

DEVELOPMENT AND VALIDATION OF A MODULE IN FLUID MECHANICS FOR PRE-SERVICE SCIENCE TEACHERS

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ABSTRACT: Fluid mechanics is one of the major subjects for pre-service science teachers under CMO 75, series of 2017. A module was developed for this course since references for this subject are scarce for teacher education students. The purpose of this research was to develop and validate a module in fluid mechanics using a descriptive method according to the a) attainment of its objectives, b) accuracy of the contents, c) originality, d) clarity, and e) appeal. The Readability of the Material and the Student Engagement Index were likewise measured and identified. Results of the validation show an average rating of 4.44 (very high) for the attainment of objectives, 4.47 (very high) for accuracy of contents, 3.89 (high) for its originality, 4.27 (very high) for clarity, and 4.00 (high) for its appeal. The general average rating of 4.21 is interpreted as very high. The validation further reveals higher ratings as to the correctness of the concepts and ideas presented, the order and sequencing of ideas, and the doability of the activities. Design and arrangement, vividness and description of the illustrations however still need improvement as lesser ratings were given to these aspects. The Readability of the module was analyzed to be 70/170, ready for Grade 13 as read by the Fry Graph, while the student involvement index is 1.1 which falls within the recommended range of 0.4 – 1.5 by Romey.

Keywords: Fluid Mechanics, Module, Pre-Service Science Teachers, Validation, Readability, Student Involvement Index

INTRODUCTION

It is commonly acknowledged that textbooks and other learning and teaching materials (LTM) play a crucial role in enhancing the standard of instruction and raising student achievement (Smart and Jagannathan, [1, 2, 3, 4]. Although instructional materials come in any form, they are all aimed to support the learning of the students. They are resources utilized in educational activities like active learning and evaluation. A print form such as a module is one type of instructional material.

Educators are aware of the purpose of learning modules, which act as a roadmap for classroom instruction. The learning module's concept is highly varied because each expert has their definition. Nonetheless, instructional modules are used to organize course content by weeks or units to create a one-directional flow of what the students should do in a course.

A module is a virtually self-contained unit of work in the course of instruction, according to Hornby, who was mentioned by Yoseph and [5, 6]. It is also a teaching strategy that is centered on the development of skills and knowledge in discrete pieces. Guido defined a module as an autonomous, independent learning material to help the student to achieve some well-defined goals [7]. The learner can proceed at his/her rate while at the same time, monitoring his/her learning. In this way, the learner can also identify his/her strengths and weaknesses [7].

Morrison claimed that self-paced learning techniques, also known as self-instruction are given the greatest consideration in instructional design [8]. There is ample data to back up the idea that independent study is the best way for students to learn.

Mullings [9]; claimed that proper scaffolds and engaging students in the independent study are found to have a high impact on the learning of students aside from its low-cost way to improve progress. In independent learning, students are active in setting goals and evaluating their academic development thus teaching them how to learn, which the very core of learning is [10].

Modular instruction promises a more efficient mass education by offering more effective individual instruction at a time when a teacher is faced with the problem of producing learning in a large group all at the same time [11]. Furthermore, modules are found to be more efficient for mass education by giving more effective individual instruction [12].

This study was aimed at developing and validating a self-instructional module in Fluid Mechanics intended for use by pre-service science teachers. Fluid Mechanics is a three-unit non-laboratory course in Bachelor of Secondary Education-major in Science specified in CMO 75, s. 2017. In the few years of its implementation, references for this course are limited with no specific material intended for the pre-service science teachers.

Development of a good module however requires the meeting of certain characteristics to be relevant and effective for the intended learners. The first phase of its evaluation is its face evaluation by expert faculty in the field, followed by its readability and student involvement Index [13].

The readability of the modules is an essential quality factor that has yet to be investigated. The readability of a text refers to how easy it is to comprehend it. As a result, no matter how good the content, language, or instructional design of the modules are, they will be useless if they are written at a level beyond the readability of the learners [14].

“Student Engagement”, which displays relevant and entertaining learning information in the science textbook aids their comprehension, encourages inquiry and problem-solving abilities, and provides an opportunity for students to think, express ideas, and debate their views through activities and exercises [15].

Particularly, this study aimed to attain the following objectives:

1. Determine the validity of the developed Module in Fluid Mechanics for Pre-Service Science Teachers in terms of its components such as:

- a. Attainment of Objectives
 - b. Accuracy of the Contents
 - c. Originality
 - d. Clarity
 - e. Appeal
2. Determine the Readability of the developed Module in Fluid Mechanics for Pre-Service Science Teachers
 3. Determine the Student Involvement Index of the developed Module in Fluid Mechanics for Pre-Service Science Teachers

Conceptual Framework of the Study

The flow of the study is described in Figure 1. Target recipients were assessed on their content knowledge in Fluid Mechanics to analyze which topic should be given emphasis and more substance in the development of the module. The design of the module followed which also includes the setting of the objectives per lesson. Development of the whole module followed including the assessments which are based on the objectives of each lesson.

The validity of the module is based on its a) attainment of objectives, b) accuracy of contents, c) originality, d) clarity and e) appeal. After the face validation, the developed module was analyzed as to its Readability using Fry Graph to determine if it was appropriate for the intended learners. To test if the module will actively involve the students, an evaluation was also done using the Romey formula for Student Involvement Index.

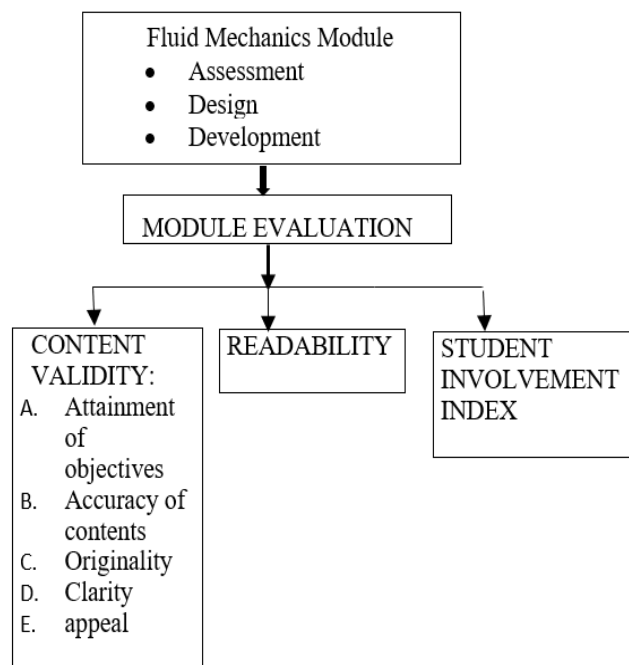


Fig. 1 Conceptual Framework

Readability of the Module

Fry Readability Graph (Fig 2) developed by Edward Fry was used to determine the readability of the developed module. This method involves the random selection of 100-

word passages on three sample pages eliminating the numbers from the word count. The number of sentences and syllables in each 100-word passage are then counted, followed by the calculation of the Average Sentence Length and Average Number of Syllables. These two lines are plotted in the Fry Graph (Figure 2) to find the point of their intersection. The area where the dot is plotted signifies the approximate reading grade level of the content.

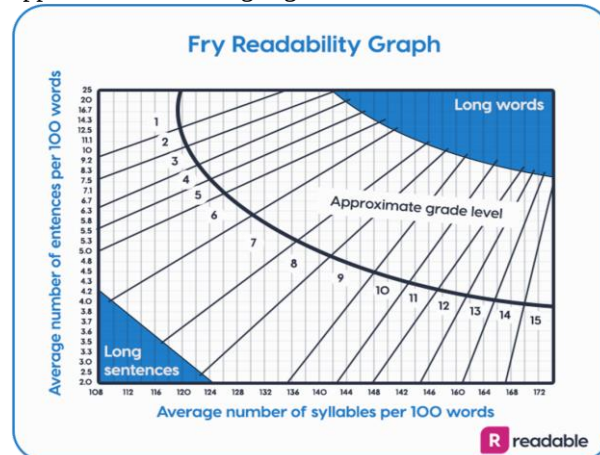


Figure 2. Fry Readability Graph

Student Involvement in the Module

Romey's procedure evaluates the student's involvement in the module. In this method, the author selected 10 pages of the module, then starting with the first paragraph, sentences were classified according to categories such as facts, stated conclusions, definitions, and questions answered immediately. These sentences belong to Category I. The sentences that are classified as: questions requiring students to analyze, statements requiring students to formulate conclusions, directions to a student to perform and analyze some activity and solve problems, and questions to arouse students to answer and not answered immediately belong to Category II. Then the ratio of the Total Category II to Total Category I is computed and compared to Romey's Involvement Index (eq. 1).

$$\frac{\text{Total for Category II}}{\text{Total for Category I}} \quad (\text{eq. 1})$$

When the value of the involvement coefficient is between 0.4 and 1.4, it is considered acceptable and suggests that the students can interact with the module effectively.

MATERIALS AND METHODS

Research Design

This study used the descriptive survey method in validating the module. A questionnaire was utilized in validating the module according to its face validity, readability, and student involvement index.

Respondents

Three experts were selected as validators of the instrument. They are physics teachers handling pre-service science teachers. Their specialization is in Physics and their length of service as faculty of the College of Teacher Education is more than five (5) years.

Instrument

A researcher-made instrument was utilized in validating the module. The parameters of the validating instrument are adapted from Talisayon and Yu (1997)[16]. It contains 20 items that are answerable on a five-point Likert scale to wit:

5 – Very High (VH)

4- High (H)

3 - Moderately High (MH)

2 – Low (L)

1 -Very Low (VL)

Readability was determined using the Fry graph by Edward Fry (1968) [17], while Romey (1968) [18] was used to determine the Student Involvement Index.

Data Analysis Plan

The data gathered from the survey were tabulated and the mean was calculated. The description of the results is analyzed based on this plan:

Mean	Description
4.21- 5.00	Very High
3.41 – 4.20	High
2.81 – 3.40	Moderately High
1.81- 2.80	Low
1.00- 1.80	Very Low

RESULTS AND DISCUSSION

Validation by Expert

Validation by the experts reveals the acceptability of the module with a *very high* rating in the attainment of objectives (4.44), as well as in the accuracy of the content (4.47), and clarity (4.27). The originality of the module was rated 3.89, while 4.00 for the appeal, all described as *high*. A general rating of 4.21 describes the module with *very high* validity. Table 1 - 5 shows this result. The validation further reveals higher ratings on the correctness of the concepts and ideas presented, the order and sequencing of ideas, and the doability of the activities. Design and arrangement, vividness and description of the illustrations however still need improvement as lesser ratings were given on these areas.

Table 1 Validation of Module as to the attainment of objectives

A. ATTAINMENT OF OBJECTIVES	Mean
1 The objectives of the module are clearly stated.	4.66 (VH)
2 The objectives are attainable within the prescribed time.	4.33 (VH)
3 The activities and evaluation are congruent with the objectives.	4.33 (VH)
AVERAGE	4.44 (VH)

Table 1 displays that the module has *very high* ratings as to the attainment of the objectives with a mean of 4.44. It shows that the objectives are clearly stated as well as its attainability and congruency with a description of *very high*. When learning objectives are communicated to students, the reasoning goes, students will be more likely to achieve the presented goals [19].

Table 2. Validation of Module as to the accuracy of contents

B	ACCURACY OF THE CONTENTS	Mean
1	The contents are well-organized and well-prepared.	4.33 (VH)
2	The sample problems, activities, and evaluation go well together with the discussion.	4.33 (VH)
3	The contents are accurate and appropriate to the level of students indicated.	4.67 (VH)
4	It is interesting and self-motivating.	4.00 (H)
5	The concepts and ideas conveyed are correct and accurate.	5.00 (VH)
	AVERAGE	4.47 (VH)

Table 2 shows that the content of the module has *very high* accuracy with a rating of 4.47. It also shows that the content of the module is appropriate to the level of the students and they are well-organized. Furthermore, the discussion in the module is in congruence with the activities and evaluation. A lower rating however is given to the module in terms of its being interesting and self-motivating with a rating of 4.00, yet, still has a description of *high*. The results imply that the module is well-prepared and accurately designed for the intended users. The accuracy of the learning material is vital to learning as it supports the intended learning goals (Rahmawati et al., 2021) [20].

Table 3. Validation of Module as to its Originality

C	ORIGINALITY	Mean
1	The module is original in its kind.	4.33 (VH)
2	The author properly recognizes the sources of information used.	3.67 (H)
3	The design and arrangement are unique	3.67 (H)
	AVERAGE	3.89 (H)

Table 3 presents that the proper recognition of the author in the module and the uniqueness of its design is rated 3.67 with a description of *high*. It is rated *very high* as being original in its kind a mean of 4.33. The mean rating for its originality is 3.89, a description of *high*. Originality is the quality of created or invented works that distinguishes them from replicas, clones, frauds, or derivatives (1976 Copyright Act)

Table 4. Validation of Module as to its Clarity

D	CLARITY	Mean
1	The contents are clearly stated and easy to comprehend.	4.00 (H)
2	The illustrations are vivid and clearly described.	3.33 (MH)
3	The ideas are in order and properly sequenced.	5.00 (VH)
4	The module conveys the ideas in a very understandable manner.	4.00 (H)
5	The descriptions of the activities are clear and doable.	5.00 (VH)
	AVERAGE	4.27 (H)

Table 4 presents that the orderliness and sequencing of ideas in the module are *very high* as well as the doability of the activities suggested. A *high* rating is obtained as to the module's clarity of content and comprehensibility. The vividness and description of the illustrations need to be enhanced as they are rated 3.33 (*moderately high*). The overall clarity of the module is *very high* with a rating of 4.27. Clarity's role is to reduce impediments to student motivation, hence removing a crucial barrier to learning: as student motivation rises, so does student learning [21].

Table 5. Validation of Module as to its Appeal

E	APPEAL	
1	The illustrations are attractive that give interest to the readers	4.33 (VH)
2	The appearance of each page is eye-catching and appealing.	3.67 (H)
3	The arrangement of the topics persuades the reader to read more.	4.00 (H)
4	The module is intellectually challenging and stimulating.	4.00 (H)
AVERAGE		4.00 (H)

Table 5 presents that the module has attractive illustrations with a mean rating of 4.33 and a description of *very high*. In terms of the appearance of each page, the arrangement of the topics, and the challenge, the module is given a rating of *high*. A mean rating of 4.00 (*high*) means that the module is generally appealing to the readers.

Readability of the Module

The plotting of the average number of sentences and syllables (Table 6) in the Fry Graph shows the calculated readability of the module to be 70/170 which is appropriate for the Grade 13 level. This is equivalent to a first-year college in the Philippines. This indicates that the developed module is appropriate for the intended user. Its content is readable and easy to understand. As mentioned by Woo [14], the readability of the module is an important quality for the comprehension of the intended learners.

Table 6. Readability Result

Page	Number of sentences	Number of syllables
6	7	163
12	6	163
20	8	184
Sum	21	510
Average	7.0	170
Appropriate for		Grade 13

Student Involvement Index

As shown in Table 7, the total number of sentences for Category I is 60. For Category II, the total number of sentences is 66. Based on these data, the calculated student involvement index is 1.1 as shown in equation 2. This value

falls within the range identified by Romey (0.4- 1.5). The result indicates that the developed module in Fluid mechanics would aid their comprehension and would encourage them to think more creatively, stimulates problem-solving skills, and inquiry skills, and discuss thoughts through activities [15].

Table 7: Student Involvement Index of the Module

Category	Number of sentences										T
	P6	P7	P8	P9	P 10	P 19	P 20	P 24	P 27	P 28	
1. Facts	3	1	4	2	2	3	0	0	2	0	17
2. Stated Conclusion	1	1	2	2	5	1	0	2	4	0	18
3. Definitions	2	0	2	0	2	6	1	0	0	0	13
4. Questions Answered immediately	1	1	0	2	0	2	1	3	0	2	12
Total for Category I	7	3	8	6	9	12	2	5	6	2	60
5. Questions requiring students to analyze	4	0	0	2	3	2	1	6	2	1	21
6. Statement requiring the student to formulate a conclusion	2	1	0	2	1	2	1	0	2	0	11
7. Directions to students to perform and analyze some activities and solve problems	2	3	0	2	3	0	2	6	1	1	20
8. Questions to arouse students to answer and not answered immediately	2	3	1	0	4	0	1	1	1	1	14
Total for Category II	10	7	1	6	11	4	5	13	6	3	66

Equation 1:

$$\text{student involvement index} = \frac{\text{total for category II}}{\text{total for category I}}$$

$$= \frac{66}{60} = 1.1 \quad \text{eq. 2}$$

CONCLUSION AND RECOMMENDATIONS

Results of the content validity, readability, and student involvement index and comments of the validators imply that the module is generally acceptable and appropriate to the intended users of the module. Further, the result of the student involvement index suggests that the module can be used as self-learning material. Comments to enhance its design and illustrations are being done to make it more appealing to the students. It was further recommended that the pre-test shall undergo pilot testing for its reliability.

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