

Development and Validation of Module in Fluid Physics

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ABSTRACT

The researcher opts for the study entitled Development and Evaluation of Module in Fluid Mechanics. The purpose of this study is to develop instructional module in Fluid Mechanics. Specifically, it aimed to evaluate the module in terms of content, design and features, organization and presentation, clarity, assessment, style or Creativity, and illustration. This study made use of the descriptive comparative research design. It described the modules and compared the assessment of respondents in terms of Learning outcomes/objectives, Structure and Layout, Self-assessment Questions and Activities, Response to Self-Assessment Questions, The Text itself, Learning Content, General Instructional, and Vocabulary and it compared the ratings given by teachers and students. The instrument used in the study was a questionnaire developed by the researcher and validated by the experts using five (5) point rating scale for the eight (8) aspects of modules. The respondents of the study were the Nine (9) Physics faculty of Isabela State University and the thirteen (13) Science major students chosen through purposive sampling. The data were tabulated and illustrated to arrive at significance findings through mean, standard deviation and t-test. The study revealed that the developed learning modules in Fluid Mechanics are acceptable learning material for teachers and students of Isabela State University. In regard to the evaluation of the developed modules, students desire a better quality of module than the teachers particularly in terms of layout and structure. Meanwhile, teachers have better appreciation for the modules' learning objectives than the students due to teaching experience and maturity.

INTRODUCTION

The 21st Century has ushered in an age of technology and innovation in which new things and millions of ideas/information are introduced at such a regularity that it has become a precondition for society to constantly adapt to change to keep on learning. This has become the constant challenge to the education sector: to cater to learners who are expected to navigate through an ever-changing world. Hence, pedagogical methods are also incessantly shifting to teach students how to observe, discern, and reason out using their senses.

Understanding how people learn is particularly important for the teachers who are interested in providing effective instruction. A knowledge of learning principles aids the teacher in establishing the proper conditions in a class to maximize how students attain new knowledge and develop an appropriate attitude towards their studies. The teacher can accomplish this through a combination of certain elements including instructional materials like books, modules and other visual aids. If the principles, methods of teaching and instructional materials provide the teachers with the means for improved technique, instructional materials, on the other hand, assist in the learning experience. Instruction in the sciences has always recognized the vitality of textbooks for learning.

Most science teachers in the K to 12 Program of the Department of Education, and even the Commission on Higher Education learning institutions such as public and private colleges and universities, employ this instructional material extensively. Because of their widespread use, these reference textbooks and modules should be carefully crafted according to the needs of the students. For starters, they must be based on the objectives, and goals of the subject to be studied. Many well-written books are readily available in commercial libraries. However, many students can not afford these materials due to economic reasons. Thus, the researcher has developed an instructional material (modules) for education students (BSEd) majoring in science. This subject is Fluid Mechanics. The content of the instructional modules is based on CMO 75, s. 2017. Fluid Mechanics deals with the science of fluids (liquids and gases). It discusses aerodynamics, the study of air and gasses in motion and hydrodynamics- the study of liquid in motion.

It also discusses principles relating speed, pressure and forces particularly Bernoulli's and Pascal's Principles. Due to Covid 19 Pandemic, Schools including HEIs resort to Emergency Remote Teaching. Isabela State University adopted the Flexible Teaching learning Modalities (FTLM) which includes both synchronous and asynchronous teaching and learning. Synchronous sessions allow the teacher to meet the students online via Zoom meeting, Google Meet, and the likes. During asynchronous sessions, the students do self-study using the modules prepared by the teachers in advance. Hence, the researcher opted for the study entitled "Development and Evaluation of Modules in Fluid Mechanics

THEORETICAL REVIEW

Importance of Instructional Materials

Teachers' effectiveness includes their ability to choose, develop and use instructional materials for enhancing instruction delivery. It is therefore a given concept that instructional materials can affect the quality of instruction. In particular, instructional materials support student learning, give lessons structure and assist teachers in differentiating instruction (Ministry of Education, 2016).

Moreover, said materials also have the power to either engage or discourage student participation and, ultimately, achievement. Interestingly enough, the UNESCO International Institute for Educational Planning (2020) recognizes how quality instructional materials can actually compensate for certain disabling factors like large class size, poorly-trained or unqualified teachers, inadequate instructional time, high levels of parental illiteracy and lack of reading materials at home which are common problems in developing countries. With this, instructional materials should be planned, selected, organized, refined and used carefully for them to achieve maximum effect (University of Wisconsin-Madison, 2019).

Types of Instructional Materials

The UNESCO International Institute for Educational Planning (2020) identified the primary instructional materials as follows: textbook, teachers' guide, supplementary materials and multimedia and digital resources.

Of all the aforementioned instructional materials, it is probably the textbook which is the most familiar. UNESCO characterizes it as 'the most visible aspects of a curriculum and are often considered the main script that shapes the teaching and learning processes'. Graves (2000) as cited by Gak (2014) also described it as a standard source of information in the study of a subject. Furthermore, it provides 'confidence and security' for teachers since they can easily utilize it to frame their lessons.

Another instructional material is the teacher's guide. Also known in some cases as the teacher's manual or teacher's handbook, its general purpose is to assist the teacher in navigating through the teaching process. Hence, as accorded by the UNESCO, it is important that this should: contain explicit statements of conceptual goals that are directly linked to activities; to provide knowledge and support to the implementation of teaching plans; to reinforce pedagogical content knowledge; to guide pedagogical activities; to present instruction delivery alternatives; and engage teachers in reflecting about their work.

Supplementary materials on the other hand pertains to other books, news publications, information pamphlets and others that can be used to enrich teaching, engage students and build students' abilities in knowledge application.

Multimedia and digital resources are also popular instructional materials at present especially when the nature of 21st Century learners are taken into consideration. Additionally, Li and Lalani (2020) highlighted the significance of this kind of instructional materials during the COVID-19 pandemic when face-

to-face instruction has been prohibited. Similarly, the World Bank (2020) has even enumerated examples from countries such as Afghanistan, Argentina, Austria, Bangladesh, Bermuda, Bhutan and Brazil which had developed and used multimedia and supplementary learning resources to cope with the issues of education access during the pandemic.

Instructional Materials Selection and Development

The significance of carefully selecting the instructional materials to be utilized in the teaching and learning process has already been emphasized in the aforementioned literature.

As Workosky (2018) aptly stated, how instructional materials are selected is as important as what materials are being selected. This is because the method of instructional material selection can actually help address certain implementation issues if it is conducted properly. A well-conducted need analysis, carefully selected criteria as well as a collaborative effort on the part of the stakeholders are all recommended for ensuring the proper selection and implementation of instructional materials.

According to O'Loughlin (2020), most state and territory education authorities stipulate guidelines for the selection of instructional materials and even schools have their standard procedures specifically designed to take into consideration the factors that affect the efficacy and appropriateness of the materials. In the guidebook of Prince Edward Island Department of Education (2017), for an instance, it was specifically stated that the selection of learning resources involves the collaboration of stakeholders, however it is the teachers who holds the most responsibility especially since they are the ones who are directly involved in instruction. In the same guidebook, the following were mentioned as specific considerations for instructional material selection: content, format and design which included the alignment to curriculum outcomes as well as appropriateness to the subject area, age, ability level, learning style and social development of students; methodology which specified that the materials to be selected should be interactive, versatile in such a way that it can meet the needs of students' individual aptitudes, abilities, learning styles, multiple intelligences and interest as well as promote critical thinking among learners; and assessment or evaluation which indicated that the materials should support continuous learning, provide formative and summative evaluation and be relevant for students' needs. Also, social considerations were indicated, particularly with regards to the following: gender equity, multiculturalism and minority education.

O' Loughlin (2020), on the other hand, also identified certain considerations for material selection: adherence to education department and school processes; link to curriculum; and appropriateness to students' needs. Secondary considerations that he specified included the promotion of inclusivity and support for diversity.

Similarly, the development and writing of instructional materials, there are also factors to consider. In the case of Philippine Normal University for example, a university circular was released indicating the guidelines for instructional material development. Therein, the criteria for quality

instructional materials were specified as follows: coherence of framework that is also consistent with the curriculum, curriculum policies and standards alongside national and international contexts; adherence to established educational objectives to enhance learning and to address the specific needs of students; reflection of accuracy of content, pedagogical appropriateness and suitability of contexts and languages for intended audience; and connectedness to the existing curriculum development process that specifies where and how materials suit a complete curriculum. In the same circular, the development of instructional materials is also credited to a faculty member and the process defined as follows: needs analysis, framework design, content development, material implementation and material evaluation (Ogena, 2014).

The Module as an Instructional Material

One of the focuses of instructional material development in the wake of the COVID-19 pandemic is the module. While it is true that many educational institutions geared up for online learning delivery modes, a majority of schools in rural areas opted for modular learning. In fact, Education Undersecretary Diosdado San Antonio declared that at least 59 percent of the total number of enrollees in public schools have opted for printed modules as their mode for learning (Magsambol, 2020).

Maloney and Kim (2020) also stated that the modular approach to course design is advantageous especially during the COVID-19 pandemic since modules can be constructed in such a way that they relieve the pressure from students through its topical nature. The module, after all, is a self-contained unit of a topic which requires the learner to perform a specific task or a series of interrelated tasks. Nardo (2017) also defines it as a form of individualized instruction which enables learners to use a self-contained package of learning activities.

According to Guido (2014), the module composes of a series of activities with teaching instructions, explanations, exercises and generalizations which the learners can go through at their own rate and even recycle when necessary. As a self-instructional material, the module promotes learner-centeredness since it enables students to discover and experiment with knowledge by themselves. They also become more responsible for their learning thus shifting their role from passive receiver of knowledge to active participants involved in the learning process. As Friestad-Tate, Schubert & McCoy (2014) pointed out, modular learning's strongest attribute is its consideration for the student's individualized approach to the content.

The module plays a significant role in higher education since it is a common instructional material used by many college instructors and professors. As mentioned by French (2018) universities tend to favor the modular structure so as to address the needs of diverse students who might need leeway in managing their studies. After all, modular learning is specifically famous for its flexibility, choice, access and mobility.

Advantages and Benefits of Modular Instruction

The benefits of the module as an instructional material are manifold and have already been cited in various studies. Dejene and Chen (2019) for an

instance, stipulate that modular learning meets the needs of today's learners better compared to the traditional methods especially in terms of the quality of learning and content. The continuous follow-up and assessment also gives instructors the necessary adjustments to the teaching and learning process.

Meanwhile, the study of Wahidah et al. (2019) emphasized the role of modular learning in light of globalization and the significance of information technology in the 21st Century. In their work, they aimed to develop e-modules: ICT-based learning materials for science with interactive properties such as ease of navigation, display of images, videos and feedback through formative tests. The teachers who implemented the said instructional material recognized its positive contribution to instruction especially in terms of helping develop new skills in ICT.

In another study, Alias and Siraj (2012) tested prototype Physics modules with students and teachers as respondents. The said instructional material was based on the perceived learning styles and the context of educational setting of the study's locale. The results of the study showed that the developed modules was particularly effective for visual learners, active learners and reflective learners. Because of the success of said modules are now used extensively and were even published on various educational websites.

Auditor and Naval (2014) also developed Physics modules to address the least mastered competencies in the 10th grade curriculum and determined their appropriateness in terms of objectives, content, design characteristics, learning activities, adaptability, clarity, and evaluation as perceived by the pool of experts, teachers, and students. The outcome of the study showed that the modules were effective in addressing the needs of the teachers and students, therefore signifying that modules are effective tool for teaching and learning Physics.

University student respondents in the study conducted by Moradi et al. (2018) also expressed their positive approval and feedback towards the use of modules as instructional materials in science and mathematics courses. Like in the previously discussed studies, the performance of the respondents also improved when they used modules in their courses.

The same perspective was also seen in the student respondents of a study by Bi et al. (2019) in which Physics was also taught in a small private online course through modules. Findings indicated that the modular approach piqued the students' interest in learning and allowed them to explore their learning potentials.

Module Design

According to Friedstad-Tate et al. (2014), the conceptualization of the module can be linked to the andragogical approaches such as metacognition, constructivism and authentic experiences. Metacognition is the process by which learners gain awareness and think about how they are thinking. Through metacognition, learners develop the ability to self-monitor, self-assess and even self-correct themselves while engaged in a learning process. In doing so, the learners go through a constructivist process in learning since they are no longer passive receivers of information and knowledge. Instead, they take

responsibility for their own learning and even put their knowledge into practice in authentic experiences. All of these can be accomplished through modular learning, especially if the modules used are well-designed and carefully developed.

And hence, in relation to this O'Neill et al. (2005) as cited by Friedstad-Tate et al. highlighted the following points as important considerations for successful modular design: "sustained interaction with content and others; relating new ideas to previous knowledge; providing explicit explanations and a clear knowledge base to students; structuring in a reasonable student workload; providing opportunities for students to pursue topics in depth so that they can understand the material for themselves; and ensuring an appropriate formative and summative assessment strategy."

METHODOLOGY

The Descriptive comparative research design made use of this study. It described the modules and compared the assessment of respondents in terms of Learning outcomes/objectives, Structure and Layout, Self-assessment Questions and Activities, Response to Self-Assessment Questions, The Text itself, Learning Content, General Instructional, and Vocabulary and it compared the ratings given by teachers and students. The respondents of the study were the Nine (9) science teachers, who are currently teaching at Isabela State University and holders of post graduate studies in Master's and Doctorate programs, and the thirteen (13) Science major students. The researcher utilized purposive sampling procedures as to the selection of the respondents of this study. Only the teachers can teaching Physics and major in science served as respondents of the study.

The instrument used in the study was a questionnaire developed by the researcher using five (5) point rating scale for the eight (8) aspects of modules such as Learning outcomes/objectives, Learning content, Structure and Layout, Self-assessment Questions and Activities, Response to Self-Assessment Questions, The Text itself, General Instructional, and Vocabulary. The indicators were interpreted by referring to the following interval scale 1.0-1.79 (Poor); 1.80-2.59 (Fair); 2.60 - 3.39 (Satisfactory); 3.40 - 4.19 (Very satisfactory); 4.20 - 5.0 (Excellent) related to the characteristics and presentation of modules. The gathered data were tabulated and interpreted in order to arrive at significant findings to answer the problems in the study. In order to do this, the following statistical tools were employed. The *mean and SD* described the evaluation of the respondents and *t-test* for independent samples to compare evaluation given by students and teachers

RESULTS

<i>Criteria</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Descriptive Interpretation</i>
OAVE	3.30	0.57	Excellent
SALAVE	3.27	0.62	Excellent
SAQAve	3.29	0.55	Excellent
RSAVE	3.35	0.67	Excellent
TIAVE	3.41	0.48	Excellent
CAVE	3.37	0.49	Excellent
PAVE	3.46	0.42	Excellent
VAVE	3.39	0.43	Excellent
OVERALL	3.35	0.45	Excellent

The table above shows the respondent's evaluation of the learning outcomes and objectives (OAVE) of the module constructed. Findings indicate that the respondents evaluated the attainability and measurability of instructional objectives. The clarity of the instructional objectives, the relevance of objectives to the topics, the time-bounded-ness of objectives and the clarity of statement for prerequisite knowledge garnered a descriptive interpretation of Excellent for overall average. This shows that the learning module's objectives and outcomes are liked by the respondents as these are clear and attainable. Since the material assessed is a learning module, the statement of the learning objectives and their connection to learning outcomes need to be well-defined, attainable and measurable. As Faulconer (2017) discussed in her study, content mastery results when students are well-informed of their learning objectives. Furthermore, learning also becomes more meaningful as the students are made aware of the direction of their lessons.

The respondents evaluation of the learning module's structure and layout (SALAVE). The findings show that the respondents rated the attainability of each learning chunk within the specified time, the availability of materials needed by the learners to complete the lesson and the consistency of text format used, the logical presentation of contents in each lesson, the interconnectedness of each learning chunk to one another, the face validity of the layout for easy navigation and the clarity of text use were rated as *Excellent*. Presents the respondents' evaluation of the Self-Assessment questions and activities (SAQAve) in the learning module examined. The data indicates that enhancement of tasks, relevance of activities to the level of students and the variety of self-assessment questions or tasks were considered as *Very Satisfactory* by the respondents; whereas the clarity of the self-assessment questions/tasks, the adequacy of the self-assessment questions/tasks, appropriateness of the difficulty levels for the questions and activities and the appropriateness of the self-assessment questions in achieving the objectives were rated *Excellent* by the respondents.

Reveals the respondents' evaluation of the responses to the self-assessment questions (RSAve) in the learning module examined. As can be

seen, the respondents considered the immediacy of feedback for the module's self-assessment questions, the clarity of explanations, the thoroughness of explanations and the immediacy of feedback to self-assessment questions were rated *Excellent* by the respondents.

The respondents' evaluation of the text itself (TIAve) in the module. As shown, the respondents rated the clarity of the text itself as Very Satisfactory. As for the rest of the indicators, the respondents assessed them all as Excellent. These included the readability of the text, the relevance and coherence to the learning objectives and learning content, the adequacy of examples to enhance the lesson, the relevance and appeal of the examples provided, the learner-friendliness of language, the appropriateness of the words and language for a self-learner, the consistency of headings and subheadings, the availability of text descriptions to orient the learners, the depicts the respondents' assessment of the learning content of the module (Cave). It is shown that lesson's content as well as the adequacy of the content to elicit and address common misconceptions were both considered by the respondents as Very Satisfactory. Meanwhile, the relevance of the content to the objectives, the logical arrangement of concepts from simple to complex, the capacity of the content in developing students' discrimination of relevant from non-relevant information, the potential of content to improve critical thinking skills and the capacity of the content to elicit logical and detailed responses from students were all considered by the respondents as Excellent. The findings imply that the respondents regard the content of the learning module positively.

A module's primary function is to enable independent learning among students with minimal intervention from teachers. If the content is not well-developed and is not effective to provide independent learning to students, the module's main goal is defeated.

Indicates the respondents' evaluation of the procedures and general instructions (Pave) in the learning module examined in this study. Findings show that the respondents rated ease of following instructions as *Very Satisfactory*. Meanwhile, they regarded consistency of procedures, logical sequencing of procedures, consistency of numbering and placement of illustrations, ease of visualization of illustrations, figures and diagrams, representations in illustrations/figures/diagrams, comprehensiveness of illustrations/figures/diagrams to allow students to view concepts from different perspectives, clarity, consistency and usefulness of instructional icons to help orient/lead the learner through the module and usefulness of instructional icons to help orient/lead the learner through the modules as *Excellent* respondents' assessment on vocabulary (VAve) used in learning module. Herein, the respondents rated the absence of unnecessary technical jargon as Very Satisfactory. Well-defined technical terms, accuracy and consistency of punctuation marks used, accuracy of grammar usage and accuracy of spelling usage, meanwhile, were rated as Excellent. distinctiveness of important points by highlighting (i.e. formatting in bold, italics, font size, borders and boxes), and the clarity of indication of relationships between

1. Comparison of Teachers' and Students' Evaluation of the
Developed Instructional Modules in Fluid Mechanics along the eight
Aspects

t-relative to type of respondent

Indicator	Type	Mean	T value	P
<i>Statement for the Learning Objectives and Outcomes</i>	Faculty	3.629630	2.502	.021
	Student	3.076923		
<i>Structure and Layout</i>	Faculty	3.67	2.036	.050
	Student	3.08		
<i>Self-assessment Questions and Activities</i>	Faculty	3.67	1.907	.071
	Student	3.15		
<i>Reponses to Self-Assessment Questions</i>	Faculty	3.56	1.317	.203
	Student	3.15		
<i>The Text itself</i>	Faculty	3.67	1.250	.226
	Student	3.31		
<i>Content</i>	Faculty	3.67	1.423	.170
	Student	3.31		
<i>Procedure / General Instructional</i>	Faculty	3.67	1.423	.170
	Student	3.31		
<i>Vocabulary</i>	Faculty	3.500000	1.045	.309
	Student	3.307692		
OVERALL	Faculty	3.603505	2.388	.027
	Student	3.182463		

The different values computed for the comparison of ratings given by the teachers and students. It is revealed that the teachers and students significantly differed in their assessment of the learning objectives and structure and layout of the module. The students gave lower rating than the faculty in these two aspects. This implies the students' more exposure and liking for technology which make them prefer better book presentation and feel that the module's layout needs improvement. The teachers prefer simple layout and design. Meanwhile, in terms of the learning objectives, teachers show broader and deeper knowledge than the students. This may be due to their teaching experience, maturity and appreciation for the subject. Students' assessment may not have been based on the characteristics of learning objectives

DISCUSSION

Based on the analysis, discussion and interpretation of data, the following findings were consolidated accordingly:

The faculty and student's respondents, in Isabela State University Cauayan Campus examined and assessed the learning module according to several indicators. Results showed that they rated the statement of learning objectives and outcomes as *Excellent* with an overall mean of 3.30 and a standard deviation of 0.57. The structure and layout was rated as *Excellent* with an overall mean of 3.27 and a standard deviation of 0.62. Similarly, the self-assessment questions and activities as well as the responses to self-assessment questions were rated as *Excellent* with the mean of 3.29 and 3.35 and the standard deviation of 0.55 and 0.67 respectively. The respondents rated the text itself as *Excellent* with an overall mean of 3.41 and a standard deviation of 0.48. As for the content, the respondents also rated it as *Excellent* with an overall mean of 3.37 and a standard deviation of 0.49. The module's procedures and general instructions was rated as *Excellent* with an overall mean of 3.46 and a standard deviation of 0.42. As for the module's vocabulary, the respondents rated it as *Excellent* with the overall mean of 3.39 and a standard deviation of 0.43. The teachers give significantly higher evaluated rating than the students on the module which mean ratings of 3.60 and 3.18 respectively.

CONCLUSIONS AND RECOMMENDATIONS

Based on the above findings, the study concludes that the developed learning modules in Fluid Mechanics are acceptable learning material for teachers and students of Isabela State University. In regard to the evaluation of the developed modules, students desire a better quality of module than the teachers particularly in terms of layout and structure. Meanwhile, teachers have better appreciation for the modules' learning objectives than the students due to teaching experience and maturity.

In consideration to the findings and conclusions of the study, the faculty and students of BSED at ISU Cauayan are encouraged to continue using the developed instructional modules in teaching-learning Fluid Mechanics. The future researchers may conduct a related study but focusing their inquiry on the impact of the learning module on the academic performance of the students; hence a pre-test post-test design is recommended; and the developed instructional modules in Fluid Mechanics be used by instructors/professors of other ISU campuses for further improvement or enhancement and for its adoption as instructional material in the entire ISU system.

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