International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

The Development of the Mathematical Physics Module Based on Self regulated learning

Yul Ifda Tanjung[a]*, Deo Demonta Panggabean[b], Teguh Febri Sudama[c]

[a,b,c]*Physics Major, Mathematics and Natural Sciences Faculty, Negeri Medan University Williem Iskandar Street, Pasar V Medan Estate, Medan, North Sumatera, Indonesia*

[a]*Email: yuly@unimed.ac.id*

[b]*Email: deo.panggabean@unimed.ac.id*

[c]*Email: teguhfebri@unimed.ac.id*

Abstract

This research is for knowing the development process, the quality of eligibility and the improvement of the students' Mathematical Physics I results using the self regulated learning-based module. This research is the development research (Research and Development/R&D) with a method adapted from Borg and Gall. The research procedure is divided by the preliminary study stage those are data collection, the material requirement analysis and the making of the research instrument, the development study stage those are composing the teaching materials and doing the improvement of the expert team's validation result, the trial stage is divided into two, those are the small group trial that is giving the questionnaire of the students' interest response on modules and limited trials by doing the Mathematical Physics I learning, using the module of students' development results. Based on the research results, it can be obtained the conclusion of Mathematical Physics I module based on the self regulated learning is eligible and can be applied to students and there is improvement of Mathematical Physics I results and learning quality, using the development results of self regulated learning-based module.

Keywords: Module; Mathematical Physics; Self regulated learning.

---

* Corresponding author.

1. Introduction

Started from 2013, The Department of Physics in Mathematics and Natural Sciences Faculty of State University of Medan started to socialize the Indonesian National Qualification Framework (KKNI)-oriented curriculum in all subjects. Various efforts were applied such as by doing workshops and KKNI oriented curriculum-based lecture's device design. The application of KKNI oriented curriculum in the Physics Department requires the readiness of natural resources which are related to the availability of infrastructures and human resources that are lecturers and students who are ready for the implementation of the curriculum. In the application of KKNI oriented curriculum in lecturing process in the classroom, is not only focusing on the model development or the learning strategy that is used. The provision of module in accordance with the curriculum demands should also be considered by the lecturer as a learning facilitator.

One of the subjects that became the focus of KKNI oriented curriculum application is Mathematical Physics. The Mathematical Physics subject is a compulsory study which provides the basics of mathematical analysis of the physics problem [1]. This subject is for creating students' ability in formulating various physics process into mathematical statement and being able to solve it analytically. The Mathematical Physics I subject develops the students' ability in quantitative analytical thinking based on a logical mathematical mindset in solving every physical matter. Students should be able to understand the concepts of Mathematical Physics study and solve the physics questions with the mathematical analysis techniques. But the conditions that occur in the reality seems quite hard for the students. In the first semester, the students get calculus I and II subjects as the prerequisite studies of Mathematical Physics. The placement of these subjects in the first semester still makes the students do not used to self-study, whereas these subjects obligate the students to work hard by themselves to master it.

The result of Mathematical Physics learning since 2012 until now shows less satisfactory result. For example, on the second semester students of 2012 in Physics Education's study Program of Mathematics and natural Sciences Faculty in State University od Medan at period 2014/2015, only about 65% of students get the C category and the rest 35% get E. This result is reinforced by the conclusion of the student opinion that says that the Mathematical Physics subject is difficult to understand because the lecturers who teach are only focusing on mathematical formulas without applying directlyto problems-formed physical applied questions.

During lecturing, students are obligated to use module in the form of notes and module of Mathematical Physics I by Mary L.Boas, *Mathematical Methods in The Physical Science*, in English [2]. The note is an adaptation of several book sources used to assist students during lecturing. But the existing notes have not fully understood by the students because it is too focused on the basic mathematical theories rather than the application of physical problems directly. Whereas, the module of Mary L. Boas and the other companion books such as the module of Solid Physics application, Optics, Mechanics and others are considered quite helpful but because of those are in English, the students find it difficult to understand the content of the module more deeply so they tend to only discuss the questions without knowing the science introduction of the books. Therefore, in Mathematical Physics learning, it is necessary to arrange a module in the form of modules with content that gives direction to the students to understand the physical concepts of equations formulas in each subchapter of Mathematical Physics and also motivate them to improve their basic knowledge and relate it to the knowledges that they get in

Indonesian language and directly focus on the application of physical problems.

The expected characteristic from this module development is a part of the efforts to encourage the students to learn by themselves (self regulated learning) as a form of KKNI oriented curriculum implementation in Mathematical Physics I learning. The self regulated learning refers to a learning that mostly occurs from the mind, feeling , strategies, and behaviors which are produced by the learners themselves that are directed towards the goals achievement [3]. In this case, the learners have self-awareness to learn in accordance with the desire with a certain strategy. The Zimmerman's research shows that a personal ability that enables the learners to be the independent learners can generate a sense of happiness (resilinecy) and be closely related to accomplishment (achievement) [4]. Other research results by Pintrich which states that learning independently (self-regulated learning) includes the management of self-understanding, self-motivation and attitude, behavior, students' context in implementing their duties as learners [5]. The Self regulated learning requires the students' confidence and persistence and the renewal of learning resources [6]. Therefore, the research is needed to know the development process of self regulated learning-based Mathematical Physics I module and the quality of the module development result according to the experts' reviews and the students' responses. The research is limited to printed module in the form of modules on the Series, Complex Numbers and Vector Algebra subjects.

2. Method

The used method is the type of research and development (Research and Development / R & D). R & D research is used to design products or procedures that are systematically tested in the resl life, evaluated, and developed in such a way that they accomplish the criteria of effectiveness, quality or similarity with a standard [7]. The research diagram is presented in Figure 1 below:

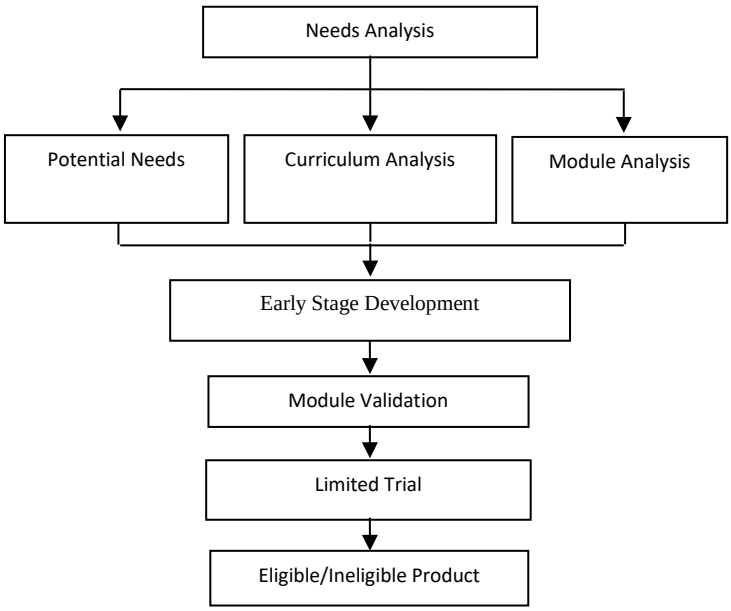

Figure 1: Research Diagram

2.1 Research Procedure

The technique stages of the research implementation are the preliminary stage to obtain the preliminary data about the analysis of students' needs, curriculum, facilities and Mathematical Physics I subjects. At this stage,the preparation of module validation sheet, students' responses sheet, the instrument in the form of preliminary and final test that will be used in the module's effectiveness trial and experimental design of module products are done. All research instruments are standardized instruments following the standard procedures. Furthermore, the development learning stage is a follow up of the module analysis results that have been done at the preliminary stage. Steps that are taken at this stage are two, those are: the first step is to analyze the problem and arrange the module, the second stage is the module development stage, based on the improvement suggestion from the validator. From these corrections and inputs, then the evaluation and improvement are done in order to get the more eligible module product's design to be tested on the students.

The trial and improvement stage is intended to analyze the early product more deeply, whether it can be used directly to the students and collect the improvement results from the students' trial at once. The trial stage is divided into two steps, those are: small group trial and large group trial. The small group trial stage is done by giving a questionnaire of students' interest of the module and asking their opinion for the module improvement at once. While the limited trial stage is done by implementing the Mathematical Physics I study, using the module of development results in one class and then observing the enhancement results of the students' learning value from the meeting I to the meeting III. The limited trial stage is intended because in the implementation, it only uses one class on the internal scope of the research.

2.2 Data Analysis Technique

The data in this research is qualitative data that is obtained from the assessments and improvements until the product is produced in the form of Mathematical Physics I module and quantitative data in the form of students' learning results that are analyzed using Pre-test and Post-test data.

For the qualitative data, is obtained from the answers of questionnaire that is answered by the validator team to the feasibility components of the contents, the presentation and the language of the module development results. The obtained data are analyzed by the following steps:

1. The obtained data are in the form of checklist-lists that are summarized in the form of assessment scale table. The used Likert Scale with the option categories are as follows:

   a) Number 4 means really agree / very interested / very good / very easy / very clear / very precise.
   b) Number 3 means agree / good / interested / easy / clear / precise.
   c) Number 2 means less good / less interested / less easy / less clear / less precise / less agree.
   d) Number 1 means really not good / really not interested / really not easy / really unclear / really imprecise / really disagree.

2. Counting the validity level of the self regulated learning–based Mathematical Physics I module on the

Series, Complex Numbers and Vector Algebra subjects.

3. Analyzing the students' learning results by doing Gain test in order to know the improvement of the students' achieved learning results in every meeting.

The normalized Gain percentage formula is calculated by using the Hake formula [8] :

$$\%g = \frac{(S_{pos}) - (S_{pre})}{(S_{max} - S_{pre})} x\ 100$$

Every (Spos) and (Spre) states the final and the early test score, whereas (Smax) states the ideal maximum score of every individual. The value of% g then converted to the normalized Gaincriteria, those are: Gain level 71 - 100 the criteria is high, 31 - 70 the criteria is medium and 0 - 30 is low.

2.2.1. Media Validation Sheet Analysis

The validation results of media and subject from the validator to all aspects assessed, are presented in table form. After that, counting the score the validity value by using the following formula:

$$The\ percentage\ of\ conformity\ scores = \frac{Total\ obtained\ scores}{Total\ ideal\ scores}$$

or it is the same as using the following eligibility percentage formula:

$$P = \frac{f}{N} x100\% \text{ [9]}$$

In which : P = Percentage of the conformity answers

f = The total or the answer frequency on every category (alternative answer)

N = The total availability of the respondents' answers' scores

Using the above formula will result the calculation of numbers in the form of percent. The score classification is then changed to be the classification in percentage form, then interpreted with the qualitative sentence [10] as listed in Table 1.

2.2.2 Students' Response Data Analysis

The analysis of the students' learning response data is the analysis of the students' response data on small group trials. This response is obtained by giving a questionnaire to the students. Small group trial of students' response data are obtained by calculating the score of the students who answer each item. The result data of students'

response of the collected questionnaire, then tabulated. The tabulated results of every item are used to count the response value (NP), with the following formula:

$$P = \frac{f}{N} x100\%$$

In which : P = Percentage of the conformity answers

f = The total or the answer frequency on every category (alternative answer)

N = The total availability of the respondents' answers' scores

Table 1: Percentage of indicator conformity criteria

No	The Interval of Percentage	Criteria
1	80%≤ X ≤ 100%	Veryvalid
2.	60%≤ X ≤ 80%	Valid
3.	40%≤ X ≤ 60%	Quite valid
4.	20%≤ X ≤ 40%	Lessvalid
5.	0%≤ X ≤ 20%	Notvalid

The obtained results are interpreted using the following criteria [10] :

Table 2: Criteria of Response Assessment Score Interpretation

Achievement Level	Criteria
0-20	Not Good
21-40	Less Good
41-60	Quite Good
61-80	Good
81-100	Very Good

3. Research Result and Discussion

Validation assessment consists of content feasibility aspects, subject presentation feasibility aspects and language assessment aspects which are contained in the validity table of subject and the module media. The assessment of module validation was conducted by two validators, namely Mr. Dr. Nurdin Siregar, M.Si (NS) and Ms. Dr. Betty M. Turnip, M.Pd. (BT). This assessment is a validation assessment of the module contents.

The validation assessment of the module is the basis for improving or accomplishing the module so that is interesting and feasible to use.

Based on the validation result from the expert team, the data obtained in Table 3:

Table 3: Module validation result

Aspect	Average (%)			Note
	NS	BT		
Content Feasibility	77,9	76,5	77,2	Valid
Subject Presentation Feasibility	79,2	77,1	78,2	Valid
Language Feasibility	81,3	77,1	79,2	Valid

Based on table 3 shows that the module validity assessment of the subject obtains the following results: 1) The assessment of module, has three measurement aspects, those are: the content feasibility aspect, including: subject conformity with SK - KD, subject accuracy, subject upgrades, encourage curiosity with the 77.2 average percentage with "valid" category, the presentation feasibility aspect, including: the techniques of presentation, complementary presentation, learning presentation, coherence and the systematical mindset with the 78.2 average percentage with "valid" category, and the topic feasibility aspect with the 79.2 average percentage with "valid" category.

Furthermore, small group trial, which is a trial of feasibility and students' learning interest that are obtained from the instrument of students' learning interest responses, is done, which consists of 4 measurement aspects, those are: the module appearance consists of 4 indicators, the concept mastery consists of 5 indicators, the learning motivation consists of 5 indicators, and the information sources acquisition consists of 3 indicators.

The assessment is done by five students with various abilities of the module product which is developed and readable.

Based on the students' responses assessment, the average score acquisitions of the module aspects, which are developed, are: 1) "self-regulated learning based physics module" indicator gets 85% with "interested" category. 2) "Concept mastery" indicator gets 86% with "Very Interested" category. 3) "Learning motivation" indicator gets 89% with "Very Interested" category. 4) "Learning sources acquisition" indicator gets 91.7% with "Very Interested" category. The average percentage of students' responses assessment on small group trials is presented in Table 4 below:

Table 4: Percentage of Small Group Trial Assessment

No	Indicator	% Average assessment of student's interest	Categori
1	Module Appearance	85	Interested
2	Concept Mastery	86	Very Interested
3	Learning Motivation	89	Very Interested
4	Learning Source Acquisition	91,65	Very Interested

From the results of the validator and students' responses assessment, it indicates that the module can be tested on the students to see the improvement of the students' learning results. At this stage, the data of students' learning results in the early ability (pre-test) and the final ability (post-test) are shown in Table 5:

Table 5: The Average of Student's Learning Result

Meeting	Data	
	Pre-Test Average	Post-Test Average
I	26,67	73,61
II	20,97	79,55
III	17,90	89,26

The results of the evaluation tests done by the students, obtain the results of the students' Mathematical Physics I learning with the average scores are: at the first meeting, the pre-test score is lower than the post-test score (26.77 <73.61), it means there is an improvement of the students' Mathematical Physics I learning results after the implementation of the self-regulated learning based Mathematical Physics I module on the Series subject. At the second meeting, the pre-test score is lower than the post-test score (20,97 <79,55), it means that there is an improvement of the students' Mathematical Physics I learning results after the implementation of the self-regulated learning based Mathematical Physics I module on the Complex Numbers subject. At the third meeting the pre-test score is lower than the post-test score(17,90 <85,03), it means that there is an improvement of the students' Mathematical Physics I learning results after the implementation of the self-regulated learning based Mathematical Physics I module on the Vector Algebra subject.

Furthermore, the normalized Gain test is analyzed, to know the effectiveness of the students' understanding improvement after learning. According to Meltzer, Gain test is obtained from the ratio of the diminution of the post-test score to the pre-test score and the diminution of the ideal score to the pre-test score [11].

The analysis result shows that *N Gain* of the first meeting is 0,640 with "medium" category, it means that the students' understanding in learning, is assessed from the effectiveness of their learning result improvement, is "quite effective". *N Gain* of the second meeting is 0.741 with "high" category, it means that the students' understanding in learning, is assessed from the effectiveness of their learning result improvement, is "quite effective". *N Gain* of the third meeting is 0.818 with "high" category, it means that the students' understanding in learning, is assessed from the effectiveness of their learning result improvement, is "effective".

From the *gain* test results, it seems that the first *gain* (*G1*) is lower than the second *gain* (G2) that is 0.640 <0.741, the second *gain* (*G2*) is lower than the third *gain* (*G3*) that is 0.741 <0.818, the first *gain* (*G1*) is lower than the third *gain* (*G3*) that is 0.640 <0.818. It can be proved from every analysis on every evaluation of the Mathematical Physics I learning result at every meeting that there is an improvement of the understanding effectiveness of the students' Mathematical Physics I study.

The improvement of the understanding effectiveness of the students' study is concluded because: the used module is the self-regulated learning based module. Self regulated learning based module has self instructional, self contained, stand alone, adaptive, and user friendly characteristics with the content focused on the application of concepts and problems that exist in physics subject [12]. This makes it easier for students to study Mathematical Physics I subjects more independently. In addition, this module has a straight forward explanation of the subject along with the examples of physics applications and how to solve them and is complemented with the questions for students with the cognitive domain from simple level to complex level and key answers so that the students gain confidence in their success work [13].

This module is arranged to make students interested and not afraid to face Mathematical Physics I study. In addition, to encourage the students to learn more independently with more satisfactory results. Characteristics gained from the development of this module is part of efforts to encourage students to learn independently (*self regulated learning*) as a form of KKNI oriented Curriculum implementation in Mathematical Physics I learning.

4. Conclusion

1. It has been produced a product of self regulated learning-based module with the development research process.
2. The self-regulated learning based module, that is arranged, is feasible according to the validator team, it conforms with BSNP assessment aspects and students' interest responses results.
3. There is an improvement of students' Mathematical Physics I learning result and quality, using the development result of self-regulated learning based module.

References

[1] Ellianawati, Wahyuni. (2012). "Pengembangan Bahan Ajar Fisika Matematika Berbasis Self regulated learning Sebagai Upaya Peningkatan Kemampuan Belajar Mandiri". Jurnal Pendidikan Fisika Indonesia, ISSN: 1693-1246, (8) : 33-40. Tersedia : http://journal.unnes.ac.id [Diakses 5 September 2016]

[2] Boas, Mary L. (2005). Mathematical Methods in The Physical Sciences (Third Edition). Singapore: John Wiley & Son (Asia) Pte.Ltd

[3] Schunk dan Zimmerman, (1998), Self regulated learning: From Teaching to Self-Reflective Practise, New York: The Guilford Press

[4] Zimmerman, Martinez, (1986), Development of Structured Interview fo Assesing Student Use of Self-Regulated Leaning Strategies, American Educational Research Journal (23)

[5] Pintrich, P.R, (2004). A Conceptual Framework for Assesing Motivation and Self-Regulated Learning in College Students. Educational Psychology Review. 16 (4): 385-407

[6] Wilson, J. (1997). Self Regulated Learners and Distance Educaton Theory. University of Saskatchewan

[7] Borg, Walter; Gall, Meredith, etc. (2003). Educational Research An Introduction 7th Edition. Boston: Pearson Education Inc.

[8] Hake, 1998, Interactive-engagement vs traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses Am.J.Phys. 66 64-74. Also online at http://www.physics.indiana.edu/~sdi [Diakses 5 September 2016]

[9] Slameto. (2010). Belajar dan Faktor-Faktor yang Mempengaruhinya. Jakarta : Rineka Cipta.

[10] Sudjana, (2009). Metode Statistika. Bandung : PT. Tarsito Bandung

[11] Herlanti, Yanti. 2006. Tanya Jawab Seputar Penelitian Pendidikan Sains, (Online), (http://dhetik.weebly.com/uploads/8/1/1/5/8115637/tanya-jawab-seputar-penelitian-pendidikan.pdf, [Diakses 23 April 2018]

[12] Lestari, Ika. (2013). Pengembangan Bahan Ajar Berbasis Kompetensi (Sesuai Dengan Kurikulum Tingkat Satuan Pendidikan). Padang: Akademia Permata

[13] Sanches, J.M.R. (2004). Self regulated learning for University Students: The Meaningful Text Reading Strategy. Electronic Journal of Research in Educational Phsycology. 12 (1): 113-132