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Validity and Acceptability of the Developed Supplementary Learning Module in Organic Chemistry

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Abstract: **This paper highlights the acceptability of a supplementary module developed for Organic Chemistry Education. The development of the module is relevant to the Theory of Constructivism, where students can learn new ideas based on their prior knowledge and experiences gained during discussions. The module was developed using the Successive Approximation Model (SAM). This utilizes the iterative process–the module was first validated by experts and revised before it was distributed to the students for use. This process ensures a well-designed module to aid in the learning needs of the students. The validation of the module, as evaluated by experts, revealed a high overall mean (4.53) and content validity index (CVI) (0.92). This denotes a valid learning module to aid the learning difficulty of students in the subject. Meanwhile, students assessed the acceptability of the developed learning module. The results (overall mean = 4.294) revealed "High Acceptability" of the developed learning module. This indicates that the module demonstrates potential as an effective instructional tool among students enrolled in Organic Chemistry classes. However, students noted areas needing improvement, such as the addition of more examples, illustrations, and learning activities.**

Keywords**: successive approximation model, supplementary module, student acceptability, instructional material.**

I. INTRODUCTION

Modular approaches have been widely implemented worldwide as part of the competency-based training agenda (Boahin & Hofman, 2014). One of its goals is to give support aids to students with learning difficulties (Ayado & Berame, 2022). This integrates self-learning modules (SLM), crafted and aligned with the most essential learning competencies (MELCs) to supplement the discussions, especially those complex and abstract concepts in Sciences and Mathematics (Abude, 2021; Anzaldo, 2021; Sadiq & Zamir, 2019). Several studies noted the positive impacts of supplementary modules. Gonzales (2015), Arnandho and Sutheejariyawattana (2022), and Sidek et al. (2022) revealed that students developed an in-depth understanding of the subject matter through supplementary modules. According to Gustiani et al. (2017), the supplementary modules help students develop cognitive skills and understand the subject matter. This motivates them to learn the module independently, needing less teacher supervision (Anzaldo, 2021; Nardo, 2017). Furthermore, this leads to their commendable academic performances (Ayado & Berame, 2022).

However, the effectiveness of the module depends on how it is developed. Sirisuthi & Chantarasombat (2021), modules without a structured framework may not yield their desired outcomes. Meanwhile, effective instructional materials (IMs) are developed systematically. Among the models for IM development is the Successive Approximation Model (SAM). Iskandar et al. (2022) and Jung et al. (2019) recognized SAM as an effective model due to its progressive nature, promoting continuous improvement and refinement of the learning materials. Its iterative process ensures that the module is well-designed before it is distributed to its target audience.

Organic Chemistry plays a significant role in human beings. It deals with the structures, properties, and reactions of compounds containing carbon, which is considered the backbone of life. This course explains relevant areas, such as medicines and health, food and nutrition, agriculture, energy, and other products used daily (Ilhan et al., 2008). Despite its importance, it is considered one of the challenging subjects. Students expressed that the reactions, mechanisms, and rules in naming and drawing the structures of organic compounds are the areas with the most complex discussions (da Silva et al., 2021; Salame & Khalil, 2023). A study by Onukwu and Ikenna (2024) revealed that students are interested in learning laboratory activities over lectures in science-related courses, such as Physics, Chemistry, and Biology. The students' lack of interest in lectures is due to the abstract and complex discussions compared to laboratory activities (de Quadros et al., 2013; Sirhan, 2007). Hence, various studies considered ways to address the lack of students' interest in learning Organic Chemistry through learning materials to supplement the discussions. This aligns with the Theory of Constructivism (Bruner, 1960), relevant to the development of supplementary modules where students learn new ideas from their previous knowledge and experiences (Andres et al., 2022).

Recently, Organic Chemistry has been widely integrated into tertiary-level education. Several institutions in the Davao Region, Philippines, offer programs with Organic Chemistry in their curriculum. However, there has been a lack of studies conducted related to providing supplementary materials to aid the discussions. Hence, this study aims to assess the acceptability of the developed learning module in Organic Chemistry as a supplement to the discussion. This fills the knowledge gap and provides relevant information on the acceptability of supplementary modules among students to enhance their understanding of the subject matter.

II. BODY OF ARTICLE

Statement of the Problem

This study seeks to answer the following research questions:

1. What is the level of validity of the developed learning module in selected topics in Organic Chemistry, evaluated by experts in terms of the following criteria:
   1.1. Objectives;
   1.2. Content;
   1.3. Presentation and Organization;
   1.4. Language and Style; and
   1.5. Usefulness?
2. What is the level of acceptability of the developed learning module in selected topics in Organic Chemistry, assessed by students?

III. METHODOLOGY

Research Design

This study utilized a descriptive-developmental research design. This design developed a learning module on selected topics in Organic Chemistry, supplemental in the discussion. Furthermore, descriptive design is used to describe the characteristics of the developed module through numerical data obtained from survey interviews (Conde, 2021; Nassaji, 2015).

Modular Development using SAM

Preparation Phase

Initial assessment with the students enrolled in the Organic Chemistry class in the First Semester of the Academic Year 2024-2025. This process allowed the researcher to develop the learning module based on the needs of the students. Based on the assessment, students find difficulties in naming and drawing the structures and the reactions of organic compounds. This observation was supported by da Silva et al. (2021) and Salame and Khalil (2023) that students find the subject matter challenging due to its complexity. Thus, students appreciate the development of a learning module supplementing the discussion.

Iterative Design

The module followed the Activity, Analysis, Abstraction, and Application (4As) template. This design allows the students to connect present ideas from the previous module through a series of activities that were included in the module. It also helps the students demonstrate the knowledge and skills gained in the module and apply them in real-world situations. Furthermore, the development was aligned with the most essential learning competencies (MELCs). The developed module, *Alpha version*, was validated by experts in terms of the five criteria to ensure that the concepts were relevant and crucial to students' learning needs. The module aimed to enhance the skills of students that are applicable in real-world scenarios.

Iterative Development

After the validation of the module conducted by experts, the *Alpha version* was revised based on the experts' recommendations. Experts believe these areas in the module need further enhancements. Firstly, some of the contents in the module were not clearly discussed, and more learning tasks should be provided in the module to enhance students' understanding. Secondly, experts emphasized the need for substantial visual representations, such as illustrations, examples, and icons, to promote better understanding of the discussions. Lastly, experts believe that simple and appropriate words are essential to deliver effective discussions in the module.

All the recommendations made by experts were incorporated in the module, *Beta version,* which was distributed and utilized by students to supplement Organic Chemistry discussions. Furthermore, students assessed the acceptability of the module, *Beta version*.

Sampling

The study included 7 experts within the Davao Region. Experts handling Organic Chemistry classes from different academic institutions in the region were the basis of the selection. In addition, the selected experts are familiar with instructional materials or curriculum design. These experts evaluate the validity of the developed learning module in terms of the Objectives, Content, Presentation and Organization, Language and Style, and Usefulness. On the other hand, 144 students from a state-governed university in the Province of Davao Oriental, Philippines, assessed the acceptability of the learning module. These students were officially enrolled in Organic Chemistry classes in the First Semester of the Academic Year 2024-2025.

Analysis

Quantitative analysis was used in this study to provide data that systematically organizes and interprets the findings. The data gathered from the surveys were encoded in Microsoft Excel 365, and the findings were presented in tables with numerical values obtained using appropriate statistical tools. Descriptive statistics (mean and standard deviation) were calculated for each statement to provide the levels of validity and acceptability of the developed learning module among experts and students.

Mean. This was utilized to address statement problems 1 and 2. Problem 1 aims to answer the validity of the developed learning module among experts in terms of the five criteria–Objectives, Content, Presentation and Organization, language and Style, and Usefulness. Problem 2 involves the assessment of the level of acceptability of the developed learning module as evaluated by students.

Content Validity Index (CVI). This statistical tool was used to address statement problem 1. It is a non-parametric test, and it does not require a large sample size. According to Lynn (1986), CVI works for at least 3 respondents, and it measures the content validity of the individual criterion and the overall item. Additionally, CVI does not solely consider the highest rating, but rather, it focuses on whether experts rated an item as "**valid**", defined in the 5-point Likert scale. The CVI threshold value should be ≥ 0.86, ideal for 6-10 experts.

IV. RESULTS

Validity of the Developed Learning Module evaluated by Experts in terms of:

Objectives

Table 1 shows the validity of the developed learning module in selected topics in Organic Chemistry in terms of the Objectives as evaluated by experts. This criterion obtained a high mean score (4.83) and a high CVI score (0.97). The high overall scores in both the mean and the CVI indicate that experts considered the validity of the learning module. This implies that the Objectives in the module were specific, measurable, attainable, realistic, and time-bound (SMART).

Table 1. Validity of the Developed Learning Module in terms of Objectives.

Validation Statement	Mean	CVI	Description
1. Specific objectives accompany each lesson in the module.	4.71	0.86	Strongly Agree
2. The objectives are stated in behavioral terms.	4.86	1.00	Strongly Agree
3. The specific objectives are measurable.	4.86	1.00	Strongly Agree
4. The specific objectives are realistic.	4.86	1.00	Strongly Agree
5. The specific objectives are attainable.	4.86	1.00	Strongly Agree
Overall	***4.83***	***0.97***	***Strongly Agree***

Among the five validation statements under this criterion, item 1 received the lowest mean score (4.71) and CVI (0.86). This indicates that the objectives in each lesson should be more specific. Meanwhile, other validation statements obtained a perfect CVI (1.00), which means that the objectives in the module are expressed in behavioral terms.

Content

The validity of the developed learning module in terms of the Content was shown in Table 2. The results showed that the validation statement 3 had the lowest mean score (4.00) and CVI (0.71) obtained. This means that the module should provide more examples and illustrations that further enhance students' understanding of the subject matter.

On the other hand, the remaining validation statements received a high mean score described as "Strongly Agree", indicating that the discussions are clearly and explicitly presented. Furthermore, the high overall mean score (4.31) and the CVI (0.89) value above the ideal threshold indicate that the content of the developed learning module is "**valid**".

Table 2. Validity of the Developed Learning Module in terms of Content.

Validation Statement	Mean	CVI	Description
1. Expected learning competencies are contained in the module.	4.29	0.86	Strongly Agree
2. The lessons are presented at a pace that allows for reflection and review.	4.43	1.00	Strongly Agree
3. There is adequate presentation or discussion of content.	4.00	0.71	Agree
4. The ideas, concepts, and points presented are well-explained.	4.43	0.86	Strongly Agree
5. Supplementary activities enhance students' understanding of the content.	4.43	1.00	Strongly Agree
Overall	***4.31***	***0.89***	***Strongly Agree***

Presentation and Organization

Table 3 shows the results of the validation of the developed learning module in terms of the Presentation and Organization evaluated by experts. Among the validation statements, experts showed strong agreement in terms of the presentation and organization. This was evident in the overall mean score (4.43) and CVI (0.94) obtained. While experts observed well-organized presentations on the module, they also emphasized areas needing improvement. These areas include the addition

of learning tasks, illustrations, and examples for a better comprehension of the discussion. However, experts appreciate the clear and logical discussions of the topics in the module.

Table 3. Validity of the Developed Learning Module in terms of the Presentation and Organization.

Validation Statement	Mean	CVI	Description
1. The presentation of topics is sequential.	4.86	1.00	Strongly Agree
2. The discussion of topics is clear and well-presented, logical and orderly.	4.57	0.86	Strongly Agree
3. The variety of activities is sufficient to realize the objectives.	4.00	1.00	Agree
4. The illustrations, examples, figures, and exercises are instruments for learning.	4.14	0.86	Agree
5. The instruments for assessment of the targeted objectives are included.	4.57	1.00	Strongly Agree
Overall	***4.43***	***0.94***	***Strongly Agree***

Language and Style

Table 4 presents the validation of the developed learning module in terms of the Language and Style examined by experts. The results revealed a high mean score and CVI for each validation statement, as well as the overall mean score (4.63) and CVI (0.94). This finding indicates that the language used in the module is simple, appropriate, and suitable for different types of learners. The instructions in the module were clear and easy to follow; however, experts believed that it could have been improved to deliver more effective learning. Furthermore, the high CVI (0.94) obtained means that the learning module developed was "**valid**".

Table 4. Validity of the Developed Learning Module in terms of the Language and Style.

Validation Statement	Mean	CVI	Description
1. The words used in the module are correctly used.	4.57	0.86	Strongly Agree
2. The vocabulary used is suitable for the comprehension level of students.	4.71	1.00	Strongly Agree
3. Instructions to students are clear and easy to follow.	4.71	0.86	Strongly Agree
4. The lessons are presented in paragraphs or sentences that are grammatically correct.	4.43	1.00	Strongly Agree
5. The module is accompanied by clear and specific directions for its use.	4.71	1.00	Strongly Agree
Overall	***4.63***	***0.94***	***Strongly Agree***

Usefulness

Table 5 shows the validity of the developed learning module in terms of Usefulness. The result of the validation revealed a high overall mean score (4.43) and CVI (0.86). This finding indicates that the developed learning module is "**valid**". However, experts recognized the need to provide additional ideas that are relevant in real-world scenarios, as shown in the mean score obtained in the validation statement 1. While the module is a beneficial learning tool, experts believe that it addresses the learning needs of all types of learners.

Table 5. Validity of the Developed Learning Module in terms of Usefulness.

Validation Statement	Mean	CVI	Description
1. The modules enable the students to analyze and apply the information and theories in real-life situations.	4.14	0.86	Agree
2. The modules are engaging, beneficial to the students' learning, and supportive of higher-level thinking skills.	4.43	0.86	Strongly Agree
3. The students can learn, understand, and answer the guide's questions thoroughly by reviewing examples and illustrations provided per topic.	4.57	0.86	Strongly Agree
4. The modules can make the students learn and understand the subject matter by reviewing the illustrations and examples at their own pace.	4.71	0.86	Strongly Agree
5. The modules have well-defined accommodations to support a diversity of learners.	4.29	0.86	Strongly Agree
Overall	***4.43***	***0.86***	***Strongly Agree***

Generally, the overall mean score across the five criteria–Objectives, Content, Presentation and Organization, Language and Style, and Usefulness of the developed learning module received a high rating of 4.53. This result indicates that the module is well-designed and easier to follow. Meanwhile, the overall CVI received a high score (0.92), meaning the developed learning module is "**valid**".

Acceptability of the Developed Learning Module Assessed by Students

Table 6 shows the acceptability of the developed learning modules among students. The high overall mean score (4.294) and a standard deviation (0.748). This highlights the effectiveness of the learning module as a supplementary tool in the discussion to enhance students' learning needs. The high scores indicate high acceptability of the developed learning module among students.

The highest rating obtained was item 6 (mean score = 4.41). This indicates that the presentation or the discussion in the module is well organized. In contrast, item 3 received the lowest mean score (4.13) among all the validation statements. This result emphasizes the need to provide ideas that enhance the skills of the students, applicable to career development. Moreover, students recognized the high acceptability of the developed learning module to aid in Organic Chemistry classes.

Table 6. Acceptability of the Developed Learning Module Assessed by Students.

Validation Statement	Mean	SD	Description
1. At the start of the module, I received clear information and guidance on what the module covered and on assessment details.	4.34	0.655	Strongly Agree
2. This module has increased my understanding of the subject.	4.24	0.698	Strongly Agree
3. The module allowed me to gain skills to aid my employability or career advancement.	4.13	0.794	Agree
4. The module contents were up to date.	4.31	0.700	Strongly Agree
5. The module was relevant to my course.	4.21	0.812	Strongly Agree
6. The module was well organized.	4.41	0.699	Strongly Agree
7. The learning resources provided in the module websites/links were helpful to my learning.	4.343	0.727	Strongly Agree
8. The reading list was helpful.	4.393	0.727	Strongly Agree
9. I was able to contact the course instructor when I needed to.	4.343	0.727	Strongly Agree
10. I have received sufficient advice and guidance concerning my module.	4.271	0.767	Strongly Agree
11. The assessment requirements and making criteria were clear.	4.314	0.759	Strongly Agree
12. The assessment tasks and associated marking criteria were made available quickly.	4.250	0.750	Strongly Agree
13. The balance between teaching and independent learning was appropriate.	4.314	0.778	Strongly Agree
14. The module prepared me well for the assessment tasks.	4.236	0.755	Strongly Agree
15. Feedback throughout the module has helped me to develop and improve my learning.	4.300	0.784	Strongly Agree
Overall	***4.294***	***0.748***	***Strongly Agree***

V. DISCUSSIONS

Validity of the Developed Learning Module as Evaluated by Experts

Learning modules are an essential component in education. It serves as a tool to supplement discussions, especially those highly complex courses. However, Sirisuthi & Chantarasombat (2021) emphasized that the positive effects of modules depend on how well the framework is used during development. According to Rogayan and Dollete (2019), objectives are crucial in modular development. The effectiveness of the module is influenced by clear and measurable objectives, making lessons easier to follow (Buselic, 2017; Dargo & Dimas, 2021). Additionally, objectives should be well-defined and articulated. It also gives clear directions for the discussions (Yazon, 2018). Students best learn new information through well-organized learning outcomes and discussions (Logan et al., 2021). This helps teachers track students' academic

progress. Thus, the development of the module should consider a defined and simple discussion and provide substantial examples to reinforce key concepts.

In addition, the content should be well-explained and provide additional learning tasks that promote better understanding of the discussion. It is considered a relevant pedagogical resource for effective discussions (Lerman, 2014). Simplified discussions of the subject contribute to the effectiveness of the learning module. This is aligned with the study of Rotas and Cahapay (2020) that unclear and ambiguous content often leads to difficulty in learning among students. Meanwhile, better content promotes independent learning (Torrefranca, 2017).

Furthermore, several studies noted the importance of logical presentations to the students' ability to better understand complex discussions (Ambayon, 2020; Andres et al., 2022). Technical formatting significantly impacts students' motivations toward the learning module (Basilio & Sigua, 2022). Incorporating more illustrations and learning activities into the module could also strengthen students' comprehension (Li et al., 2019; Cossid, 2021). Additionally, Castro and Tumibay (2021) suggested that using clear and concise language positively impacts students. Learning modules are considered flexible instructional materials (IMs) able to meet various learning needs (Salcedo, 2016; Savec & Devetak, 2013). This aligns with the current ideas in science education, where teaching methods should be sensitive to students' learning needs (Bernacki et al., 2021). This strength is essential to keeping students abreast of the discussions. However, Gallardo (2021) emphasized that the relevance of the learning module varies depending on its suitability to the field of specialization.

Acceptability of the Developed Learning Module Assessed by Students

The students appreciated the precise information and guidance provided in the module. This helps them understand the subject and gain the skills needed for career development. They recognized that discussions in the module are well-organized and relevant to the course. Additionally, ample learning resources are available, which are essential for students. This indicates that students appreciated the clear communication of learning objectives, which is vital for effective engagement with the course material (Reay, 2020). Studies by Bernardo and Roleda (2008), Carrol and Burke (2010), and Munna and Kalam (2021) added that well-defined objectives reinforce the module in enhancing subject comprehension.

On the other hand, foundational subjects like Organic Chemistry may require explicit examples of real-world applications to highlight their practical value (Henderson et al., 2019). The high rating reflects the relevance of career-driven factors in student engagement and comprehension (Fuad et al., 2019). Students emphasized that instructors were easily reached when needed. This suggests that the module is well-supported. This highlights the crucial role of instructors in positively impacting students' learning process (Abuhassna & Yahaya, 2018; Gray & DiLoreto, 2016; Guidote, 2020; Shand & Farrelly, 2018).

Lastly, students appreciate independent learning; however, instructors' guidance is as necessary. They believe regular feedback provided in the module was seen as instrumental in helping students develop and improve their performance and understanding of the module (Tan-Espinar & Ballado, 2017; Wisniewski et al., 2020). This balance promotes active learning while encouraging students to work with the material independently (Nardo, 2017; Szadziewska & Kujawski, 2017; Yazon, 2018).

VI. CONCLUSION

This study focused on the validation of the developed learning module in selected topics in Organic Chemistry to supplement the discussion. Experts examined the validity of the learning module across the five criteria– Objectives, Content, Presentation and Organization, Language and Style, and Usefulness. On the other hand, students assessed the acceptability of the developed learning module.

The result of the validation revealed the module's potential to aid students in the learning process. The high mean score and CVI for each criterion denote a valid learning module. Experts recognized the strengths of the learning module. These strengths include simple and appropriate words used in the module, easy-to-follow instructions, and a well-organized presentation. These are all crucial in promoting a better understanding of the subject matter.

Students appreciate the clear and logical discussions in the module. They recognized the relevance of the module and its ability to support independent learning. The high mean score indicates the "High Acceptability" of the learning module in supplementing Organic Chemistry classes. However, students noted areas in the module that lacked clarity in the discussions. Hence, they emphasized that the learning module could have been improved to deliver more effective learning.

Furthermore, these findings suggest that the development of the module should focus on the most essential learning competencies (MELCs). It is also highly recommended to use words that are simple and appropriate to cater to different types of students. Additionally, future developments should provide more illustrations, examples, and icons. Also, it should give more explicit and comprehensive discussions to strengthen the effective delivery of the concepts.

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