for Teaching Physics *Am. J. Phys.* **62**, 9 p. 796–803.

[19] Prince M, 2004 Does Active Learning Work ? A Review of the Research *J. Eng. Educ.* **93**, July p. 223–231.

[20] Harskamp E and Ding N 2006 Structured Collaboration versus Individual Learning in Solving Physics Problems *Int. J. Sci. Educ.* **28**, 14 p. 1669–1688.

[21] Heller P M, and Finley F N 1992 Variable Uses of Alternative Conceptions: A Case Study in Current Electricity *J. Res. Sci. Teach.* **29**, 3 p. 259–275.

[22] Benckert S, and Pettersson S 2008 Learning Physics in Small-Group Discussions - Three Examples *Eurasia J. Math. Sci. Technol. Educ.* **4**, 2 p. 121–134.

[23] Jonsson G, Gustafsson P, and Enghag M 2007 Context Rich Problems As an Educational Tool in Physics Teaching–A Case Study *J. Balt. Sci. Educ.* **6**, 2 p. 26–35.

[24] Enghag M, Gustafsson P, and Jonsson G 2009 Talking Physics during Small-Group Work with Context-Rich Problems - Analysed from An Ownership Perspective *Int. J. Sci. Math. Educ.* **7**, 3 p. 455–472.
[25] Tobin K G, and Capie W 1981 The Development and Validation of a Group Test of Logical Thinking *Educ. Psychol. Meas.* **41**, 2 p. 413–423.
[26] Hake R R 1999 *American Educational Research Association's Division D, Measurement and Research Methodology: Analyzing Change/Gain Scores* (USA: Woodland Hills)
[27] Garnett P J, Tobin K, and Swingler D G 2007 Reasoning Abilities of Secondary School Students Aged 13-16 and Implications for The Teaching of Science *Eur. J. Sci. Educ.* **7**, 4 p. 387–397.
[28] Tobin K G and Copie W, 1982 Relationship Between Formal REasoning Ability, Focus of Control, Academic Engagement and Integrated Process Skills Achievement *J. Res. Sci. Teaching.* **19 (1)**, 2 p. 113–121.
[29] Garnett P J, Tobin K, and Swingler D G 2014 Reasoning abilities of Secondary School Students Aged 13 - 16 and Implications for the Teaching of Science *European Journal of Science* December 2014 p. 37–41.
[30] Atay P 2006 *Relative Influence of Cognitive and Motivational Variables on Genetic Concept in Traditional and Learning Cycle Classrooms* (Middle East Technical University: Ankara)

Improvement of Scientific Analysis and Communication Skills through the Application of SSP Physics Topic Impulse Momentum Based on Traditional Games "Patah Kaleng"

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Abstract. The purpose of this study was to determine the improvement of students' scientific analysis and communication skills taught through the application of the SSP Physics Guided Inquiry learning model based on the traditional game "Patah Kaleng", especially the topic of impulse momentum. The research design was a quasy experiment, a type of pretest-postest control group design. All class XI MIA students of SMA Negeri 1 Biak Kota, Papua became the population in this study using simple random sampling technique. The experimental class is class XI MIA 5 and the control class is class XI MIA 2. The instrument consists of: (1) a formative analysis thinking test and (2) student scientific communication observation sheets. The data in this study were analyzed using normalized gain values, one-sided t-test, and descriptive percentages of students' scientific communication observation sheets. The results showed that: the students' scientific analysis and communication skills in learning using the SSP Physics Guided Inquiry learning model based on the traditional game "Patah Kaleng" were better than students who were taught using SSP Physics Direct Instruction learning model without traditional game.

Keyword: ssp physics, traditional game "patah kaleng", analytical skills, scientific communication, impulse momentum.

1. Introduction

Physics learning activities must be in accordance with the characteristics of physics as a natural science, which these characteristics include observing, asking, trying or collecting data, associating or reasoning activities, and communication activities, where this activity aims to build and train thinking skills analytical students. Students' analytical thinking skills are important because they can explore reasoning skills, lead to problem solving, and bridge creative abilities, besides that it can also be said to be the basic skills needed to develop higher order thinking skills.

The facts show that students' analytical thinking skills are still in the low category [1]. These facts are: (1) in the research conducted by Arifin, it was explained that the low average score of physics subjects was caused by the low ability to think analytically [1] and (2) from the results of observations made by Magfiroh which explained the average value. . The score of multiple choice test on analytical thinking skills was obtained 65.35 out of 100 [2]. Low analytical thinking skills can affect students' understanding of the material [3]. This can make it difficult for students in the problem solving process [4]. Many factors can cause low analytical thinking skills [4]. First, the implementation of the physics learning process is still centered on the teacher [5]. Second, the content is not contextual [6]. Third, students use a memory-based approach in physics problem solving activities [6]. This skill can be possessed by students because of a habit to train the mind with intuition and imagination that must be considered in expressing new possibilities, opening new perspectives, and generating new ideas from an experience [7].

A student is said to have the ability to think analytically when he is able to analyze and evaluate any information he receives appropriately. The ability to think analytically is impossible for students to achieve if the student has not mastered the cognitive aspects beforehand because the material in the concept of physics requires a lot of problem solving emphasizing the ability to think analytically, so that if the students' analytical thinking ability is low, it is feared that their learning outcomes will also be low [8].

As an educator, a teacher must create learning that is able to train students' ability to think analytically, find learning information independently and actively create cognitive structures in students [7]. The existence of interactive classes is a prerequisite for efforts to form optimal students' critical thinking skills, students are thinkers not being taught, and teachers act as mediators, facilitators, and motivators who help students in learning not teaching. This study aims to analyze students' abilities in analytical thinking. This is important as input for teachers in order to improve students' analytical thinking skills through appropriate learning designs.

Guided inquiry is a learning process that can provide students with problem solving and communication skills [10]. The learning context in this model is to help students gain analytical thinking skills and problem-solving thinking, students generate new knowledge of real-world problems [12]. Guided inquiry is an instructional model, starting with introducing relevant problems at the beginning of the instruction cycle and to provide context and motivation for students to follow the learning process [13].

In line with these problems, one method was applied in this study to apply the physics SSP based on the traditional game "patah kaleng" in the learning process. In this study, researchers used the guided inquiry learning model and Direct Instruction, where this study aims to analyze the analytical thinking skills and scientific communication of students in the experimental class and in the control class for the topic of impulse momentum. In this study, 7 aspects of analytical thinking skills were used, namely: (1) problem identification and making observations; (2) asking questions; (3) planning investigations; (4) collect data / information and conduct investigations; (5) analyzing data; (6) draw conclusions; and (7) communicating the results. In this study, researchers integrated analysis thinking skills in the learning process, through planning learning activities for students to formulate questions and problems, collect relevant information, take problem-solving actions, consider alternative thinking in an open manner, and communicate results and solutions.

In addition to analysis thinking skills, researchers also analyze students' scientific communication. In this study, scientific communication studied includes the realm of verbal scientific communication,

where the interaction occurs verbally between teachers and students when the learning process is in progress. In this study, the researchers also used the SSP Physics based on the traditional game "patah kaleng" as a set of learning used by the teacher in the learning process..

The physical SSP based on the traditional game "patah kaleng" is an integrated learning tool for traditional games from Biak Numfor Regency, Papua, namely "patah kaleng", which is a traditional game like soccer in modern times. Physics SSP based on traditional games "patah kaleng" is able to facilitate teachers and students in the learning process, assessment and evaluation of learning. Before the research was carried out, the researcher made observations at SMA N 1 Biak Kota, Papua as a research school. This observation activity aims so that researchers have a clear picture of the learning process that is taking place and the completeness of the facilities and infrastructure that support the learning process, so that it can be seen whether the method to be applied in this research is correct.

2. Metode Penelitian

Quasi Experimental Design Pretest-Posttest Control Group type has been used in research. In this study all class XI MIA students of SMA Negeri 1 Biak Kota, Papua were made the population. The sampling technique used was simple random sampling. This sampling technique requires 2 classes, each class consisting of 40 students. In the experimental group the SSP Physics Guided Inquiry learning model was applied based on the traditional game "patah kaleng", while in the control class the SSP Physics model was applied to the direct instruction learning model non traditional game. The dependent variable in this study includes students' scientific analysis and communication skills; While the independent variable is the application of the SSP Physics Guided Inquiry learning model based on the traditional game "patah kaleng".

The analytical ability score was obtained from the test instrument (pretest and posttest). The score of scientific communication skills was obtained from the observation sheet instrument. The data processing of the pretest and posttest scores used a two-way difference test, namely the right-hand t-test and N-gain test or gain factor test <g> [4]. The right-hand t-test was used to test the truth hypothesis while the N-gain test was used to determine the greatest increase in students' analytical skills before and after treatment. Students' scientific communication skills were analyzed by descriptive percentages.

Table 1. Research design.

Group	Pretest	Treatment	Posttest
Experimental Class	O_1	X_1	O_2
Control Class	O_1	X_2	O_2

Information in table is experiment class that is class XI MIA 5 using SSP Fisika Guided Inquiry learning model based on traditional game "patah kaleng", control class is class XI MIA 4 using SSP Fisika Direct Instruction learning model, O1 is pretest for experiment class and O2 is pretest for control class.

The scientific communication skills measured in this study are oral communication skills which include verbal and nonverbal communication. Six aspects assessed in student communication skills include: (1) organizing presentations; (2) delivery of content; (3) attitudes, methods and expressions of the body in conveying material to; (4) sound clarity during presentations; (5) time efficiency; and (6) responding to audience questions. Scientific communication skills are known from observation sheets. The ability to think analysis is known by using tests namely pretest and posttest.

The research flow consists of three stages, namely: the preparation stage before carrying out research, including making research instruments, testing research instruments, determining the population and samples. In the preparation stage, the researcher tested the homogeneity of the sample class. Furthermore, in the implementation stage, the researcher applies a planned "treatment" (applying the SSP Physics Guided Inquiry learning model based on the traditional game “patah kaleng” oriented

problem solving on the topic of impulse momentum. Using this model, students are asked to form groups and conduct experiments, discussion, and presentation in groups based on the student worksheet given. Before learning takes place, students are given a pretest to find out their initial knowledge, then after learning given a posttest to find out the knowledge obtained during learning. Scientific communication is observed through observation during learning takes place.

Data analysis includes analytic thinking analysis and analysis of scientific communication of students. The pretest and posttest data obtained were used to analyze students' analytical thinking skills, then the score was tested by one-sided t-test and normal gain to analyze the analytical thinking skills obtained by students in the experimental class and students in the control class. To analyze the scientific communication of students the researchers used observation sheets, where this data was used to see the percentage of students' success on each indicator.

3. Results and Discusion

The results obtained in this study included students' analytical thinking and scientific communication skills. The data obtained for the results of students' analytical thinking and scientific communication skills before and after learning for the topic of impulse momentum in the experimental class and control class can be seen in the table.

Table. 2 Data on the results of students' analytical thinking and scientific communication skills for the topic of impulse momentum

Class		Indicator	Pretest	Postets	T count	T table	Description	Normal (gain)
Experiment	Analysis thinking	Highest score	50	100	3,82	2.00	Significance (high)	.82
		Lowest score	30	75				
		Average	35	85				
	Communication Scientific	84.37% (Very Good)						
Control	Analysis thinking	Highest Score	30	80	3.82	2.00	Significance (moderate)	.63
		Lowest score	15	50				
		Average	35	65				
	Communication Scientific	72.54% (Good)						

The results of the calculation in table 2 show that the price of t count > t table then H_0 is rejected, so it can be concluded that the analytical skills of the experimental group students who use SSP Physics Guided Inquiry learning model based on traditional game "patah kaleng" are better than learning SSP Physics based on direct instruction learning model non traditional game.

Based on the N-gain test, the value of <g> was obtained for the experimental group 0.82 (high), while the control group was 0.63 (moderate). The results of this study are in line with the fact that the application of the Guided Inquiry learning model can improve students' analytical skills maximally [5]. The results obtained by the control group were <g> = 0.66 (moderate) and the experimental group <g> = 0.70 (high) which [1] concluded that the experimental group experienced a higher analytical ability than the control group. Sari also said that the application of problem based learning models can improve students' analytical skills in implementing learning activities and students become the focus in implementing learning [3]. Sastradika states that inquiry-based learning even though it is required to think deeply by solving problems given by the teacher, inquiry-based learning can actually improve test results [10].

One of the factors of students' analytical skills can be increased, namely because the learning process uses SSP physics guided inquiry learning model based on the traditional game "patah kaleng", where this learning requires students to be more active in the learning process, where the intended student activity is active in seeking information, determine the topic of discussion, investigate problems, analyze, discuss, and present the findings [11]. In addition, the application of using the SSP physics guided inquiry learning model based on the traditional game "patah kaleng" in the learning process can increase student activity and participation in finding material (information) by themselves using the help of various learning resources such as relevant learning books or using the internet, especially material that is integrated with games traditional "patah kaleng" [10], [11]. Reading various references, it can directly increase the knowledge of students, so that it can encourage students' analytical skills.

The syntax in the Guided Inquiry learning model makes students accustomed to collaborating with group members, where each student feels responsible for the results they get so that students are motivated to work together in collecting facts from various sources to analyze a problem topic to get better learning outcomes. well. This is in accordance with the opinion [12] that each student is responsible for using his or her abilities intensively in collaborative investigation activities to find solutions to a problem, and plays an active role in discussions, so as to make the focus of students' thinking more focused on studying and finding solutions to a problem, and make students able to analyze in depth.

In the Guided Inquiry learning model, the guiding stage is the most important stage because in the learning process the teacher acts as a guide / guide for all students as long as students build new understandings while carrying out the investigation process, where each student must collect facts from various reliable sources for analyze a problem topic [12]. After all the necessary materials have been collected, group members exchange opinions, discuss, clarify and analyze all the ideas and facts they find. This was also revealed by [10] that conducting investigations can improve analytical thinking skills because students get a lot of information from the references they get.

3.1. Analyze thingking skill

The results of the analysis show that the analysis thinking skills of students in the topic of impulse momentum in the experimental class using the SSP physics model of Guided Inquiry learning based on the traditional game "patah kaleng" were higher than the control class using the SSP physics model of Direct Instruction learning. The improvement of students 'analysis thinking skills using SSP physics Guided Inquiry learning model based on the traditional game "patah kaleng" is caused because in the learning process students follow systematic settlement steps in Guided Inquiry learning which can improve students' analysis thinking skills. The results of the gain test analysis showed an increase in the analysis thinking skill of the experimental class and the control class. The gain score category for the experimental class is high and the control class is moderate. Analysis thinking skills of students, both experimental and control classes have increased, where the analysis shows that the increase in analysis thinking skills in the experimental class is better than the control class.

The analysis of the hypothesis test results showed that the average analysis thinking skill of the experimental class students through the application of the SSP physics Guided Inquiry learning model based on the traditional game "patah kaleng" was higher than the average analysis thinking skill of the control class students. The results of the average significance test for the increase in students' analysis thinking skills showed the same results as the results of the gain test analysis, where there was a significant increase in the experimental class. The atmosphere in the learning process requires students to be active during learning, namely to be active in finding creative solutions to problems, actively interacting with other groups through specific observation activities, group discussions, and class discussions, and presenting to the class [13]. The involvement of students in the learning process has a positive impact in increasing the analysis of students' skills [14], it can be seen from the results of the N-gain test that the value of <g> for the experimental group is 0.82 (high), while the control group is 0.63 (moderate). Overall, it can be seen from the average N-gain value, the increase in the analytical

skills of students is in the high category. It can be said that the application of the SSP Physics Guided Inquiry model based on the traditional game "Patah Kaleng" can improve students' analytical skills.

3.2. Scientific communication skill

Table 2. shows the percentage of students' scientific communication skills in the experimental class and students in the control class. The average score of students' scientific communication skills in the experimental class was higher than the average scientific communication skills of students in the control class. The aspect of sound clarity during presentation in the experimental class has the highest percentage compared to other aspects, the percentage of sound clarity during presentation in the experimental class is higher when compared to the control class, so it can be seen that the ability of experimental class students in sound clarity during presentation is better than control class. The experimental class uses the SSP physics model of Guided Inquiry learning based on the traditional game "patah kaleng", where in the learning process emphasizes process skills in solving problems, the researcher is only limited to guiding students and then through group discussions, students try to communicate their creative ideas to solve problems. . The argumentation stage, requires students to play an active role in groups, in contrast to the control class that uses the SSP physics learning model Direct instruction, where in this learning students still have a dependence on the teacher in solving a problem, so the expression of opinions in the control class is still low. The low score of students in the fourth aspect of both the experimental and control classes is because students are not used to making presentations in front of the class. Students tend to be shy in delivering the content of the presentation material. Nearly 30% of students still do not have the courage to make eye contact with the audience (peers) and present a presentation in a way that is not interesting to follow.

Physics SSP Guided Inquiry learning model based on the traditional game "patah kaleng" provides the widest possible opportunity for students to find as much information and facts as possible from trusted sources, to put forward creative ideas to solve a problem [10]. In the learning process, there are stages of expressing ideas, where this stage frees all students to express their opinions, the teacher is only a facilitator, where the teacher's task is to collect and listen to student opinions and give good appreciation for each student's opinion, not to evaluate each other's opinions each student [15]. The application of the SSP Physics Guided Inquiry learning model based on the traditional game "patah kaleng" can improve students' scientific communication skills [16]. There is an increase in scientific communication skills orally in students who follow learning with innovative and creative learning models and learning methods [17].

Analysis of the measuring skill measured in this study is seen from the normalized gain (N-gain). The application of the SSP physics Guided Inquiry learning model based on the traditional game "patah kaleng" in the learning process is said to be effective in improving the analysis of students' skills if more than 75% of students achieve a gain index with the criteria "medium" to "high". N-gain was obtained from the results of the students' pretest and posttest in the field test. N-gain analysis of students' pretest and posttest results. For the explanation of the N-gain results can be seen in the graph in Figure 1.

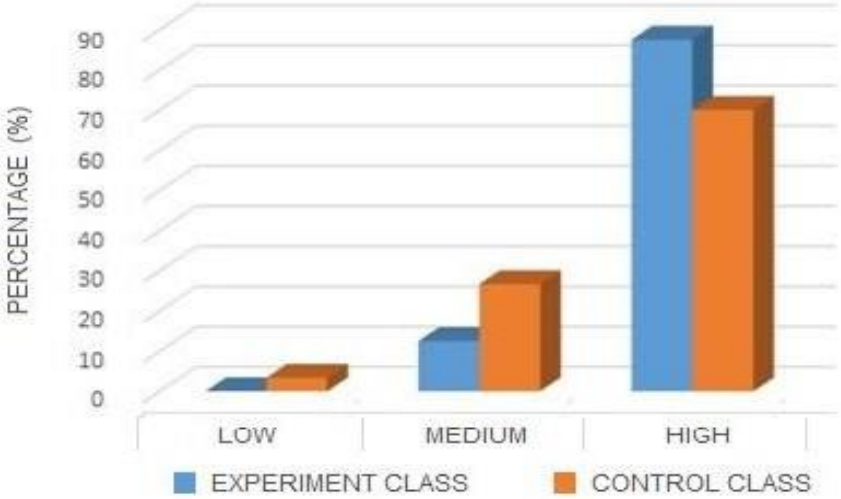

Figure 1. Comparison of the percentage of students' analysis thinking skills in the experimental class and the control class

Based on Figure 1, it can be seen that the average N-gain in the experimental class is 89% with a high gain index, 10.00% with a moderate gain index, and 0% with a low gain index. The average N-gain in the control class is 78% with a high gain index, 28% with a moderate gain index, and 5% with a low gain index. Based on the results obtained, it can be seen that the N-gain with a high and moderate gain index is more than 75%, so it can be said that the application of the SSP physics guided inquiry learning model based on the traditional game “patah kaleng” application in the learning process is very effective in improving students' analysis thingking skills.

The increase in students' analysis thinking skills in the experimental class was due to the fact that students were familiar with the traditional game "Patah Kaleng", making it easier for students to understand the concepts of momentum and impulse. All parts of this traditional game can provide an overview of the concepts of momentum and impulse because in it there is the activity of running after the ball (momentum), kicking the ball (impulse), colliding between players, colliding between balls hitting cans (kaleng).

In general, the analytical thinking level of the experimental class students (class XI MIA 5) after participating in the learning process using the SSP physics guided inquiry learning model based on the traditional game "patah kaleng" increased from the results of the pretest and posttest scores. This can be seen from the percentage analysis of thingking skills of class XI MIA 2 students which is presented in the graph in Figure 1.

The results of the increase in students' scientific communication skills after using the SSP physics guided inquiry learning model based on the traditional game "patah kaleng" are presented in Figure 2, where the scientific communication skills in the experimental class were better than the control class. Figure 2 shows the N-gain average of the results of the analysis thinking skill in terms of scientific communication skills.

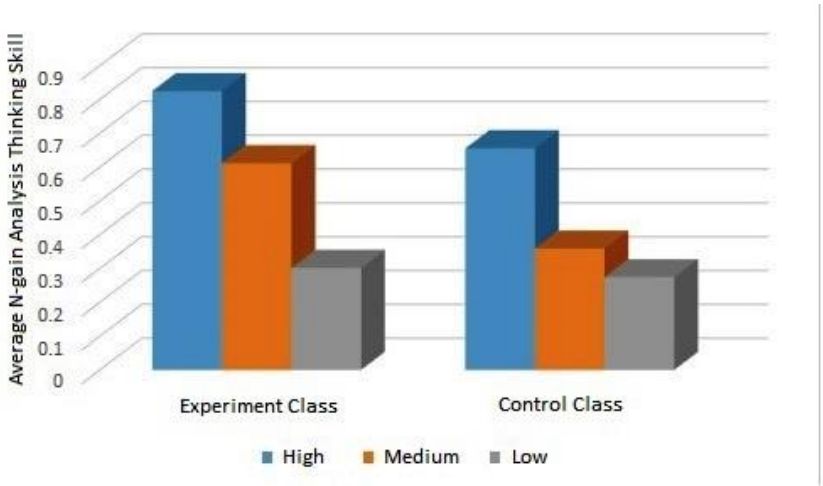

Figure 2. Average N-gain Analysis Thinking Skill judging from Scientific Communication Skill.

From the results of the graph data in Figure 2, it can be seen that for the overall average N-gain value of the experimental class is better than the average N-gain value of the control class, where for the analysis thingking skills the experimental class is in the higher category inversely proportional to the control class N-gain average. Likewise, the average N-gain value of the scientific communication skills for the experimental class was higher when compared to the control class, even though the two sample classes were both in the moderate category. This can happen because students who have good scientific communication skills will find it easier to understand learning material and easier to convey ideas / ideas and easier in discussing with friends, so that the learning outcomes they achieve will be better [18]. The research results obtained in this study are in line with the results of research conducted by [18] which states that high scientific communication skills will make it easier for students to discuss, find information, analyze and evaluate data and make reports, so that it can affect learning achievement, so there is a correlation. between these two variables, where the higher the scientific communication skill, the higher the analysis thingking skill, conversely the lower the scientific communication skill, the lower the analysis thingking skill [19]. A number of research findings, among others, confirm that students at the beginning of guided inquiry learning because of the many activities they have to do on their own, students' skills grow and are able to build their own knowledge [26].

Learning with the guided inquiry model requires students to carry out experiments, specifically on the concept of momentum and impulse, students are directed to learn this subject matter directly by observing, investigating, analyzing the surrounding environment, and communicating the results of the discussion [27]. So that the application of Guided Inquiry learning based on the traditional game "Patah Kaleng" can improve students' analytical skills. Based on the results of the study, the scientific communication skills of experimental class students who apply the SSP physics model of Guided Inquiry learning based on the traditional game "Patah Kaleng" have good criteria, because [28] the learning process is student centered while the teacher acts as a facilitator, which In learning activities students are more intensive in making and compiling discussion results based on observations in the surrounding environment. This is in accordance with the findings [29] which stated that the steps in guided inquiry learning stimulate students to be actively involved in learning and with guided inquiry learning students become more active so that students can communicate with each other. Communication can be done through writing, pictures (graphics, charts), reading and speaking (discussions, presentations) [30]. Whereas in the control class that applies SSP physics, the direct instruction without traditional game learning model has sufficient criteria. Sarwi's findings suggest that guided inquiry learning is effective for developing scientific communication skills for prospective physics teacher students [31].

It can be concluded that the experimental class students who use the SSP physics application of the Guided Inquiry learning model based on the traditional game "Patah Kaleng" can achieve higher scientific analysis and communication skills. Learning with the Guided Inquiry model has a syntax,

includes instruction with real experiments, learning experiences that students find will last longer and makes the process of remembering consciously [27]. These results are in line with the findings of Bilgin [32] who described guided inquiry as a student-centered approach that has a positive effect on student academic success and develops scientific process skills and student scientific attitudes.

The average student gain value data obtained is tested first with the Kolmogorov Smirnov test, this is so that researchers know whether the data obtained is normally distributed. The results obtained from the Kolmogorov Smirnov test for each sample class, namely 0.943 and 0.816 with the criteria for the asymp.sig (2-tailed) value ≥ 0.05, so that the gain data for both sample classes were normally distributed. The N-gain data was then tested using the homogeneity test, to determine the variance in the two sample classes. Kolmogorov Smirnov test results show the sig value. greater than 0.05, namely 0.931, which means that the data gain is homogeneous in the two sample classes.

Table 3. The average n-gain value of analysis thinking skills in terms of students' scientific communication skills.

Student scientific communication	Average N-gain of analysis thinking	
	Experiment class	Control class
High	.8421	.6417
Medium	0.6215	.3644
Low	0.3114	.2846

The difference in the average gain value of student learning outcomes is due to the application of different SSP physics in the experimental class and control class, where the SSP physics guided inquiry model is used based on the traditional game "patah kaleng" in the experimental class, and the SSP physics model is used in the Direct Instruction class control. The results obtained are consistent with the results of research conducted by [21], where the scores of students taught using SSP physics guided inquiry model based on traditional games "patah kaleng" were better than students taught with SSP physics model Direct Instruction. The results obtained in this study are in line with research conducted by [22] where the learning outcomes obtained by students are very significant differences, due to the guided inquiry model that is applied, in which the guided inquiry model provides the opportunity for students to collect reliable facts, develop their abilities thinking logically, analytically, systematically, creatively, and critically, which ultimately results in maximum learning outcomes [14]. Students' scientific communication skills have three criteria, namely high, medium, and low. The students' scientific communication skill criteria for the average gain value analysis thinking skill are presented in Table 3.

From the results of Table 3 presented, it can be seen that students who have high scientific communication skills criteria, then the analysis thinking skills they get will be high. Scientific communication skills possessed by each student will affect the results of analysis thinking skills they achieve. The results obtained in this study are in line with research conducted by [23] where there is a significant influence between scientific communication skills on student achievement. There is a positive correlation between scientific communication skills and learning outcomes, where if students have high scientific communication skills, the learning outcomes obtained are also better than students who have low scientific communication and analysis thinking skills [24].

The overall results of this study indicate that in order for the ability of analysis thinking skills and scientific communication skills to develop properly in the learning process, what must be done is to use the right learning model and integrate it with local local wisdom, making it easier for students to understand and learn the concepts. concepts of physics [25].

4. Penutup

Based on the results of data analysis and discussion, it can be concluded that the students' scientific analysis and communication skills can be improved by using the SSP Physics Guided Inquiry learning model based on the traditional game "patah kaleng". Suggestions that can be given in this study are

important so that teachers condition students to be ready to carry out learning activities by providing guidance on implementing activities clearly and in detail. The application of appropriate learning can improve students' scientific analysis and communication skills

References

[1] V Serevina, Raihanati and W Andriana, 2020. "Development of website on general physics subject to increase analytical skills of students", *J.Phys.Conf.Ser The 2nd International Conf.on Research and Learning of Physics*., **vol 1481**. hlm 012081

[2] A A I A Putra, N S Aminah, A Marjuki, and Z S Pamungkas, 2020. "The profile of student's problem solving skill using analytical problem solving test)apst) on the topic of thermodynamic", *J.Phys.Conf.Ser 6th International Conf.on Mathematics, Science, and Education (ICMSE).*, **vol 1567**. hlm 032082

[3] R Sari, R Perdana, Riwayani, Jumadi, I Wilujeng and H Kuswanto, 2019. "The implementation of problem-based learning model with online simulation to enhance the student's analytical thingking skill in learning physics", *IOP Conf. Ser: J.Phys.Conf.Ser*., **vol 1233**. hlm 0120230

[4] Arifin & Khanafiyah, 2011. "Penerapan Model Pembelajaran Aktif Melalui Strategi Rotating Trio Exchange untuk Meningkatkan Kemampuan Analisis dan Aktivitas Belajar Siswa SMA Kelas X Semester II Pokok Bahasan Kalor", *Jurnal Pendidikan Fisika Indonesia*.

[5] Magfiroh & Sugianto, 2011. "Penerapan Pembelajaran Fisika Bervisi SETS untuk Meningkatkan Kemampuan Berpikir Analisis Peserta Didik Kelas X", *Jurnal Pendidikan Fisika Indonesia*.

[6] Ikhwanuddin, 2010. "Problem Solving dalam Pembelajaran Fisika untuk Meningkatkan Kemampuan Mahasiswa Berpikir Analitis", *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, **vol 40**. hlm 2580-5533

[7] Anwari, 2017. "The Implementation of Collaborative-Based Guided Discovery Reviewed from Student's Analytical Thinking Skills and Social Skills", *Jurnal Inovasi Pendidikan IPA*., **vol 3**. hlm 128-136

[8] Savira, Budi and Supriyati, 2019. "Pengembangan E-Modul Materi Momentum dan Impuls Berbasis Process Oriented Guided Inquiry Learning (POGIL) untuk Meningkatkan Kemampuan Berpikir Tingkat Tinggi Siswa SMA Kelas X", *Prosiding Seminar Nasional Fisika***.**

[9] Agustin, Yuliati and Zulaikah, 2016. "Kesalahan Siswa SMA dalam Memecahkan Masalah Momentum-Impuls", *Prosiding Seminar Nasional Pendidikan IPA Pascasarjana UM*

[10] D Sastradika and Jumadi, 2018. "Development of subject-specific-pedagogy based on guided inquiry about newton's law to improve senior high school students' scientific literacy ability", *IOP Conf. Ser: J.Phys.Conf.Ser ICRIEMS 5*., **vol 1097**. hlm 012017

[11] F P Sari, S Nikmah, H Kuswanto and Wardani, 2019. "Developing physics comic media a local wisdom: sulamanda (engklek) traditional game chapter of impulse and momentum", *IOP Conf. Ser: J.Phys.Conf.Ser ICRIEMS 6*., **vol 1397**. hlm 012013

[12] Kuhlthau, Maniotes and Caspari, 2007. "*Guided Inquiry: Learning in 21st Century School*. USA: Greenwood Publishing Group.

[13] Alberta, 2014. *"Focus on inquiry: a teacher's guide to implementing inquiry-based learning".* Canada: Alberta Learning

[14] Sudjit, Paiboon dan Pairoaj, 2012. "The Model of Analytical Thinking Skill Training Process Research", *Journal of Applied Sciences* **vol 7**. hlm 17-20.

[15] E A Patriot, A Suhandi and D T Chandra, 2018. "Optimize scientific communication skills on work and energy concept with implementation of interactive conceptual instruction and multi representation approach", *IOP Conf. Ser: J.Phys.Conf.Ser International Seminar of Mathematics, Science and Computer Science Education*., **vol 1013**. hlm 012029

[16] S Sarwi, N Fauziah and B Astuti, 2018. "The analysis of scientific communications and atudents' character development through guided inquiry learning", *IOP Conf. Ser: J.Phys.Conf.Ser ICMSE.*, **vol 983**. hlm 012031

[17] A E Kusuma, Wasis, E Susantini and Rumansyah, 2020. "Physics innovative learning: RODE

learning model to train student communication skills", *J.Phys.Conf.Ser 1st IC-MSCEdu.*, **vol 1422**. hlm 012016
[18] D Oktasari, Ismet and S M Siahaan, 2020. "Validation construct: confirmatory factor analysis (CFA) instruments scientific communication skills students in learning physics", *IOP Conf. Ser: J.Phys.Conf.Ser ICMSE.*, **vol 1567**. hlm 032095
[19] S Sapriadil, A Setiawan, A Suhandi, A malik, D Safitri, S A S Lisdiani and N Hermita, 2018. "Optimizing students' scientific communication skills through higher order thinking virtual laboratory (HOTVL)", *IOP Conf. Ser: J.Phys.Conf.Ser International Seminar of Mathematics, Science and Computer Science Education.*, **vol 1013**. hlm 012050
[20] A R N Firmansyah, D T Chandra, I Kaniawati, A Samsudin, H Novia, and P Siahaan, 2019. "Development of MBI_2 as interactive media in order to enhance scientific communication skills in global warming subject", *J.Phys.Conf.Ser MSCEIS 2018.*, **vol 1422**. hlm 012016
[21] D Afriani, I Wilujeng, Jumadi and H Kuswanto, 2019. "Implementation of problem based learning model assisted edmodo to measure students scientific communication skills", *IOP Conf. Ser: J.Phys.Conf.Ser International Seminar on Science Education.*, **vol 1233**. hlm 012041
[22] D Diniya, D Rusdiana, and H Hernani, 2019. "Promoting coupled-inquiry cycle through shared curricular integration models to enhance students argumentation", *IOP Conf. Ser: J.Phys.Conf.Ser ICMScE 2018.*, **vol 1157**. hlm 022029
[23] D F Rahman, D T Chandra, and S Anwar, 2019. "Development of an integrated science teaching material oriented ability to argue for junior high school student", *IOP Conf. Ser: J.Phys.Conf.Ser ICMScE 2018.*, **vol 1157**. hlm 022056
[24] E Erwin, N Y Rustaman, H Firman and T R Ramalis, 2019. "Profile of the prospective teachers response to the development of scientific communication skills through physics learning", *IOP Conf. Ser: J.Phys.Conf.Ser ICMScE 2018.*, **vol 1157**. hlm 032040
[25] N L Makhmudah, Subiki, Supeno, 2019. "Pengembangan model fisika berbasis kearifan lokal permainan tradisional Kalimantan Tengah pada materi momentum dan impuls", Jurnal Pembelajaran Fisika., **vol 8**. hlm 181-186
[26] L Schifman *et al*, 2013. "Sleuthing Through the Rock Cycle_: An Online Guided Inquiry Tool for Middle and High School Geoscience Education", Journal Geoscience Education., **vol 61**. hlm 268–279
[27] C J Wenning, 2011. "The Levels of Inquiry Model of Science Teaching", J. Phys. Teach. Educ., **vol. 6**, no. 2. hlm 9–16
[28] H Fives, W Huebner, A S Birnbaum and M Nicolich, 2014. "Developing a Measure of Scientific Literacy for Middle School Students", Science Education., **vol. 98**. hlm 549–580
[29] C Gormally, P Brickman, and M Lut, 2012. "Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments", Science Education., **vol 11**, no.4. hlm 364-377
[30] L Praptiwi, Sarwi, and L Handayani, 2012. " Efektivitas model pembelajaran eksperimen inkuiri terbimbing berbantuan My Own Dictionary untuk meningkatkan penguasaan konsep dan unjuk kerja siswa SMP RSBI", Unnes Science Educational Journal. **vol 1.** hlm 1-10
[31] Sarwi, A Rusilowati, and S Khanfiyah, 2013. "Implementasi model eksperimen gelombang Open-Inquiry untuk mengembangkan keterampilan komunikasi ilmiah mahasiswa fisika", Jurnal Pendidikan Fisika Indonesia., **vol 9**. Hlm 123-131
[32] I Bilgin, 2009. " The effect of guided inquiry instruction incorporating a cooperative learning approach on university students' achievement of acid and bases concepts and attitude toward guided inquiry instruction", Sci. Reaserch Essay., vol **4.** hlm 1038-1046

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Design of prototype early warning system cold lava flood using FSR 402 sensor based on ATMega 328P microcontroller

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Abstract. A prototype of early warning system cold lava flood has been successfully designed in laboratory-scale. This research aims to design a prototype of early warning system cold lava flood with FSR 402 sensor in laboratory-scale 1:3500, to know how to characterize FSR 402 sensor, to know the classification levels of cold lava flood disaster in laboratory-scale based on voltage parameter and to simulate an EWS device of cold lava flood in laboratory-scale. The planning process was divided into two steps, the first step was designing a hardware and software. The second step was simulating this device by using three fluid's samples. This device produces four classification levels of cold lava flood disaster: Normal (<1600mV), Watch (≥1600 to <3200mV), Advisory (≥3200 to <4800mV) and Warning (≥4800mV). So, this EWS can sound an alarm and display disaster information through LCD 1602.

1. Introduction

Indonesia is located in the pacific ring of fire so that it has many active volcanoes. One of the active mountains in Indonesia especially in the special region of Yogyakarta is Mount Merapi. Mount Merapi has been active since 1900 until now with short period of rest on average no more than 3,5 years. Mount Merapi is a permanent disaster threat (Voight et al., 2000) [1]. The Sleman Regency Government has established 9 villages in Glagaharjo that are prone with eruption and cold lava floods of Mount Merapi, namely Palemsari, Pangukerjo, Kaliadem, Petung, Jambu, Kopeng, Kalitengah Lor, Kalitengah Kidul, and Srunen (Herianto, 2012) [2]. The impact of the eruption can potentially cause cold lava flood in Kali Gendol, Kali Kuning, Kali Opak, Kali Woro, Kali Senowo, Kali Lamat, Kali Putih, Kali Krasak, Kali Boyong, and Kali Bedog. Cold lava flood happened because of the high rainfall in mountain slope (2.600 - 3.000) mm (DGWR,2001b) [3] and data on several rivers of Mount Merapi show that the flood mostly flows in Kali Putih. Besides, Kali Putih is a densely populated area (BNPB, 2011) [4]. The eruption materials were brought along with this cold lava flood in the form of sand, gravel and large stone, so the river often has large boulders left behind. The efforts to reduce fatalities due to cold lava floods are by doing a preventive disaster mitigation process in the form of an early warning system. The similar work that has been done before was that the warning was conveyed by SMS and WEB containing information about the cold lava flood indicated by the sound signal and the water level. This research describes an Early Warning System (EWS) for cold lava flood in the form of a prototype with an FSR 402 sensor using Arduino Uno atmega 328P. The results of this information will be conveyed by LCD 1602 and alarm.

2. Circuit and Fundamental Theory

2.1. FSR 402 Sensor

FSR is a thin polymeric material that has decreased resistance when given a load on its surface. The sensor has a diameter of 18.28 mm, 0.46 mm thick, 6 cm long with 2 feet of positive and negative feet. This sensor is able to operate with a force of more than 50kg and converts forces to pressure. This FSR sensor uses a voltage divider configuration with +5 volt input. The FSR 402 sensor requires a minimum system circuit using resistors for optimal results. Resistor has a function to limit the number of current flowing in a circuit. From the ohms law, that the resistance is inversely proportional to the amount of current flowing through it (Ruri, 2013) [5].

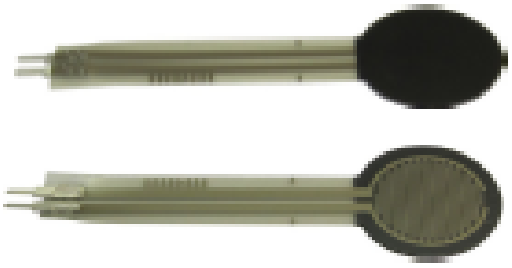

Figure 1. FSR 402 Sensor (www.interlinkelectronics.com)

2.2. Power Supply Circuit

Power supply is a device that is used to provide the voltage of electronic equipment by changing the voltage output level according to the electronic equipment. This circuit uses non-CT transformer 1 Ampere to reduce the voltage from 220 Volts to 5 Volts and 12 Volts. Here is the picture of the series in **Figure 2**.

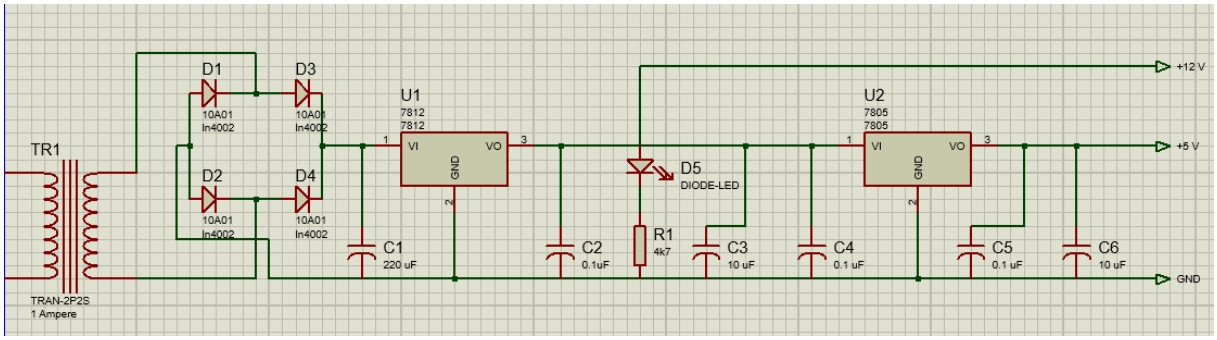

Figure 2. Power Supply Circuit

2.3. Arduino Uno

Arduino Uno is a hardware as well as software that is used to manufacture prototypes in a microcontroller-based electronic circuit. This research used Arduino Uno with ATmega 328P microcontroller.

2.4. Alarm

An alarm is defined as a warning or notification sound. In early warning system, the alarm is used to notify the people when there is a disaster. The main component of the alarm is a buzzer or an electronic component that has functions to convert the electrical vibrations into sound vibrations. Basically, the principle of the buzzer is almost the same as the loudspeaker. The buzzer consists of a coil mounted on the diaphragm and when the coil is flowed by electric current, it becomes an electromagnet. The coil will be pulled in or out, depending on the direction of the current and the

magnetic polarity. Each movement of the coil will move the diaphragm back and forth to make the air vibrate and later will produce sound (Efrianto, 2016) [6].

2.5. LCD 1602

LCD is one of the important components in making this research because the LCD can display the commands that must be run by the user (Yusuf, 2009)[7]. The size of the LCD that is used in this research is 16x2, means that the LCD has 16 characters with 2 lines. The LCD works by receiving the data from the microcontroller by D1-D7 on the LCD. The LCD requires a voltage of +5 VDC and only needs low power. At the time of receiving the data, pin 5 LCD (R (Read) / W (Write)) must be set into logic 0 and logic 1, so that it can send the data to the microcontroller. If RS (Register Select) = 0 and R / W = 0, data will be written to DDRAM. Meanwhile, if RS and R / W with logic 1 read the data from DDRAM to the DR register, the characters that be displayed on the screen are stored in DDRAM memory (Mazidi, 2011)[8].

3. Working Principle

This device consists of three circuit blocks, namely the power supply circuit, the minimum sensor system FSR 402, the alarm and the minimum LCD 1602 systems. The way of this device works is as follows.

- The power supply lowers the voltage from 220 volts to 12 volts to activate Arduino Uno.
- Pouring fluid samples A (Water), fluid B (Water, Sand, Soil, Gravel), fluid C (Water, Sand, Soil, Gravel, Stone) alternately on the Kali Putih river replica.
- This fluid will push down the FSR 402 sensor, the sensor will produce an output voltage.
- The output voltage is used for the classification process of the level of cold lava flood disaster.
- The display on the LCD screen and alarm will work according to the results of the classification.

4. Materials, Components and Device's Construction

The tools and the materials used in this study are saws, electric drill, cutting pliers, solder, melzer grinder 5 MD-125C, DT830B digital multimeter, screwdriver, power supply, hammer, arduino uno, glass, tenol, project board, PCB, sterofoam, glue, plugs, aluminium, wood beams, iron plates, acrylics, bolts and bearings. Then, the components used in this circuit are LCD 1602, 1 Ampere non-CT transformer, Elco (2200 microfarad 25 volts, 0.1 microfarad 50 volts) buzzer QC Passed 3-24 Volt DC, LED, resistor (100K Ohm, 47K Ohm, 30K Ohm, 10K Ohm, 3K Ohm), IC cooler, DC connector, IC 7812, IC 7805, In4002 diode, 10K Ohm potentiometer, and FSR 402 sensor. To compile the EWS device, the researcher firstly created a 1: 3500 scale Kali Putih river replica scheme and made a tub sized 70cm x 35cm x 30cm from acrylic as a place of testing then arranged the FSR 402 sensor buffer.

Figure 3. Circuit of EWS

Figure 4. Prototype of EWS

The circuit shown in **Figure 3.**, assembles the power supply with an output 12 volts by using IC regulator 7812. Next step is assembled each block such as the FSR 402 sensor minimum circuit block,

alarm block, and 1602 LCD minimum circuit block. This device program uses the C ++ language on the Arduino Uno application. **Figure 4.** Displayed the prototype of EWS aluminium to simulate the 3 samples of cold lava flood in laboratory-scale. If the fluid flows to the prototype, this will give pressure to the FSR sensor which causes the voltage to change. The next process is in Arduino Uno, forwarded to the LCD and the alarm according to the disaster level.

5. Result and Discussion

In this research, the characterization process of the FSR 402 sensor is performed using the minimum sensor FSR 402 system. The component which is used as the minimum system is a resistor. The process of determining the value of resistor is based on the information in the datasheet. The result is shown through **Figure 5**. Then, the sensitivity analysis is displayed in **Figure 6**.

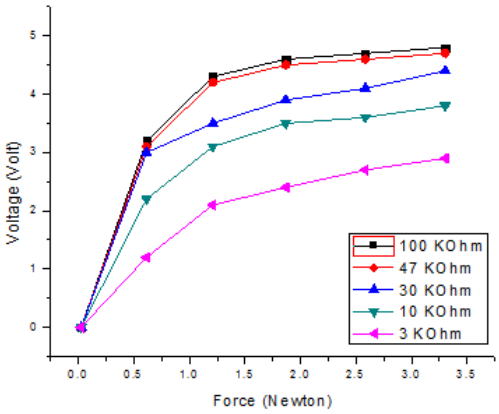

Figure 5. Result of characterization FSR 402 sensor

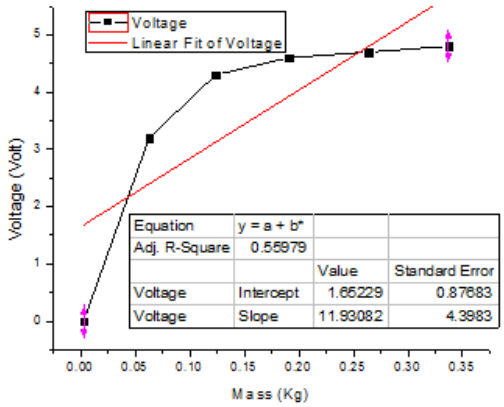

Figure 6. Result of sensitivity FSR 402 sensor

Based on the characterization process on **Figure 5.**, the minimum FSR 402 sensor circuit system uses a 100K Ohm resistor for the optimum FSR 402 output sensor. The graph means that the response of the FSR 402 sensor has a maximum limit of the output voltage value 4.8 Volts. If a mass load is added, the output voltage remains at its maximum limit and do to change the voltage. The result of the FSR 402 sensor output voltage will be optimum if it uses the right resistor for the minimum circuit system. The 100K Ohm resistor is used because it gives higher voltage output. Meanwhile, **Figure 6.** shows the FSR 402 sensor sensitivity result that is analysed using mathematical calculation to determine the pressure with the following equation. The slope sensitivity result was 11.9 which means that if 1 kg mass is added, the voltage increase 11.93 volt.

Assume that the magnitude of gravitational acceleration:

$$g = 9.8\, {}^{m}/_{s^2} \tag{1}$$

Then, to determine the force, the researcher uses this equation.

$$w = mxg \tag{2}$$

Where :

w = Force ($Newton$)
m = Mass (Kg)
g = Gravity (${}^{m}/_{s^2}$)

And the pressure:

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

(3)

Where :

P = Pressure ($^{N}/_{m^2} = Pa$)
w = Force ($Newton$)
A = Surface Area (m^2)

This device is designed with a 12 volt output power supply that has been compared to a power supply device and produces a graph in **Figure 7**.

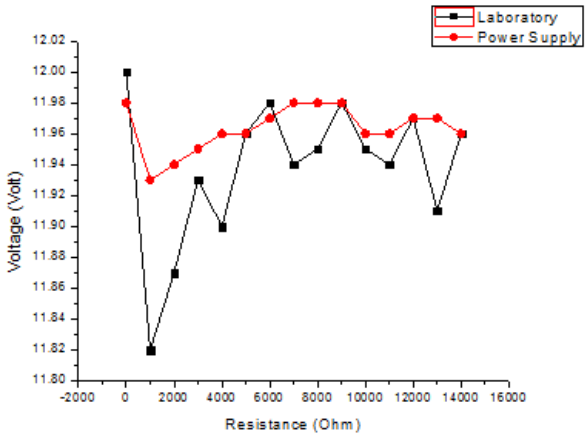

Figure 7. The result of power supply comparison

A power supply with an output voltage of 12 volts is used as an Arduino Uno voltage source. Based on the result of power supply comparison, it has an error of 0.17% and the error limit is included in the error tolerance that has maximum limitation 10%. The classification of normal information by using this EWS device with an alarm and a LCD is presented in **Figure 8. Figure 9** shows watch information and the alarm sounds is 1 second, while **Figure 10** shows advisory information with the alarm sounds is 2 second. Meanwhile, **Figure 11** shows warning information and the alarm sounds is 4 second.

Figure 8. Normal status LCD display

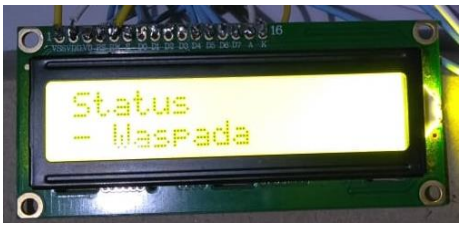

Figure 9. Watch status LCD display

Figure 10. Advisory status LCD display

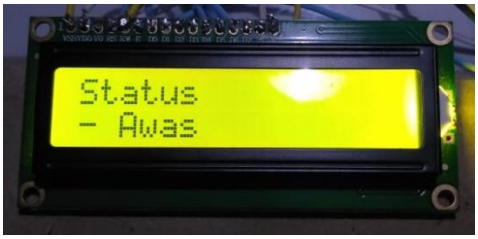

Figure 11. Warning status LCD display

Based on the characterization of the FSR 402 sensor, the results of the classification level of cold lava flood disaster in laboratory scale are as follows.

Table 1. Classification of cold lava flood laboratory-scale

Voltage		Classification
(Volt)	(Milivolt)	
0 s/d 1.599	0 s/d 1599	Normal
1.6 s/d 3.199	1600 s/d 3199	Watch
3.2 s/d 4.799	3200 s/d 4799	Advisory
≥ 4.8	≥ 4800	Warning

These results have been tested with 3 fluid samples in a Kali Putih river replica of 1: 3500 from 52.528 m wide to 15 cm wide. Furthermore, the fluid sample A produces the Normal status, the fluid B sample produces the Watch status, the fluid C sample produces the Advisory and Warning status.

6. References

[1] Voight, B., et al. (2000). *Historic al eruptions of Merapi Vocano, Central Java Indonesia. 1768-1998. Journal of Volcanology and Geothermal Research.* Amsterdam: Elsevier. Volume 100(2000). 69-138

[2] Herianto, dkk. (2012). Sosialisasi dan negosiasi proses relokasi pengungsi korban erupsi merapi di Cangkringan Yogyakarta upaya pengurangan potensi konflik. Yogyakarta: Penerbit Universitas Gajah Mada.

[3] *Directorate General of Water Resources* (DGWR). *Republic of Indonesia.* (2001d). *Review master plan study on Mt Merapi. Supporting report[D] hydrology.*

[4] BNPB. (2011). Dampak letusan Gunung Merapi mencapai Rp 3,56 triliyun. *Indeks Rawan Bencana Majalah GEMA BNPB.* Volume 2 Nomor 1:17 .

[5] Ruri, Z.H. (2013). Sistem keamanan ruangan menggunakan sensor *passive infrared* (PIR) dilengkapi control penerangan pada ruangan berbasis mikrokonotroler ATMega 8535 dan *real time clock DS1307. Jurnal Teknologi Informasi & Pendidikan.* Volume 1.1.

[6] Efrianto, dkk. (2016). Sistem pengamanan motor menggunakan *smartchard* Politeknik Negeri Batam. *Jurnal Integrasi.* Volume. 8. Nomor.1. 01-05.

[7] Yusuf, M. (2009). Prototipe sensor parkir mobil berbasis mikrokontroler AT89S51. Surakarta: Penerbit Universitas Sebelas Maret.

[8] Mazidi, Muhammad Ali. 2011. *The Microcontroller and Embedded System: Using Assembly and C.* Pearson Education, inc: New Jersey.

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The Development of Electromagnetic Method to Reduce Noise Signals

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Abstract. Research using electromagnetic methods had been widely used in the survey of subsurface structures. This research was a development from previous research, namely the subsurface structure analysis of a temple in Blitar[1]. The Very Low Frequency Electromagnetic method (VLF-EM) was chosen because it is easy to use, environmentally friendly, and does not damage the object of research. The data recording process was carried out by dividing the research area into several trajectories, where each path was spaced between points of 0.5 meters. At each point, data recording was carried out. The value recorded by the VLF-EM tool was in the form of tipper data in the form of real and imaginary parts. Furthermore, these values were processed using the NA-MEMD filter [8][9] to reduce the interference signal during the data recording process. The final result of this research is a mapping of the existence of anomalies that are suspected of being underground materials in the research area. This method is able to record real and imaginary value variations. The results that have been obtained are that there are three tracks that can be displayed. In the three lines, on average, after decomposition of the signal using the NA-MEMD filter, five IMF decomposition results were obtained and two or three IMF decomposition results were selected whose sinusoidal signal graph display was quite stable.

1. Introduction

The subsurface structure can be indentified through several methods, including electromagnetic methods [1] [3]. This method can be applied because it is environmentally friendly. It is not destructive the object [4]. The layers below the surface of the soil can be distinguished based on the value of resistivity and conductivity [5] [10]. Factors that influence soil resistivity values include porosity, fluid content, and degree of fracture [6]. The Very Low Frequency Electromagnetic (VLF-EM) method is used to mapping the types of material in a certain depth [7]. The frequency of VLF-EM method is 5 - 30 KHz [8]. The primary waves that propagate in the underground medium when it comes to the conductive surface of a material will emerge secondary electromagnetic fields due to induced currents [2] [9]. The results of VLF-EM data consists of two parts, namely the real and imaginary components [10]. The real component is called inphase. The imaginary component is called quadrature.

VLF-EM is inseparable from noise that comes from electromagnetic radiation in the surrounding object during the data recording process [1] [8]. Noise Assisted Multivariate Empirical Mode Decomposition (NA-MEMD) filter can be used to reduce this noise [7] [8] [9]. The depth that can be reached by the VLF-EM during data recording depends on the transmitter frequency [1] [7].

2. Research Method

The research began with conducting a field survey. After that, the researcher collected data. Data collection began with dividing the area into parallel paths. Each track was given a point with a scale of 0.5 meters. At each point, VLF-EM data was recorded. After finishing recording one track, then we moved to the next track which had scale 2 meters. Data recording was continued until the last track. The results of the data recording were inphase, quadrature, t-field, and tilt. The results of the recording was data tipper. That values were entered into excel to be graphed. This graph showed the results of the recording of VLF electromagnetic waves which were still mixed with noise from the surrounding environment. After that, the inphase and quadrature values were processed using NA-MEMD filters to reduce existing noise [8][9]. The results of data processing were in the form of decomposition of the signal in the form of IMF1, IMF2, IMF3, and so on. From all the decomposition results, several stable signal graphs were selected and merged.

3. Result and Discussion

These are the results of signal decomposition and NA-MEMD filter.

- **Line 1**

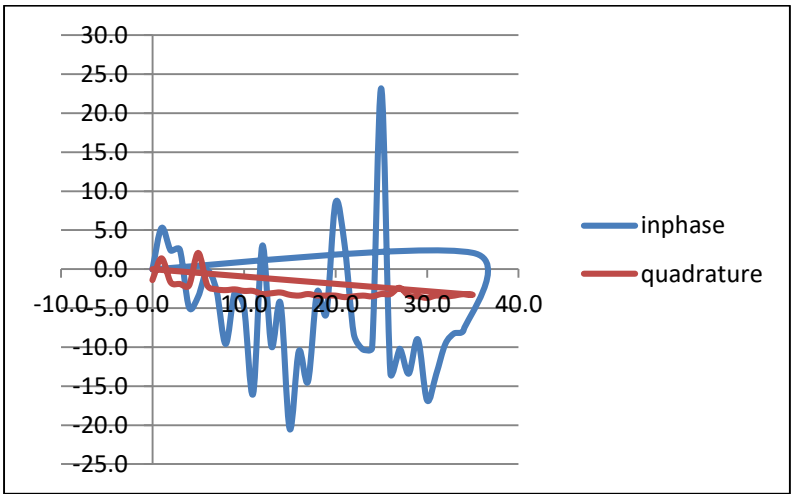

Figure 1. The graph of recorded signal line 1

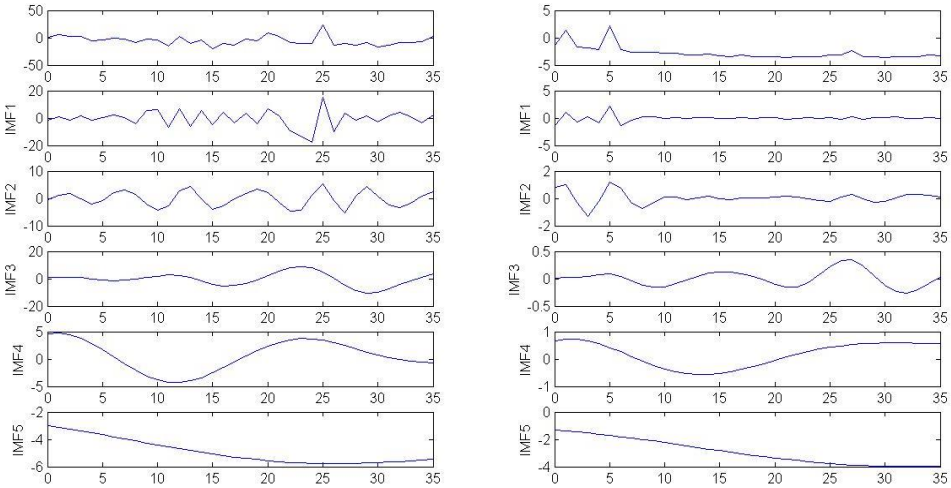

Figure 2. The signal decomposition line 1

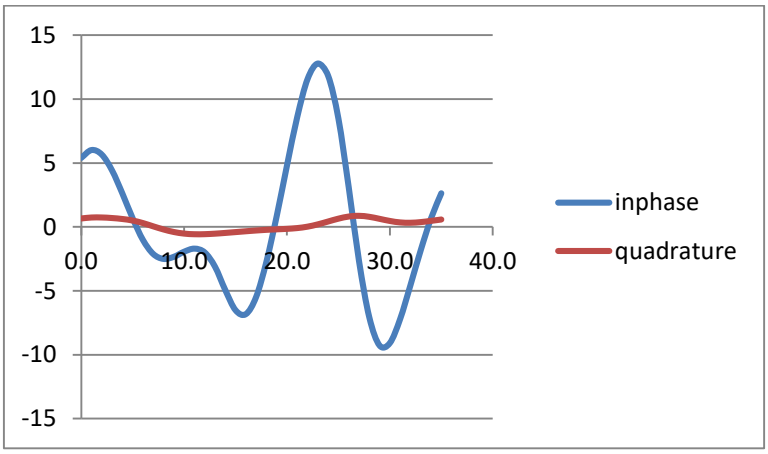

Figure 3. The graph of noise reduced signal line 1

- **Line 2**

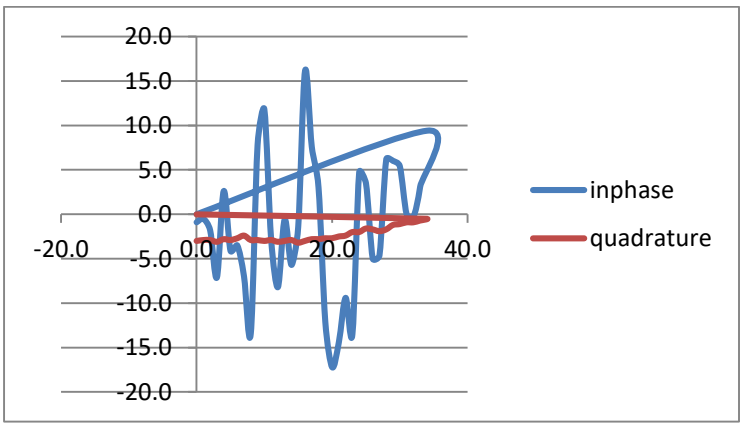

Figure 4. The graph of recorded signal line 2

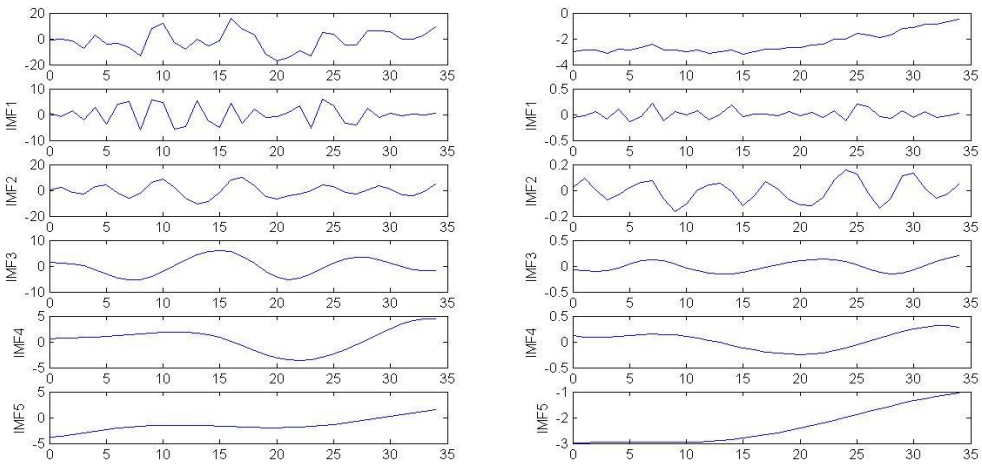

Figure 5. The signal decomposition line 2

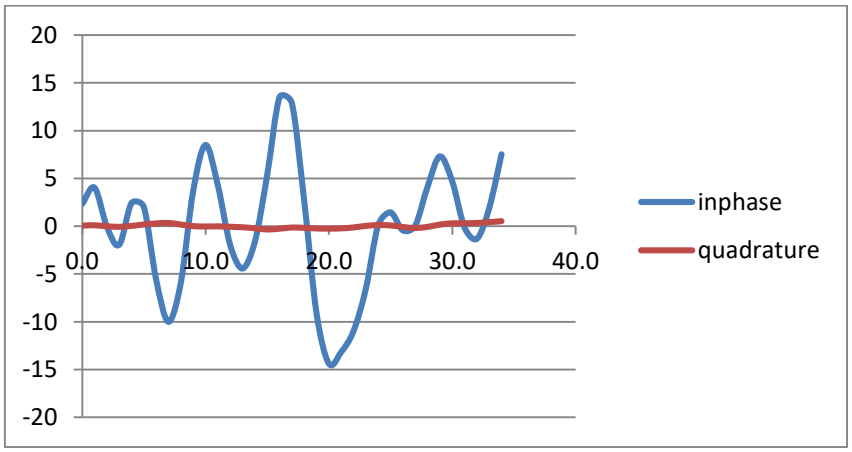

Figure 6. The graph of noise reduced signal line 2

- **Line 3**

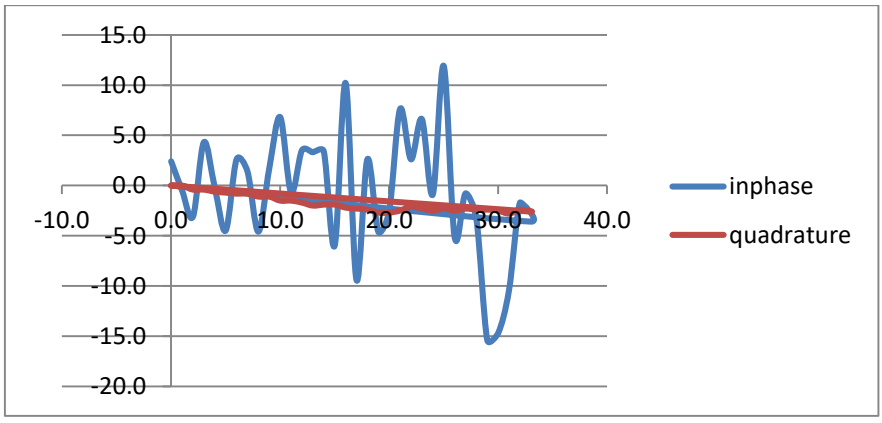

Figure 7. Graph of recorded signal line 3

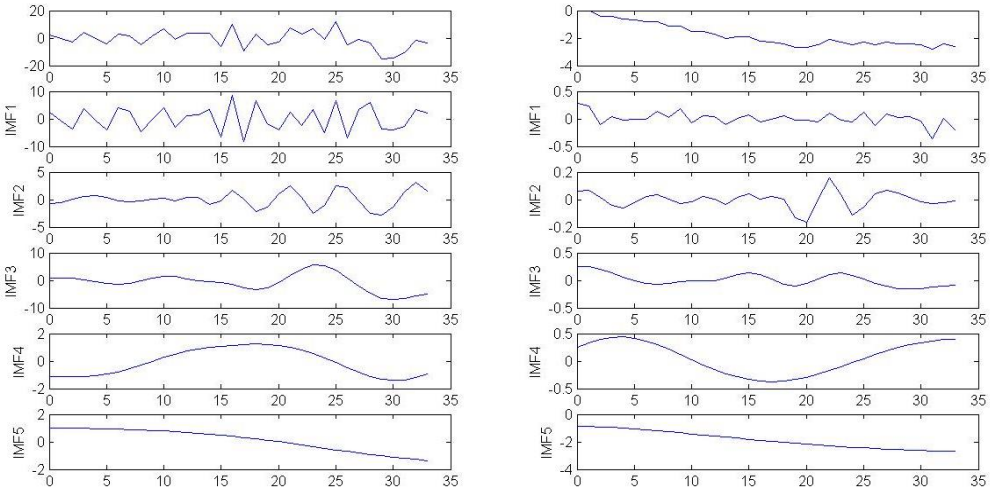

Figure 8. The signal decomposition line 3

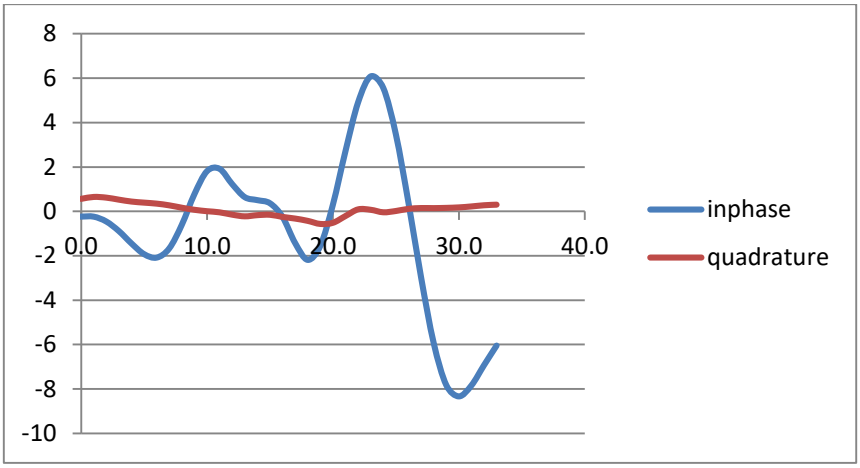

Figure 9. The graph of noise reduced signal line 3

Based on the results, in each line there are five signals decomposition. They are IMF1, IMF2, IMF3, IF4, and IMF5. We choose the stable graph of sinusoidal. We choose IMF3 and IMF4 both inphase and quadrature in each line. So, we get the graph of noise reduced signals.

4. Conclusion

There are two types of anomalies are detected in each line. Both inphase and quadrature give the decomposition of five signals and we choose the IMF that image a stable sinusoidal.

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6. References

[1] MAULIDINA, M., BAGUS JAYA S., dan SUNGKONO. "The Subsurface Structure Analysis of Gambar Wetan Temple, Blitar Using Very Low Frequency Electromagnetic (VLF-EM) Method". Prosiding "The 2nd International Conference on Research, Implementation, and Education of Mathematics and Sciences (2nd ICRIEMS)". Yogyakarta. 2015.

[2] EFFENDI, R., S. SYAMSUDIN, W.S. SINAMBELA, SOEMARTO. Medan Elektromagnetika Terapan. Penerbit Erlangga. Jakarta. 2017.

[3] WIJAYANTO, T., B. J. SANTOSA, D. D. WARNANA, dan A. D. CANDRA. "Penerapan Metode Very Low Frequency Electromagnet (VLF-EM) untuk Menafsirkan Bidang Longsoran, Studi Kasus Desa Jombok, Kecamatan Ngantang, Kabupaten Malang, Jawa Timur". Spektra: Jurnal Fisika dan Aplikasinya, Vol. 16 No. 3, Des. 2015.

[4] SHARMA, S. P., dan ANAND SINGH. "Advancement in 2D interpretation approach in very low frequency electromagnetic measurements. 23rd Electromagnetic Induction in the Earth Workshop. Chiang Mai, Thailand. 2016.

[5] SINGH, A. dan S. P. SHARMA. "Fast imaging of subsurface conductors using very low frequency electromagnetic data". Geophysical Prospecting, vol. 63, no. 6, pp. 1355-1370, 2015.

[6] K. K. K. SINGH, K. B. SINGH, dan A. PRAKASH. "Multielectrode resistivity imaging technique for the study of coal seam," *J. Sci. Ind. Res.*, vol. 63, no. 11, pp. 927–930, Nov. 2004.

[7] ZUHDI, M., M. E. ARMANTO, D. SETIABUDIDAYA, NGUDIANTORO, dan SUNGKONO. "Exploring Peat Thickness Variability Using VLF Method. Journal of Ecological Engineering, vol. 20, issue 5, pp 142-148, Mei 2019.

[8] SUNGKONO, A.S. BAHRI, D.D. WARNANA, F.A. SANTOS, dan B.J. SANTOSA. "Fast, simultaneous and robust VLF-EM data denoising and reconstruction via multivariate empirical mode decomposition". *Computers and Geosciences*, vol. 67, pp. 125-138, 2014.

[9] SUNGKONO, A.S. BAHRI, dan B.J. SANTOSA. "Application of Multivariate EMD to Improve Quality VLF-EM Data: Synthetic and Fields Data". *Applied Mechanics and Materials* vol. 771, pp. 170-173, 2015.

[10] F. A. MONTEIRO SANTOS, A. MATEUS, J. FIGUEIRAS, dan M. A. GONÇALVES. "Mapping groundwater contamination around a landfill facility using the VLF-EM method — A case study," *J. Appl. Geophys.*, vol. 60, no. 2, pp. 115–125, Oct. 2006.