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Preliminary Research on the Development of Digital Hypercontent Modules in Mathematical Physics Subjects

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Abstract. This research is an initial study on student learning outcomes in the Mathematics Physics course. Mathematics Physics is a compulsory subject for the Physics Education Study Program, University of Muhammadiyah Makassar. Mathematical Physics examines the application of mathematics in solving physical phenomena. However, mathematical Physics is often considered difficult by students. Still, Mathematical Physics is essential because of its role as a provision for students to study advanced Physics courses, such as Mechanics, Optics, Waves, Electricity, and so on. Therefore, the search on the perception and acquisition of student learning outcomes in Mathematics Physics lectures is the basis for providing intervention for researchers through research and lessons in the selection of strategies, learning methods, and even the development of learning tools. This research is survey research. The way of data collection is through interviews with 14 fourth semester students of the Physics Education Study Program at the University of Muhammadiyah Makassar. The results of the study found that as many as 57,14% of students scored less than 70 (categories C, D, and E). this percentage gain is still far from the expected results in Mathematics Physics learning. In addition, the absence of learning tools that are following the characteristics of the Mathematics Physics course for Physics Education students also has an impact on the common understanding of students' Physics concepts.

INTRODUCTION

Mathematics Physics is one of the compulsory subjects that all students of the Physics Education Study Program in University of Muhammadiyah Makassar must be taught. Mathematical Physics is a combination of Physics and Mathematics subjects[1]. Physics is an empirical science and has abstract concepts, then it need reasoning skill to study it[2]. Mathematics has a necessary role in Physics, which can solve Physics problems from the simple problems to the most complex forms. In addition, mathematics also helps one's reasoning in tracing the translation of mathematical equations. Mathematics can be used to predict several possibilities that occur in physical phenomena[3]. Mathematical physics is a course that is classified as a tooling course , then the presented material consists of various mathematical methods and techniques as a tool for studying and analyzing multiple Physics lectures[4]. Mathematical physics is present as a course that is provided to students in learning physical phenomena, such as classical mechanics, quantum mechanics, waves, optics, introduction to core physics, quantum physics, and so on[5]. The form of questions that given in the Mathematics Physics course usually contains physical phenomena with analytical solutions. So that, in attending the lectures, the students are expected to have high mathematical representation skills[6]. The aim of Mathematics Physics is that the students can formulate various physical processes into Mathematical statements and solve them analytically, quantitatively, and predictively based on the developed reasoning model. To achieve this goal, the learning of Mathematical Physics should be designed with appropriate learning methods and equipped with teaching materials directed at the application of mathematics in

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solving Physics phenomena. The characteristics of the hypercontent module are related to the module, that is, each section in the hypercontent module is designed separately (stand alone). Each has components of a complete or self-learning system, so that readers can randomly study, starting and ending from any unit. The structure of the content in the module is packaged in sections, each section consisting of a specific purpose, sub-unit benefits, illustrations, studies and sub-study[7]

Mathematics learning in the classroom tends to take place conventionally or using traditional learning strategies. In addition, several weaknesses in the school that are still happening today are the low learning outcomes of Mathematics and Physics in every semester. Based on the research results in 2018 and 2019, the expected learning outcomes of Mathematics Physics were caused by the non-uniformity of primary mathematical abilities possessed by students[1], [5]. Another weakness is that the Mathematics Physics course is less attractive because this course is considered challenging. After all, there are too many calculations and formulas for each material. Another research carried out at the Physics Education Study Program, University of Muhammadiyah Makassar, researched how learning Mathematics Physics with online learning was during the COVID-19 pandemic. The study results found that there were several weaknesses in the learning situation of Mathematics Physics during online learning. Namely, the difficulty of understanding the material if the lectures were carried out face-to-face (virtually), for students in the area experiencing challenges related to the stability of the internet network[4].

From the description above, the authors formulate the focus of the problem in this study, how to obtain Mathematics Physics learning outcomes for Physics Education students in the 2020/2021 academic year and identify the difficulties experienced by students in attending lectures. Based on the focus of the problem, this study aims to obtain preliminary research data from a series of survey research stages regarding the acquisition of Mathematics Physics scores and identify the difficulties experienced by students in attending Mathematics Physics lectures. Furthermore, this data will be supporting information for the Mathematical Physics module, which will be developed further. The expected benefits in this research are: For lecturers, finding the difficulties experienced by students when attending Mathematics Physics lectures, the results of this research can be used as a reference by lecturers in developing tools and strategies for teaching Mathematics Physics. For students, it can overcome the students learning difficulties to improve learning outcomes for Mathematics and Physics.

METHOD

This research is non-experimental quantitative research, namely survey research. This survey research aims to collect information concerning variables from a group of objects. The subjects in this study were all students who programmed the Mathematics Physics course which consisted of 14 students (11 female students and 3 male students) in the odd semester, 2020/2021 academic year. This research aims to analyze Physics Education students' achievement or learning outcomes in the Mathematics Physics course and analyze students' difficulties on participating in Mathematics Physics learning. The research instruments used in this study were learning outcomes tests and interview guidelines. The method of collecting data was by giving a test at the end of the Mathematics Physics lesson and an interview. The interview contains several open-ended questions. There are several indicators of the interview questions, namely: the level of difficulty of the Mathematics Physics material; The importance of learning Mathematical Physics; Availability of Textbooks.

Furthermore, the learning outcomes data obtained are converted into quantitative data according to the score's weight. The aim is to make a percentage of student achievement. Meanwhile, the data obtained from the interviews were analyzed by data reduction methods, data display, and verification or concluding. In the data reduction stage, the researcher sharpens, focuses the data, and removes unnecessary data to complete. After the data is reduced, the next step is to display the data. Data presented in narrative form. The presentation of the data begins by describing the study results. Namely, the data obtained from the researcher has gone through triangulation and data reduction, then the analysis is carried out in the discussion. The last stage in qualitative data analysis is drawing conclusions and verification. At this stage, new findings never existed before, derived from data that have been reduced, focused on arriving at a decision.

RESULTS AND DISCUSSION

Learning mathematics in science (physics) is considered very important to support learning Physics. Furthermore, learning mathematics in science is seen necessary for developing education, society, and the industrial world[8]. Moreover, learning science involves several scientific fields[9]. Based on a preliminary study that has

been carried out on physics education students in the odd semester of the 2020/2021 academic year in Mathematics Physics learning, it was found that data on the acquisition of students' Mathematics Physics learning outcomes for one semester. In addition, qualitative data were also found related to the difficulties experienced by students when attending Mathematics Physics lectures. The results of this study can be described as follows:

1. The acquisition of mathematics physics learning outcomes for physics education students at the Muhammadiyah Makassar University in the odd semester of the 2020/2021 academic year.
   The Basic Mathematics Physics course is a group of Mastery of Science subjects in the Physics Education study program at the University of Muhammadiyah Makassar with a weight of 3 credits. The basic mathematical physics learning provides the basis for mastery of mathematics used in physical science applications. The students' learning outcomes of Basic Mathematics Physics can be seen in the following table.

TABLE 1. Acquired Values for Basic Mathematics Physics Courses for Students of the FY Physics Education Study Program. 2020/2021

Score	Number of Students	%
A	2	42,86
B	4	
C	7	57,14
D	0	
E	1	
Number of Students	14	100

Source: UNISMUH Physics Education Study Program

Table 1 above shows that students with grades less than 70 (categories C, D, and E) are 57.14%. This percentage gain is still far from the expected results in Mathematics Physics learning.

2. The results of data reduction based on the results of student interviews
   Based on the analysis of student interviews that have been reduced, further grouping is carried out based on the indicators of interview questions. These categories can be seen in the following table.

TABLE 2. Data Categories Based on Reduction Results

No	Indicator	Alternative Answer	Description
1	Material difficulty	level Easy	I liked the Math Physics content
		Quite difficult	In certain complex materials, for example: fold integrals, calculus of variations, partial derivatives
		Difficult	Too many calculations and formula derivation Requires complex mathematical knowledge
2	The importance of learning math physics	Urgent	Become a provision for learning Physics content
	The importance of learning math physics	Quite important	Not all Physics content requires Mathematical Physics
		Not too important	Physics content does not require mathematical knowledge
3	Availability of textbooks	Easy	It can be found anywhere
		Quite difficult	Most of the textbooks are in English
		Difficult	English reference book There is no particular Mathematics Physics book for Physics Education student

The analysis of interview data found that several subjects stated that the Mathematics Physics course was easy and fun. Meanwhile, most of the topics perceive that the Mathematics Physics course is a difficult lesson. On the indicator of the importance of learning mathematics physics, most students stated that mathematics physics learning is essential and is a provision for studying physics content. Meanwhile, in the third indicator related to the availability of textbooks or learning modules, most students stated that it was challenging to obtain mathematics physics textbooks according to the learning achievements of physics education students.

A diagram that can show the number of subjects who responded to the interview indicators of student difficulties in learning mathematics physics can be seen in the following chart.

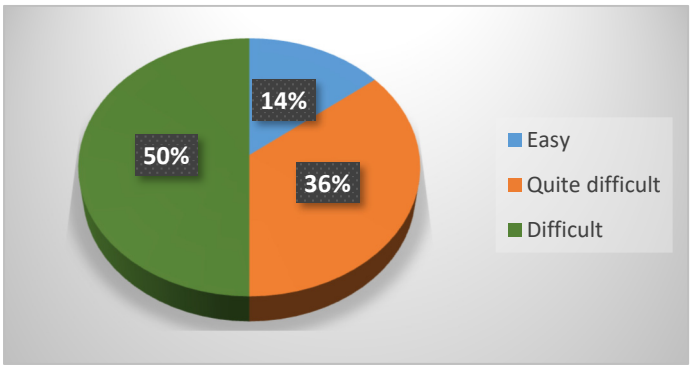

FIGURE 1. Perceptions of the difficulty level of the Mathematics Physics course

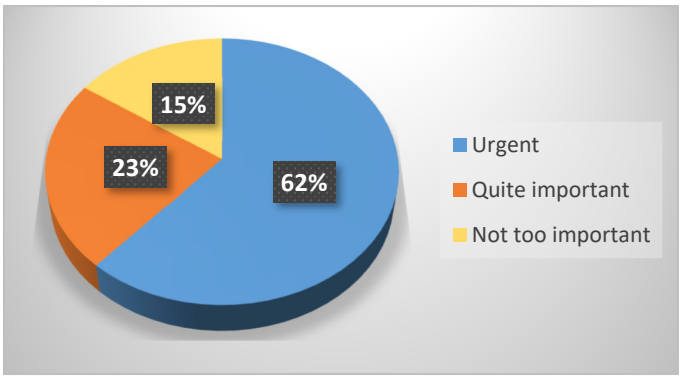

FIGURE 2. Perceptions about the importance of the Mathematics Physics course

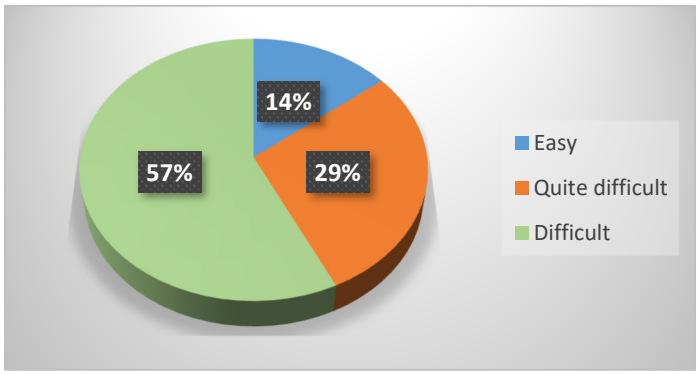

FIGURE 3. Perceptions about the availability of Mathematics Physics teaching materials

3. Difficulties faced by students when attending Mathematics Physics lectures

From the results of data reduction, data display, and data verification, several students revealed the problems they experienced when taking Mathematics Physics lectures as follows.

a. Students got difficult in using mathematical equations on Physics problems. Students were less competent in seeing the similarity of cases when working on issues. Based on the lecturer's experience, students got difficult in working on the questions if the questions given change slightly from the questions exemplified earlier. Likewise, from the results of student interviews with open-ended questions, students stated that if the Mathematics Physics questions given were similar to the questions demonstrated by the lecturer, they could do it. But if the construction of the question is changed slightly, students tend to have difficulty solving the problem, even though the question is still in the same material or content. The problem learning is in line with a study in 2014 that stated that one of the obstacles for students in Mathematics Physics lectures was that students were unable to solve contextual physics test questions. Students had difficulty formulating mathematical equations that were under the situation presented in the questions [10]. This difficulty can be overcome by how the lecturer in the course familiarizes students to work on contextual questions with different levels of difficulty. The test of the questions starts from the group of easy or simple completion, questions with medium solutions and problems with complex solutions.

b. The students were difficult to find reference books that match the learning achievement of Physics Education students. So far, the reference book used by students is a textbook entitled "Mathematical Methods in the Physical Sciences" by Mary L. Boas. This textbook is quite complete because it presents material that is equipped with sample questions and practice questions. It's just that this book is a reference book for Mathematics Physics courses for pure Physics students, not Physics Education students. Besides that, this book also has an introduction to English-language material. Physics Education students whose English skills are lacking, it is rather difficult to understand the material presented in this book. Another complementary reference book is a book on mathematics for physics by Muhammad Arsyad. This book is a mathematical physics book intended for pure physics students. In addition, students also download references from the internet that are by the lecture material. However, this material is still planned for pure physics students, not Physics Education students. There is no unique Mathematics Physics reference book for physics education students. The difficulty of these teaching materials was also explained in Ellianawati's research in 2011. The low student learning outcomes in the Mathematics Physics course were caused by the lack of Mathematics Physics teaching materials (textbooks or lecture modules) that had an introductory language that was easy for students to understand and appropriate. With the curriculum of the Physics Education study program[11].This difficulty can be overcome by the lecturer developing teaching materials, which can be in the form of books or modules for Mathematics Physics lectures adapted to Physics Education students' learning achievements. This module can be made with a simple language of instruction to be easily understood by students. The modules developed should be presented with contextual examples of questions and equipped with a large number of practice questions to practice independently. The development of Mathematics Physics teaching materials by lecturers is essential because it can improve students' mathematical reasoning. Mathematical reasoning can help students conclude and prove a statement, build new ideas, and solve physics problems using mathematical theorems [11]. In addition, designing a book or module can provide concept strengthening to students through tiered practice questions[11].

c. The COVID-19 pandemic situation is a new problem in Mathematics Physics lectures. Students find it challenging to take virtual face-to-face lectures online. Not all students can attend courses due to limited costs (internet quota) and unstable internet network conditions. The problem of learning is also felt in Pakistan, which also carries out online education. Most students cannot access the internet in learning because of technical issues (unstable network) and monetary [12]. Other than the internet access which makes online learning difficult during the pandemic, the factor of students and teachers also plays an important role. The students' motivation is low in participating in education, time management skills are not optimal, and the lack of communication devices such as smartphones. From the teacher, regarding explaining the concept and the use of online learning applications[12].

Some solutions that can be offered to minimize this difficulty are learning materials in the form of lecture video recordings, using several online learning applications that are lightweight, easily accessible, and do not require a strong internet network. Learning materials must be dynamic, interesting, and interactive. And lecturers can use Google Classroom and Edmodo, which have a task reminder feature [14]. Online learning does not only have difficulties in its application. Online learning also has benefits for

students. One of which helps students to develop a sense of autonomy over their learning, as seen from the more questions from students in the live chat column and comments on the WA group, compared to offline learning, students rarely ask questions in learning in the classroom. in class[13].

This survey research still has limitations regarding the lack of depth in revealing data regarding students' perceptions of the difficulties they face when studying mathematical physics due to the relatively small number of subjects. This author's challenges will be considered for planning advanced mathematics physics lectures in the following semester. Through this preliminary research, it can be seen that the need for mathematical physics teaching materials that are by the characteristics of the Mathematics Physics course needs to be made and developed. Then the current learning situation is still wholly online. So the Mathematics Physics module, which is intended explicitly for Physics Education students, is planned to be made in the form of Hyper content. It is easily accessed and downloaded by students via their respective smartphones. In addition, another consideration of the researcher is that the Mathematics Physics course is less attractive to students. Hence, the author wants to provide flexibility for the students to work on modules according to their respective learning strategies by making modules oriented towards Self Regulated Learning in the following semester.

CONCLUSION

Based on the research and discussion results, it can be concluded that the acquisition of students' essential mathematics physics learning outcomes in the odd semester of 2020/2021 was still far from the expected results. In which 57.14% of students have a score of less than 70 (categories C, D, and E). In addition, students' learning difficulties are caused by the unavailability of Mathematics Physics teaching materials by Physics Education students' learning achievements. So far, only teaching materials for pure physics students have been used. Therefore, it is necessary to develop modules or teaching materials for Mathematics Physics that are in accordance with the characteristics of physics education. So that the material can be more easily accessed for students, the lecturer team developed this module in the form of a digital hypercontent module.

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