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Designing a constructivist learning aid module in disentangling least mastered competencies in the wave motion

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Abstract: This study sought to design constructivist learning aid module in disentangling least mastered competencies in wave motion among the 72 Grade 7 students of Quezon Science High School, S.Y. 2019-2020. Specifically, it sought to test if there is significant difference between the pre-test and post-test scores. Also, level of acceptability of the developed instructional material was evaluated. A 30-item achievement test (pre-test and post-test) and the questionnaire. One-group pre-test post-test design was used as the research design. The findings showed that the mean scores of the students in the pre-test and post-test is 11.29 and 29.08 respectively. The computed t-value is -13.176 is less than the tabular value of -1.99 at 0.05 level of significance. There is a significant difference between the pre-test and post-test scores after the utilization of the said learning material. It implies that the constructivist learning aid module is a valid tool in disentangling the least mastered competencies in wave motion. The average weighted mean values for the following criteria on the level of acceptability are as follows: learning objectives (3.74); learning activities (3.72); clarity (3.74); accuracy (3.76); appeal (3.67); and usability (3.74). These criteria fall under "strongly agree". Thus, the developed constructivist learning aid module in disentangling least mastered competencies in wave motion is commendable to use.

Keywords: Constructivist approach, least mastered competencies, wave motion, Grade 7 students, science teachers

Merancang modul alat bantu belajar konstruktivis dalam mengurai kompetensi yang kurang dikuasai dalam gerak gelombang

Abstrak: Penelitian ini berusaha merancang modul alat bantu belajar konstruktivis dalam mengurai kompetensi yang kurang dikuasai dalam gerak gelombang pada 72 siswa kelas 7 Quezon Science High School, S.Y. 2019-2020. Secara khusus, riset berusaha untuk menguji apakah ada perbedaan yang signifikan antara nilai pre-test dan post-test. Juga, tingkat penerimaan bahan ajar yang dikembangkan dievaluasi. Sebuah tes prestasi 30-item (pre-test dan post-test) dan kuesioner. One-group pre-test post-test design digunakan sebagai desain penelitian. Hasil penelitian menunjukkan bahwa nilai rata-rata siswa pada pre-test dan post-test masing-masing adalah 11,29 dan 29,08. Nilai t yang dihitung adalah -13,176 lebih kecil dari nilai tabel -1,99 pada tingkat signifikansi 0,05. Terdapat perbedaan yang signifikan antara nilai pre-test dan post-test setelah pemanfaatan materi pembelajaran tersebut. Hal ini menyiratkan bahwa modul alat bantu konstruktivis merupakan alat yang valid dalam mengurai kompetensi yang kurang dikuasai pada gerak gelombang. Rata-rata nilai untuk kriteria tingkat akseptabilitas sebagai berikut: tujuan pembelajaran (3,74); kegiatan belajar (3,72); kejelasan (3,74); akurasi (3,76); banding (3,67); dan kegunaan (3,74). Kriteria ini termasuk dalam kategori "sangat setuju". Dengan demikian, modul alat bantu belajar konstruktivis yang dikembangkan dalam mengurai kompetensi yang kurang dikuasai pada gerak gelombang layak untuk digunakan.

Kata Kunci: Pendekatan konstruktivis, kompetensi yang paling sedikit dikuasai, gerak gelombang, siswa kelas 7, guru IPA

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INTRODUCTION

Physics is crucial because it has played a significant role in the development of many contemporary innovations and in understanding many of the occurrences that occur in our daily lives (Akanbi & Shehu, 2020). Erinosho (2013) emphasized that physics is fundamental to understanding the complexities of modern technology and is indispensable for the technological advancement of a nation. However, Akanbi (2003) stressed that poor academic performance in physics can be attributed several factors. It includes the absence of physics teachers, inadequate laboratory equipment and facilities, and a lack of learning materials. Bamidele (2004) reported the lack of motivation in physics by learners, since it was perceived that this field of natural science is a difficult discipline. This is parallel to the idea of Erinosho, (2013) that physics remains the least favored science subject among students generally. Under this concept, Otico (2014) emphasized the least mastered competencies related to wave motion in physics. This includes the inability of the students to explain how waves carry energy from one phase to another. In addition, many students are unable to tell the difference between transverse and longitudinal waves, mechanical and electromagnetic waves, and other similar waveforms with any precision. Similarly, most students are unable to draw the conclusion that energy, such as light and sound, moves in waves. The researchers did not employ a model to show the link between frequency, amplitude, wave velocity and wavelength. As a result, there are some students fall under the developing and beginning level as they could not understand abstract concept and could not perform well in exercises on their own (Bantoc, 2014).

While the study of Bantoc (2014), Otico (2014), and Erinosho (2013) claimed the factors as well as the difficulties in learning physics specifically wave motion, their findings lack further investigation. Other alternative strategies to overcome the difficulties of studying physics wave motions as one of the least mastered competencies were not included in the many research mentioned above. Also, the studies of Akanbi (2003) and Bamidele (2004) found out what the students thought about the subject and what factors affected them. Their results brought up questions like how to solve the problem using a constructivist learning aid module. It was argued by Adak (201) that constructivism's formalization was a way of articulating the process by which students assimilate their new information. It was argued that students might get new information from their experiences by adapting and assimilating what they've learned. Moreover, Kim (2005) has found that constructivist teaching has been proven to be more successful than conventional teaching. Furthermore, ineffectual in regard to self-concept and learning method, but it has some influence on motivation anxiety about learning and self-monitoring. On the other hand, the use of the learning aid module was emphasized to the findings of Robinson and Crittenden (2004). These are instructional materials that consist of learning objectives, a sequence of learning activities, and assessment and evaluation. Moreover, it facilitates effective learning experiences with enthusiasm among the students. It can be interpreted that the utilization of learning modules within the teaching-learning process can be a great potential in order to solve the existing problems in relation to the least mastered competencies in several areas of discipline. Hence, the present study explored this issue as an extension of prior research in terms of giving a solution to detangling the least mastered abilities in wave motion by using a constructivist learning aid module in teaching-learning process.

Ekici (2016) stressed that for the past several years, the decline when it comes to filed interest in the field of science and technology among the learners was acknowledged in which this concern is apparent in the field of physics which has a pivotal function in science and technology. Ekici (2016) also mentioned that based from these issues, several programs and strategies have been implemented in many countries to solve the existing problems. Adding, there have been several extensive instructional programs to teach physics in a more effective and efficient procedure. Learners' perceptions of the context of any courses greatly affect their learning process. Hence, understanding the fundamental concepts of the said area of inquiry leads to the acquisition of scientific and engineering goals. These goals in the field of education are one of the primary concerns in accordance with the learning competencies of the K to 12 basic education curriculum. The National Research Councils' Framework (2012) for K to 12 Science Education put forth a new vision of science education where students engage in science and engineering practices to develop and use core ideas and concepts to explain phenomena and solve problems in physics.

For several years, educators encountered several difficulties with regard to the academic performance of the students in the field of science education, specifically physics. For many students, learning and teaching physics are challenging tasks because of the perceived conceptual difficulty of the subject (Angell et al., 2004; Mualem & Eylon, 2007; Mulhall & Gunstone, 2012). The perspectives of high school students and instructors on physics were examined in the study by Angell et al. (2004), which found that Learning physics is "difficult" yet "enjoyable," according to students. Mathematical proficiency is crucial for conceptual understanding of physics, as educators have stressed time and time again. On the other hand, students are less successful in this area of study. On the other hand, students don't believe that math skills are necessary for physics. They believe that physics is difficult, irrelevant, and boring to high school students (Williams et al., 2003). In their investigations, researchers have revealed why they are perceived as tough (Owen et al., 2008). The study found that physics becomes increasingly difficult to understand as students progress through secondary school. Physics also becomes less descriptive and more quantitative throughout this time period (Owen et al., 2008). Teachers believe that students have a preconception that physics ideas are difficult based on the findings of these studies (Oon & Subramaniam, 2011). Physics concepts are deemed too esoteric to understand by students, according to academics. In addition, educators feel that students should have a strong background in mathematics to fully grasp physics principles (Oon & Subramaniam, 2011). Another study found that pupils need to be proficient in mathematics in order to fully grasp the concepts of physics (Angell et al., 2004). The other studies have found the same thing (Gill, 1999; Politis et al., 2007).

The problems stated above are still apparent in the results obtained from numerous assessments and evaluations. For instance, Bernardo (2020) reported the results in Trends in the International Mathematics and Science Survey 2019. The Philippines revealed that the students ranked last when it comes to Grade 4 science and mathematics. In order to achieve the desired objectives in enhancing the students' academic performance, educators must provide adequate learning experiences within the educative process. One of the primary ways in scaffolding students' learning process is through the utilization of learning modules. Robinson and Crittenden (2004) emphasized that learning module includes instructional materials that consist of learning objectives, a sequence of learning activities

as well as assessment and evaluation. Moreover, it facilitates effective learning experiences with enthusiasm among the students. It can be interpreted that the utilization of learning modules within the teaching-learning process can be a great potential in order to solve the existing problems in relation to the least mastered competencies in several areas of discipline. Modular learning adapt learning objects that are more closely related to a holistic approach to information, often including a problem-oriented approach (Tseng et al., 2008).

Şahin (2009) said that problem-based learning entails teaching students how to tackle real-world issues via experiential learning. Additionally, using a modular approach to teach physics through situations, learners perceived a negative view of modular learning after the introductory physics classes. This negative contention occurred since students felt that the teaching of physics is best interested in means of rote learning. The learners' desirable point of view solely centered on how physics was strongly related to real life and how it is relevant to other disciplines. Although some confounding variables already exist, like course load and grading variations, the findings were significant. Furthermore, Gahutu (2010) studied modular learning and found out that students perceived that they learned best when the pedagogy was less theoretical. This can be achieved by working through the material using practical classes and demonstrations. Overall, students indicated more satisfaction with the modular, self-directed approach to learning than with the classroom's prior, more conventional manner.

Scientific concepts, particularly in physics, are not yet established when it comes to K to 12 curricula, as supported by the findings of some researchers (Angell et al., 2004; Mualem & Eylon, 2007; Mulhall & Gunstone, 2012; Owen et al., 2008; Williams et al., 2003). Hence, many students have least learned competencies about the concepts and ideas in relation to the lessons dealing with force, motion, and energy in physics, specifically in the topic dealing with wave motion. Students find physics as one of the most difficult subject to pass. Students experienced such anxiety in explaining several science concepts and eventually lose their confidence in understanding the lesson. Likewise, aside from the negative perceptions of the students towards the discipline, learners are blocked with the subject matter's difficulty. Hence, there are competencies which are not learned well. These least mastered skills are required to be mastered prescribed in the K to 12 curriculum learners' guide. This study was anchored in accordance to Article XIV, Section 5 (2) of the 1986 Philippine Constitution; teachers are allowed to engage in developing any instructional materials like workbooks and modules that may provide meaningful learning experiences in order to enhance science concepts and understandings among the students. It can be interpreted that teachers have a great responsibility to the help the students in learning the scientific skills and concepts that they find hard to understand. There is a wide variety of teaching strategies and techniques that can be employed within the educative process in order to eliminate the students' negative attitudes towards the subject matter. The utilization of several instructional aids either print or non-printed material is also utilized.

The study of Vargas (2009) is especially relevant to this research study because it guides the researcher in designing and developing modules which is also related to the idea of Gacelo (2012) dealing with the essential components in creating a self-instructional module. One of the advantages of using the said instructional material is that it allows the students to accomplish several learning tasks through the principle of "learning by doing"

by Dewey (1986) in relation to social learning theory will be practiced since it promotes experiential learning. Here, learners can be found busy at work constructing their own knowledge through personal meaning, rather than teacher-imposed knowledge and teacher-directed activities (Schiro, 2012). Learners will be seen learning by doing in these learning environment and they will be able to solve problems by means of hands-on approaches. Science concepts are best learned through discovery as well constructivist approach in accordance to the theory of development of Bruner (Ozdem-Yilmaz & Bilican, 2020). Through the said approaches, the ideas to solve the problem will result to learning. In addition, it allows the teacher to present the lesson with increasing difficulty since it greatly influences the understanding of the students towards the lessons. Moreover, learning aid module as instructional material can be a great help in scaffolding the students in order to address their needs in learning (Dewi & Primayana, 2019; Moradi et al., 2018).

Based from the related literature and studies presented the researcher created a learning aid module that provides a wide array of learning experiences through a series of activities to improve the conceptual understanding about the science concepts in relation to wave motion. This innovative instructional material has a significant contribution for the implementation of the K to 12 curriculum in the country. This study sought to design constructivist learning aid module in disentangling least mastered competencies in wave motion among the Grade 7 students of Quezon Science High School, S.Y. 2019-2020. Specifically, it sought to answer the following sub problems: (1) to test the significant difference between the pre-test and post-test scores of the grade 7 students after the utilization of the said instructional material; (2) to explore the acceptability level of the developed instructional material as perceived by the student-respondents in terms of learning objectives, learning activities, accuracy and clarity, appeal, and usability.

METHOD

At the Quezon Science High School (QSHS), this research was done. It is a science-focused public high school located in Tayabas City. 446 students from grades 7 through 12 were enrolled in the school. Quezon Province has four (4) congressional districts, and these students came from each of them. The school's goal is to develop learners who are both academically well and well-versed in the fundamentals of the workplace, making them internationally competitive and value-oriented.

One-group pre-test-post-test design was used in this research, which was used to validate the said instructional material. Pre-test results were compared to post-test results to see whether they differed significantly. This will serve as a piece of strong evidence to determine the development of the least mastered competencies in relation to the concept of wave motion through the use of a validated learning aid module.

The respondents of the study consisted of 72 Grade 7 students in Quezon Science High School. The researcher selected this group of student-respondents for the said study through purposive sampling. These respondents were selected since the concept about wave motion is prescribed within the learning competencies of Science 7 for the 2nd grading period under the K - 12 Basic Education Curriculum offered by the Department of Education.

The researcher constructed an achievement test in the form of pre-test and post-test to determine if the developed learning aid module had a positive effect on the students'

ability in understanding the concept about wave motion. This accomplishment test was administered to students after using the aid module. The questions that were included in the aforementioned evaluation were classified into the levels of knowledge, process, and understanding levels as prescribed.. The researcher consulted with the department's master's teacher in the Science and Technology Department to get their input on the test's development and validity. As a result, various alterations were made.

The researcher used a variety of literary resources, including book references, electronic sources, least-mastered competencies, and other current modules, to gather some notions and ideas that finally led to a strategy for how this module has been developed in order to build an educational resource. The said material contains: of (1) generation and propagation of waves, (2) mechanical and electromagnetic waves, (3) transverse and longitudinal waves, and (4) characteristics of waves. Afterward, the instructional material was developed. The constructivist approach was integrated into the learning material. The material consists of learning activities that will allow the learners to explore and construct new knowledge in relation to wave motions. As a final step, a panel of experts was convened to discuss if the content validation of the learning module was appropriate. The research took into account any and all recommendations for changes to the content of the materials.

The researcher adopted a questionnaire to explore the acceptability level of the learning aid module in disentangling the least mastered competencies in the wave motion. This questionnaire has been modified to a Likert scale, namely SA (strongly agree), A (agree), D (disagree), and SD (strongly disagree). The questionnaire was used to determine the agreement level of the student on the instructional material acceptability based on six criteria that are: (1) learning objectives; (2) learning activities; (3) accuracy; (4) clarity; (5) appeal; and (6) usability.

The data collection technique includes two steps. The researcher carried out the accomplishment test during the first phase of the study. This test served as both a pre-test and a post-test, and it was administered before and after the student utilized the learning aid module in the appropriate manner. The aforementioned accomplishment test was initially administered prior to the utilization of the aforementioned content in order to evaluate the students' prior existing knowledge regarding the topic of wave motion before they were exposed to the said content. The scores of the learners were obtained since the data were required for the processes that were to come later. After the students had utilized the learning assistance module for a period of two weeks, a post-test was provided to all of them to determine how much they had learned about the topic at hand, and it was given to each of them individually. Finally, the results of the tests were gathered. Each Grade 7 student received a hard copy of the learning aid module. The science teacher of the said institution will utilize the said learning aid module as the core instructional material in order to deliver the topic within two weeks. If there is some confusion on the part of the student-respondents with regards to the directions given for each activity in the instructional material, they were taken into account for further understanding. The instructional material was used by the science teacher in Grade 7 during the classroom discussion since it served as the main reference material among the student-respondents. It also provided a wide variety of formative and summative assessments after the discussion inside the class to monitor the learning outcomes among the students. It also presents several learning activities that can be used to have additional tasks for further enrichment

to extend the learning process among the students. During the second week of December, the researcher made use of the said material as part of the third grading period for the 2019–2020 school year. At the completion of the third grading period, the researchers provided the questionnaire to the Grade 7 student-respondents to gauge their degree of acceptance and of the aforementioned teaching content. Students were given a copy of the questionnaire to fill out and return to the school. Afterward, their replies were analyzed and reviewed in order to ascertain the acceptance of the educational content. In this way, the degree of student approval of the generated instructional material was measured based on the categories stated in the questionnaire.

RESULTS

For assessing significant variations between the pre and post-test scores, Table 1 provides a summary of data. There were 50 items on the pre and post-tests, with a mean score for the students of 11.29 and a standard deviation of 7.78, respectively, according to the study data. The post-test standard deviation is larger than the pre-test standard deviation. Post-test results are more evenly distributed than pre-test scores, as seen by this finding.

Table 1. Significant difference between pre-test and post-test scores

	Highest Score	**Lowest score**	**Mean**	**SD**	**Difference between Means**	***t*-value**	**Level of Significance**
Pre-test	35	19	11.29	7.78	17.79	-13.176	0.05
Post-test	44	39	29.08	11.67			

The t-test was done to see whether there was a statistically significant difference between the tests. Its calculated t-value is -13.176, which is lower than the table value of -1.99 at the 0.05 p-value level. The null hypothesis that "there is no significant difference between the pre-test and post-test scores of Grade 7 students" was rejected since the t-value was smaller than the tabular value. It only proves that the scores obtained in the post-test can be attributed to the utilization of learning aid module in understanding the concepts about wave motion.

Table 2 shows the students' responses in relation to the acceptability level of the learning aid module in disentangling least mastered competencies in wave motion as to learning objectives of the material. In terms of "Objectives clearly reflected the infused values in each activity" it has a weighted mean of 3.81 which is "strongly agree". This means that the learning aid module contains learning objectives that are integrated with scientific attitudes which are necessary in understanding the subject matter, specifically the concept about wave motions. The same thing with the other criteria for the learning objectives of the module such as "the objectives consist of clarified and specified learning tasks", "the objectives of the learning activities followed the content standard of the subject matter," and "the objectives in the material were attainable and measurable" have weighted means of 3.76, 3.76, and 3.64 respectively (all scores fall into the category strongly agree).

Table 2. Distribution of weighted mean of the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to learning objectives

Statement	SA (4)	A (3)	D (2)	SD (1)	WM	Descriptive Rating
The objectives of the learning activities followed the content standard of the subject matter.	56	17	0	0	3.76	Strongly Agree
The objectives consist of clarified and specified learning tasks.	56	17	0	0	3.76	Strongly Agree
The objectives in the material were attainable and measurable.	47	26	0	0	3.64	Strongly Agree
Objectives clearly reflected the infused values in each activity.	59	14	0	0	3.81	Strongly Agree
Average					3.74	Strongly Agree

The acceptability level of the learning aid module in disentangling the least mastered competencies in wave motion in terms of learning activities of the material was revealed in Table 3. The weighted mean for all items ranged from 3.67 to 3.81, which included "strongly agree" in the descriptive rating. The student-respondents strongly agree on the statement that “activities that were developed to enhance the understanding the concepts about wave motion”. This response implies that the students have a comprehensive overview in studying the real nature of waves since the learning aid module allows them to integrate their schema to the new learning concepts through the use of the activities specified in the said material. The material also provides “activities that were presented in an organized manner” and “activities were distributed fairly from easy to complex”. It can be inferred that the material consists of proper sequencing of topics of the learning aid module in which the prerequisite topics were discussed first. Understanding the nature of and anatomy of waves were presented before the students identify the relationships that exist among the variables, including the frequencies, amplitude, wavelength and energy.

The material also includes “activities that were created to stimulate my interest in learning.” It only connotes that it fosters active learning since the said material gives a wide variety of opportunities to develop student participation in the educative process. The instructional material contains “activities that were arranged accordingly to develop critical thinking”. Furthermore, the learning aid module also contains “activities that were applied to real-life situation” since it provides activities that are easy however it necessitates discovery that can be found within the experimental settings. It also gives “activities that were linked logically to other topics” since it has a weighted mean value of 3.67 that has a descriptive rating of “strongly agree”. In addition, “activities were suited appropriately to the needs of our group in the class”. It only implies that the material scaffolds the collaborative learning that is usually regarded as an essential strategy in all disciplines. Lastly, the material also contains “the activities were arranged accordingly to develop critical thinking” that has weighted mean value of 3.80 which corresponds to the descriptive

rating of "strongly agree." This means that the material promotes higher order thinking skills leading to the stimulation of active learning process. The acceptability level of the instructional enrichment material in terms of its learning activities is 3.54 (strongly agree). Based from the result of this study, the learning activities incorporated in the material provide the students several ways of assessing themselves. It helps the students to enhance their skills towards research variables.

Table 3. Distribution of weighted mean of the Level of Acceptability of the Learning Aid Module in Disentangling Least Mastered Competencies in Wave Motion as to Learning Activities

Statement	SA (4)	A (3)	D (2)	SD (1)	WM	Descriptive Rating
1. The activities were developed to enhance the understanding the concepts about wave motion.	55	18	0	0	3.75	Strongly Agree
2. The activities were distributed fairly from simple to complex.	53	19	1	0	3.71	Strongly Agree
3. The activities were presented in an organized manner.	54	19	0	0	3.74	Strongly Agree
4. The activities were linked logically to other topics.	51	20	2	0	3.67	Strongly Agree
5. The activities were created to stimulate my interest in learning.	53	20	0	0	3.73	Strongly Agree
6. The activities were arranged accordingly to develop critical thinking.	60	12	1	0	3.80	Strongly Agree
7. The activities were applied to real-life situation.	44	29	0	0	3.60	Strongly Agree
8. Activities were suited appropriately to the needs of our group in the class.	55	18	0	0	3.75	Strongly Agree
9. The activities can be understood easily.	51	22	0	0	3.70	Strongly Agree
10. The learning activities were based naturally on infused values.	54	19	0	0	3.74	Strongly Agree
Average					3.72	Strongly Agree

Table 4 shows students' responses in relation to the acceptability level of the learning aid module in understanding the concepts about wave motion as to the clarity of the material. The weighted mean for all the items ranges from 3.68 to 3.79, which is strongly agree categorized. In terms of "the activities of the material were logically connected to previous lessons," it has a weighted mean of 3.68. It can be interpreted that the sequence of the concepts about waves is well-organized since the topics are related to one another. Moreover, for the other criterion such as "the characters of the material were comprehensively, visibly, and intelligibly crafted" has a weighted mean value of 3.77. This

may be due to the graphics and illustrations that stimulate the effort and motivation among the students. The material also contains “appropriate use of language that is considerable within the level of students’ understanding”. It can be interpreted that the words and the technical terms used in the said material give a clear explanation towards the vocabulary among the students. It has a weighted mean value of 3.73.

Table 4. Distribution of weighted mean of the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to clarity

Statement	SA (4)	A (3)	D (2)	SD (1)	WM	Descriptive Rating
1. The material was logically arranged to supply order of understanding.	55	18	0	0	3.75	Strongly Agree
2. The material was variedly provided to master concepts and ideas.	54	19	0	0	3.74	Strongly Agree
3. The material instructions could be simply understood and processed by our group in the class.	58	15	0	0	3.79	Strongly Agree
4. The material characters were comprehensively, visibly, and intelligibly crafted.	56	17	0	0	3.77	Strongly Agree
5. The material activities were logically connected to previous lessons.	50	23	0	0	3.68	Strongly Agree
6. The material contains appropriate use of language that is considered within the level of students’ understanding.	53	20	0	0	3.73	Strongly Agree
Average					3.74	Strongly Agree

The material was “logically arranged to supply order of understanding” has a weighted mean of 3.75. It only implies that the material aids the learners to understand the relationships among the subtopics about wave motion and make some connections between what is learned together with their own experiences. The learning aid module also “includes instructions that could be easily understood and processed by our group in the class”, and “the material was diversely supplied to master concepts and ideas”, have weighted mean values of 3.79 and 3.74 respectively. It only indicates that the material integrates other disciplines since it contains other branches of knowledge including formula derivation and recognizing research variables.

Table 5 reveals the students’ responses regarding the acceptability level of the learning aid module in understanding the concepts about wave motion as to accuracy of the material. The weighted mean for all the items ranges from 3.71 to 3.84, categorized as "strongly agree" in the descriptive rating. The learning aid module contains “precise content of tables, charts and diagrams in order to show some models about the topic”. This criterion has a weighted mean value of 3.84. It only indicates that the illustrations presented in the said material show appropriate and exact data and information. Furthermore, the material contains “labels in the illustrations that are considered to be scientifically correct” as well

as “the data and other information within the text.” These criteria have a weighted mean value of 3.74. Lastly, the instructional material “presented the correct formulas necessary to understand the relationship among the variables involved in the said topic.” The said criterion has a weighted mean value of 3.71. It can be interpreted that the students enable to infer the correlations among the variables that includes the frequency, amplitude, wavelength, speed and energy of the waves through the use of the correct formulas, labels and data found within the text.

Table 5. Distribution of weighted mean of the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to accuracy

Statement	SA (4)	A (3)	D (2)	SD (1)	WM	Descriptive Rating
1. The material revealed precise content of tables, charts and diagrams in order to show some models about the topic.	61	12	0	0	3.84	Strongly Agree
2. The instructional material presented the correct formulas necessary to understand the relationship among the variables involved in the said topic.	52	21	0	0	3.71	Strongly Agree
3. The labels found among the illustrations are considerable to be correct.	54	19	0	0	3.74	Strongly Agree
4. The data and other information found within the text of the material are scientifically correct.	54	19	0	0	3.74	Strongly Agree
Average					3.76	Strongly Agree

The acceptability level of the in terms of the learning aid module in disentangling least mastered competencies in wave motion as to appeal of the material is illustrated in Table 6. All items for this criterion fall under the descriptive rating of “strongly agree” since the obtained weighted mean ranged from 3.58 to 3.75. In terms of “the information the material enabled me to develop critical thinking and problem solving” received a weighted mean value 3.75. It only suggests that the material developed the critical thinking and problem solving skills in relation to understanding the concepts about wave motion. The material also “stimulated my interest toward learning the lessons”. This criterion has a weighted mean of 3.74 since the students were observed that they employ cooperative learning during their activities inside the class. Additionally, the material “provided varied benefits to my own learning capacity” has a weighted mean value of 3.68. It only implies that the students received some learning advantages leading to a more comprehensive understanding of the lesson. The same thing with “the exercises’ layout established my

comfort and motivation" and "the material's lessons captured my own interest." These criteria have weighted mean values of 3.58 and 3.49 respectively. These results can be linked to the fact that the instructional material has font styles, graphics, visual effects, and photographs intelligible. The acceptability level of the instructional enrichment material in terms of its appeal is 3.67, which is categorized as "strongly agree" in the descriptive rating. The result reveals that the learning aid module provides a wide-ranging advantage in the learning outcomes of the students initiated by the curiosity and motivation that activates their ability to understand the concepts about wave motion.

Table 6. Distribution of weighted mean of the level of acceptability of learning aid module in disentangling least mastered competencies in wave motion as to appeal

Statement	SA (4)	A (3)	D (2)	SD (1)	WM	Descriptive Rating
1. The material's lessons captured my own interest.	49	22	2	0	3.59	Strongly Agree
2. The exercises' layout established my comfort and motivation.	48	23	2	0	3.58	Strongly Agree
3. The material provided varied benefits to my own learning capacity.	50	23	0	0	3.68	Strongly Agree
4. The material stimulated my interest in learning the lessons.	54	19	0	0	3.74	Strongly Agree
5. The information form the material enabled me to develop critical thinking and problem-solving.	55	18	0	0	3.75	Strongly Agree
Average					3.67	Strongly Agree

Table 7 reflects the students' responses in relation to the acceptability level of the learning aid module in disentangling the least mastered competencies in wave motion as to usability. The obtained weighted mean for all the items in the usability of the material range from 3.66 to 3.81 which corresponds to the descriptive rating of "strongly agree". The average weighted mean for the level of acceptability of instructional enrichment material in terms of usability is 3.74, which is "strongly agree." Based on the result of this study, the learning aid module helps the students understand the concepts about wave motion since it provides a variety of learning activities that fit their capabilities. It only means that the learning aid module improves the students' study habits and active involvement at their own pace.

Table 7. Distribution of weighted mean of the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to the usability of the material

Statement	SA (4)	A (3)	D (2)	SD (1)	WM	Descriptive Rating
1. Instructional enrichment materials helped me gain satisfaction in recognizing experimental variables.	59	14	0	0	3.81	Strongly Agree
2. The use of instructional material as an aid in learning scientific research skills made every topic more exciting and enjoyable.	57	16	0	0	3.78	Strongly Agree
3. The instructional enrichment materials gave the students self-confidence in doing scientific research activities.	52	21	3	0	3.71	Strongly Agree
4. The instructional enrichment materials create strategies that allowed me to practice knowledge and skills in my own pace.	55	18	0	0	3.75	Strongly Agree
5. Instructional enrichment materials stimulated my own desire and interest to learn more about the subject matter.	48	25	0	0	3.66	Strongly Agree
6. The material helped me gain maximum participation during the lectures and discussions.	55	18	0	0	3.75	Strongly Agree
7. Instructional materials as tool for learning how to recognize experimental variables improved my study habits.	55	18	0	0	3.75	Strongly Agree
8. I learned more when given activities suited to my ability.	56	15	0	0	3.74	Strongly Agree
9. With the aid of instructional enrichment materials, I gained self-worth in dealing with research variables.	53	20	0	0	3.73	Strongly Agree
10. Instructional enrichment materials improved my skill in recognizing experimental variables.	54	19	0	0	3.74	Strongly Agree
Average					3.74	Strongly Agree

DISCUSSION

The finding implies that the student increased their understanding of the concept of wave motion through the use of the learning aid module. This result can be attributed to the learning objectives of the learning aid module that are realistic, detailed, attainable, and measurable within the learning abilities of the student-respondents. In addition, it provides activities that address the students' needs by applying authentic tasks that enhance active learning. It only means that the learning aid module relates the students' experiences with

their expectations. Therefore, they can explicitly demonstrate their knowledge and skills in relation to the concepts of waves. Numerous research projects have focused on utilizing the learning aid modules. In agreement with this concept, Libata et al. (2021) indicated that modules were the most effective learning instrument for promoting a good transfer of learning. They discovered that modules mimic student performance. It improves the quality of teaching, hence providing learners with a superior education. According to them, the most effective and relevant educational tools that educators should prioritize are modules. Merano (2012) stressed that several researchers shared the same ideas on the theories that will enhance the educative process and improve understanding using learning aid materials. In addition, Palila (2004) mentioned in his research study that utilizing a modular approach to the educative process is an instrument for obtaining extensive acceptance to the different educational institutions since it fosters independent learning and curricular development. Lastly, Mbaubedari et al. (2022) pointed out that learning materials play an important function in developing the students' learning outcomes when it comes to the teaching-learning process. Hence, the quality of instruction depends upon the design and structure of information on which the learning aid material was made.

Based on the level of acceptability of the teaching aids module in describing the competencies that are less mastered in wave motion with learning objectives, it was found that students strongly agreed. It implies that the module contains detailed and well-explained learning objectives that are considered within the students' level of ability. It only means that the objectives of the said material follow the ultimate goals of science teaching. The said module provides learning objectives that follow the standard list of competencies as prescribed in the K to 12 Curriculum that is expressed in terms of realistic results that the teachers intend to achieve. Therefore, the objectives are quantifiable, well-defined, and attainable. The average weighted mean for the level of acceptability of didactic enrichment material regarding learning objectives is 3.74, which is “strongly agree.” It only indicates that the learning aid module comprises objectives that provide a collection of well-defined and particular learning practices and integrated values that are quantifiable and attainable and correspond to the topic's content requirements.

Learning objectives describe the information and abilities that the teacher expects students to gain throughout their learning experience (Osueke et al., 2018). Learning objectives must be specific, reasonable, achievable, and measurable within the available time limit base on basic competence (Darma et al., 2019). As a result, at the end of the learning, all passing students should be able to show the knowledge and skill defined by the learning achievement. The learning objectives determine the material's intended results. Good learning goals in learning materials define an observable performance, one that the instructor can witness and assess.

The important characteristic of effective learning activities is that they facilitate the attainment of intended learning objectives (O’Clair, 2017). A deeper understanding of knowledge and the ability to apply knowledge in real-life situations are likely to be attained if students work on problems or projects that reflect an authentic professional situation or complex theoretical issues. Learning activities of instructional materials are those that enable students to learn actively. The idea is rooted in a constructivist view of learning: learning is attained when learners actively construct their own meanings or understandings. Learning activities that facilitate active learning are often also student-

oriented – the focus is on the students' learning processes and how they work on tasks. Hence, it fosters critical thinking skills among the learners.

Based on the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to clarity, it was found that students strongly agreed. Based from the results, it only indicates that the learning aid module conveys such content that can be understood easily since the concepts are well-arranged thoroughly. This result corresponds to the study of Merano (2012) that instructional material develops self-pacing of learning and individualized instruction which is organized in logical sequence; therefore, it can help students to become independent. In addition, Newby (2006) defined clarity as to the capability of the instructional material to provide instructions, expositional or otherwise, which help the learners come up with a clear material understanding. The clarity of learning aid modules has been linked with increasing students' achievement. Clarity is a vital key to helping the learners understand the relationships among the lessons and establish linkages between what is taught and their own learning activities. The important concept of clarity is the logical arrangement of the contents of the learning aid module that can be understood and processed easily by the students to achieve mastery of the ideas and concepts.

Based on the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to the accuracy, it was found that students strongly agreed. These results are considered to be parallel with the findings of Newby (2006) that learning aid modules must include essential features in order to reveal the truthiness of the contents that can be found in the said material. Learning aid modules must contain appropriate words and statements in order to elaborate the concept of a certain topic. Moreover, students benefit from the accuracy of the data and pictures used to convey a broad range of fundamental concepts and ideas, including facts, laws, theories, and principles, in order to better appreciate and explain them. In order to learn and appreciate the concepts and ideas, it is vital to use instructional materials that are suitable for comprehension.

Based on the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to appeal, it was found that students strongly agreed. All words must be spelled properly, all font sizes are readable, all margins are set appropriately, and all media and resources connected to the available teaching material are emphasized by Newby (2006), in line with the findings. Therefore, learning aid modules' layout must be well-established in order to enhance students' comfort and motivation in order to avoid negative perceptions of the material. These features will foster the students' interest in learning to attain higher-order thinking skills.

Based on the level of acceptability of the learning aid module in disentangling least mastered competencies in wave motion as to the usability of the material, it was found that students strongly agreed. The results conform to the study of Palila (2004) that through the utilization of instructional materials, learners can regulate their time management as well as the pace of their learning in accomplishing the different tasks as prescribed in the instructional module. Its target audience must use the learning aid modules to attain specified learning objectives with efficiency, effectiveness, and satisfaction. There are several factors to consider while developing an effective learning aid module, such as its target audience's expectations and motivations. This will significantly impact the entire

learning experience if the students' experiences meet their expectations. The learning experience should either meet or exceed the expectations of the students.

CONCLUSION

The developed constructivist learning aid module in disentangling the least mastered competencies in wave motion is a valid learning tool for enhancing the process of learning Moreover, the learning instructional material in disentangling the least mastered competencies in wave motion is remarkable for use since the base on parameters, learning objectives, learning activities, clarity, accuracy, the appeal of the material, and usability were observed by the respondents. In addition, a summative evaluation of the constructivist learning aid module may be conducted to determine the effectiveness of the material in disentangling least mastered competencies in wave motion aside from testing its validity. Furthermore, other authentic learning experiences and performance assessments may be used to enhance further the understanding of the nature of wave motion. The learning aid module in disentangling the least mastered competencies in wave motion can be utilized by other students in order to eliminate those misconceptions about the real nature of waves. The same type of material for other topics in force, motion, and energy within the area of scientific inquiry may be developed to address the needs of the students to continue and foster the acquisition of the paramount goals of science education.

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