ACCEPTABILITY OF A WEB-BASED MODULE IN TRIGONOMETRIC FUNCTIONS UTILIZING ACTIVITY-ANALYSIS-ABSTRACTION-APPLICATION (4A'S) PATH

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ABSTRACT: *The use of online learning and teaching in this pandemic time are considered vital in promoting continuous education. Nowadays, educators are encouraged to transform all of their traditional teaching materials into an online format to facilitate continuous learning. This present study aimed to assess the developed Web-Based Module in Trigonometric Functions (WBMTF) as perceived by Information Technology (IT) Experts and Mathematics Experts of Bohol Island State University, Philippines. A descriptive developmental research design was employed. The study utilized two survey questionnaires. The first questionnaire was the "CAI Material Checklist" from Hossain & Akter (2013); Cajandig & Lomibao (2021). The second questionnaire was an "Evaluation of Instructional Technology Materials (EITM). It was a modified questionnaire patterned from Cajandig, A. and Lomibao, L. (2021). Both questionnaires used the 5-point Likert Scale. Results revealed that WBMM was highly acceptable in terms of technology and very highly acceptable in terms of a design of technology as assessed by Information Technology (IT) Experts. Moreover, mathematics experts rated "highly acceptable" to relevance to the curriculum, organization and structure, and instructional quality. The researcher concluded that WBMTF is highly acceptable as a learning material for online learning and teaching. As recommended, restrictions to wrong inputs must be considered, insertion of tutorial videos and varied digital tools to supplement learning and teaching. Further, WBMTF can be used as an alternative platform for online learning and teaching and future researchers may conduct parallel studies that will incorporate different pedagogy to maximize learning and teaching.*

Key Words: mathematics, education, mathematics education, module, instructional material, web-based module, assessment, descriptive developmental research design, online learning, 4A's Approach, Web-Based Instruction

1. INTRODUCTION

The COVID-19 pandemic resulted in an inevitable increase in the use of digital technologies due to social distancing standards and containment at the national level [1]. This pandemic has challenged the education system all over the world and forced educators to switch to online education rapidly. [22]. It was found out that universities around the world are increasingly moving toward online learning. Thus, this mode of learning is suggested to be essential in promoting continuous learning despite crisis [2]. However, the quality of online education is a critical issue that needs proper attention [3]. There is a greater need for educational institutions to strengthen the practices in the curriculum and make it more responsive to the learning needs of the students. This means educational institutions should prepare the courses for online transfer to facilitate continuous learning. This further implies aligning the competencies that students should learn in the subject courses in an online format [4].

Web-Based Instruction uses the World Wide Web as a repository for instructional information and the Internet as the distribution channel for that content [23]. It is a mode of online instruction that facilitates online distance learning. Advantages include accessibility, economies of scale, flexible scheduling, ease in updating, individualized instruction, and incorporation of novel instructional methods [7-8]. Some researchers noted that interaction and timely feedback, are often absent from Web-based instruction. particularly from individual Websites devised to teach [11].

Moreover, the use of the Web for instruction is at an early stage of development. Recently, there has been a lack of tools for instructional developers to use, but this shortcoming is beginning to change. The potential of Web-based instruction will increase as pedagogical practices improve, advances in standards for structured learning content progress, and improvements in bandwidth are made [12].

In this present study, the researcher developed a Web-based Module in Trigonometric Functions designed for online learning. It is application software that is capable to display modular lessons in Trigonometric Functions. It is a website in nature in which the user can visit, read, learn and interact with the site. It offers controls over who can have access to the pages and who can share the materials. It is user-friendly, usable, and readable through different mobile devices, laptops, and desktop computers. The flow of the lesson utilizes 4A's approach Activity-Analysis-Abstraction-Application (4A's) to have a meaningful learning experience.

The following are the stages of 4A's:

1. Activity. This will convey understanding to what the learners already know and clarity to what learners should learn further. At this early stage, the student should already have a review of what they will be learning through the activity that will be presented.

2. Analysis. The teacher on this part will just ask process questions to the students.

3. Abstraction. The teacher on this part will now focus fully on the lesson being presented and ask more lead questions to lead the students in strengthening what they know and should know more. The student here starts to feel more the importance of the lesson to her and see the significance of it to his/her life.

4. Application. The word itself describes the stage as bringing the student to a more concrete way of using how are they going to use what they have learned and thinking of new ways on how it can be improved further.

Hence, this study further aims to assess the developed Web-Based Module in Trigonometric Functions incorporated with 4A's (Activity-Analysis-Abstraction-Application) path as educational software for teaching and learning mathematics in an online learning environment.

2. METHODOLOGY

2.1 The Development Process

The following steps were undertaken in developing the Web-Based Module in Trigonometric Functions:

1. The researcher designed the WBMTF based on contents of the syllabus in AS 2 (Plane Trigonometry

with Solid Mensuration) for Technology Students. The material focused on Meaning and Nature of Trigonometry, Trigonometric Functions of an Acute Angle in a Right Triangle, Trigonometric Functions of Any Angle, Application of Trigonometric Functions and Solution of Oblique Triangles. WBMTF is a researcher-made computer-aided instructional material with the integration of 4A's approach for instruction. This material is a website in nature. It provides easy navigation, trendy intuitive design, convincing web content and attractive graphics and images. It can be accessed via smartphones, laptops, and desktop devices.

The researcher utilized Google site in creating the website. Google's site is free and has a simple and user-friendly interface. The WBMTF is created using templates for different pages without the need for advanced technical knowledge. For the user's interface, it has the following features:

(i)The user can navigate the icons and view the subject matter incorporated with 4A's Approach (Activity-Analysis-Abstraction-Application) in the development of the lesson. The evaluation part is also included at the end of every topic.

(ii)The user can view lesson slides and can download them in a printable version.

(iii)The site required the email account of the user to continue using the site and to verify and track outputs.

(iv)In the Activity part and Evaluation part, the user can input his/her answers.

(v)The user can view the remarks whether his /her answer is correct or incorrect for the user to learn and improve.

(vi)The user can view resource links for easy access.

(vii) It has also a feedback icon where the user can write their comments and suggestions about the site.

For the administrator interface, it has the following features:

(i) It can decide if users can create and edit the website

(ii) All the content on the website is stored in the google drive of the administrator.

(iii) It can upload/update/edit and delete files in the website. The updated site will be automatically reflected in the user's interface.

(iv) Access to students' output for the monitoring of the progress or the status of the students in using the website.

2. Creating the Website

There was one (1) computer expert who assisted the researcher in creating the website. The researcher presented the possible features, flow, and content of the website.

3. Testing the website

A trial test was conducted to ensure that the website is properly operational. There were three (3), Bachelor of Science, in Industrial Technology 1st year students who tried to use the Web-Based Module. To test the administrator's interface, the researcher and the computer expert tried to use the site. After the trial phase, there were features added to make the site more engaging and interactive such as the inclusion of digital tools, changing of graphics and images, appropriate slides presentation, and restriction to wrong answers.

4. Assessment of the experts on the website.

The researcher presented the site to the five (5) Computer Experts and five (5) Mathematics instructors in order to assess and validate the website. Their recommendations and suggestions were taken into consideration to have a fully functional website.

5. Finalization of the Web-Based Module

The researcher and computer expert finalized the web-based module considering the recommendations and suggestions.

2.2 Evaluation Process

This study used a descriptive developmental design. Survey questionnaires were used to assess the acceptability level of Web-Based Module in Trigonometric Functions. The first questionnaire was the "CAI Material Checklist" from Hossain & Akter (2013); Cajandig & Lomibao (2021) with a k-alpha = 0.6372 coefficient which means a high level of reliability. The second questionnaire was an "Evaluation of Instructional Technology Materials (EITM), a modified questionnaire patterned from Cajandig, A. and Lomibao, L [25], with a k-alpha = 0.8557 coefficient, which means a high level of reliability.

The participants of this study were ten (10) Information Technology (IT) experts who checked and evaluated the Web-Based Module based on the recommended criteria on Computer-Aided Instructional (CAI) Material Checklist with the following criteria: technology and design of technology. These ten (10) IT experts are composed of two (2) university programmers and eight (8) professors who are teaching in the Computer Engineering Program. Moreover, there were ten (10) Mathematics teachers who checked and evaluated the Web-Based Module based on the recommended criteria on Evaluation of Instructional Technology Materials (EITM).

3. RESULTS AND DISCUSSION

3.1 Web-Based Module Qualitative Discussion

Figure 1. Home Page

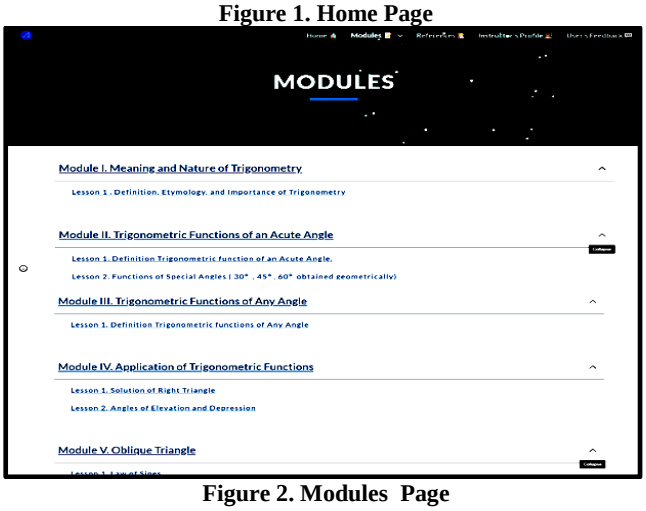

Figure 2. Modules Page

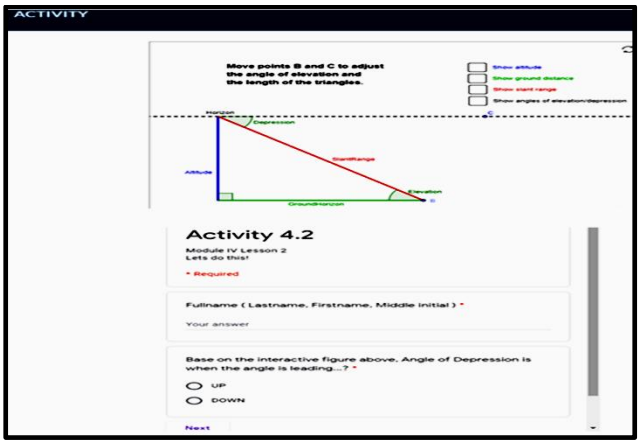

Figure 3. Sample Activity

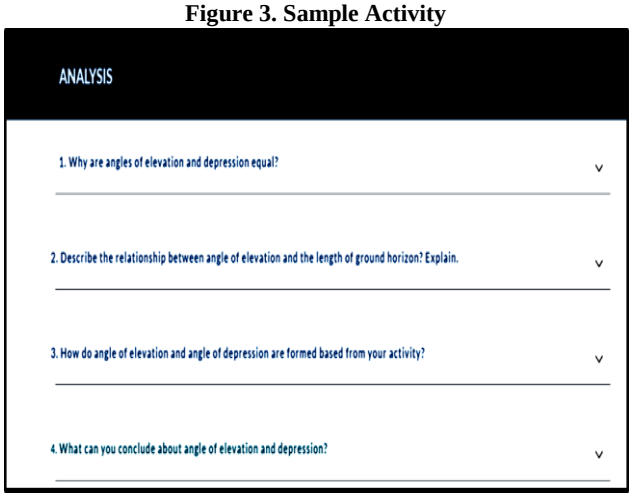

Figure 4. Sample Analysis

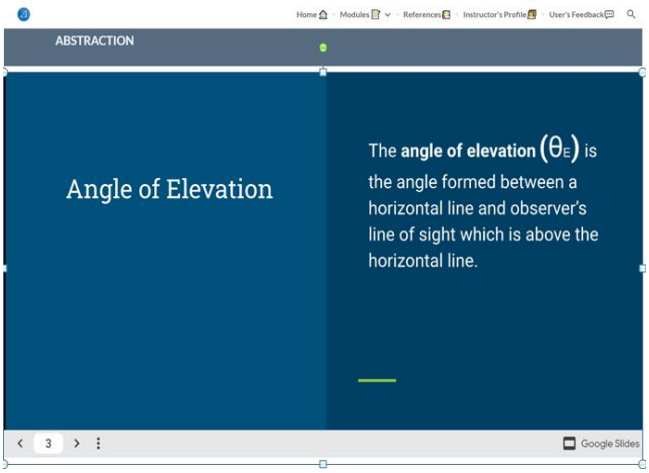

Figure 5. Sample Abstraction

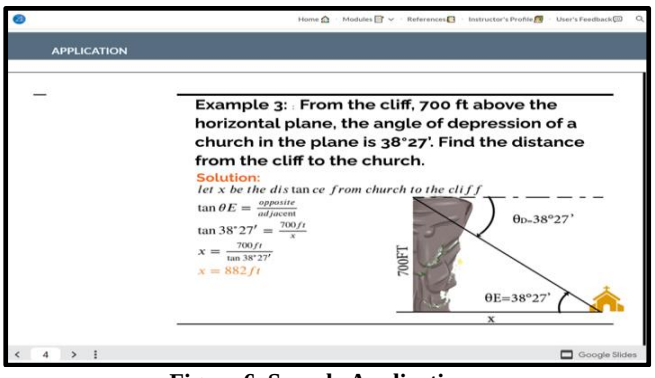

Figure 6. Sample Application

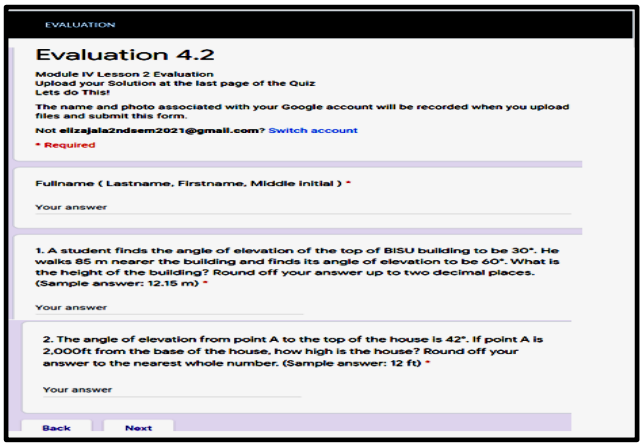

Figure 7. Evaluation form

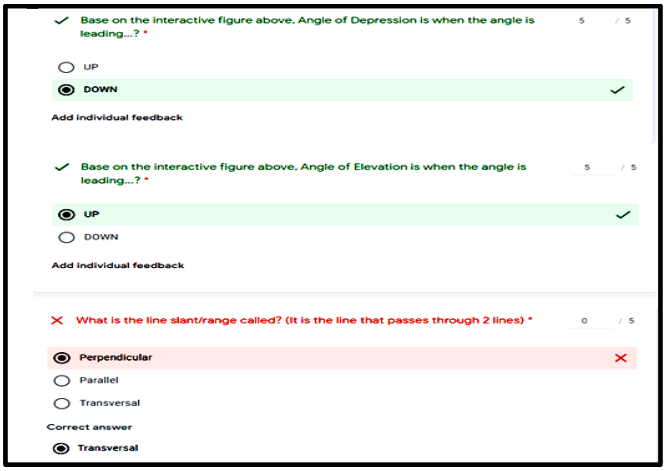

Figure 8. Remarks Activity

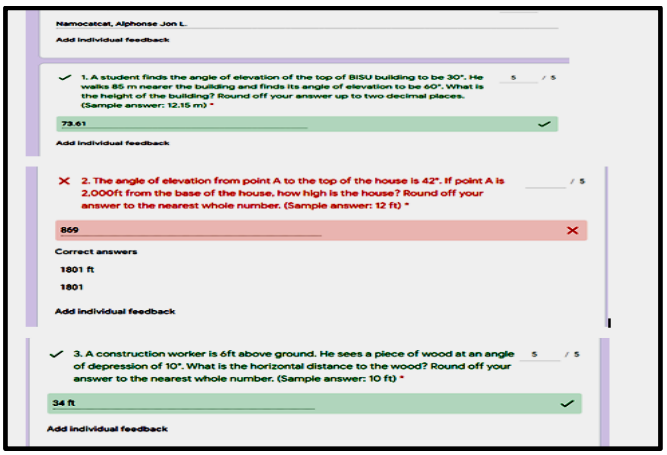

Figure 9. Remarks Evaluation

Figure 1 shows the Home Page of the Web-Based Module where the user can start navigating the pages of the site. On this page, the user can locate the course description and student learning outcomes. The icons located at the top corner of the page were Home, Modules, References, Instructor's Profile, and User's Feedback. Figure 2 displays the sequence of the modules. There are five modules listed on this page. Each module is broken down into specific lessons. The user simply clicks each module to see its contents. Figure 3 shows the activity form where the user can answer. This corresponds to the first part of the 4A's Approach which is the activity. In this stage, the users' prior knowledge is to be assessed. Figure 4 shows the analysis part where the user can think salient concepts based on the given activity. This corresponds to the second part of the 4A's

Approach. It consists of process questions that lead the user to the core of the topic. It also stimulates higher-order thinking skills. Figure 5 illustrates the abstraction part where the user can connect and expound his prior knowledge. This corresponds to the third part of the 4A's Approach. These are the core concepts
and ideas of the lesson. Also, it deepens users' understanding of the lesson. It is a slide presentation where the user can conveniently click or tap each slide until the last slide. Figure 6 shows the application part of the lesson. In this stage, the user can apply the learned concepts to practical problems. This corresponds to the last part of the 4A's Approach. Figure 7 shows the evaluation form of the module. It allows the users to input answers and solutions in the last part of the evaluation form. The goal of this form is to enhance and assess the learning of users. Figures 8 and 9 display the remarks of the Activity and Evaluation part respectively. Every correct answer will be marked as a checkmark. Also, every wrong answer will be marked "X". These remarks will help the user assess his performance on a specific lesson. The user can view the remarks immediately right after the submission of the form.

3.2 THE EVALUATION RESULT

Table 1. IT Experts' Assessment on Web-Based Module in Trigonometric Functions in terms of Technology

A. Technology	Mean	Interpretation
1. The screen layout is balanced, and the graphics are positioned appropriately.	4.4	Very Highly Acceptable
2. It is easy to find where you are and want to go within the program.	4.3	Very Highly Acceptable
3. Users can stop and find a way to exit when they need it.	3.7	Highly Acceptable
4. All resources link work well.	4.3	Highly Acceptable
5. Help or assistance instructions are provided and easy to access.	4.2	Highly Acceptable
6. Instruction materials can be downloadable or printed out in a clear layout.	3.2	Moderately Acceptable
7. Interactions between the user and the material are user-friendly.	4.1	Highly Acceptable
SECTION MEAN	**4.03**	**Highly Acceptable**

Table 1 shows the assessment of IT experts in the acceptability level of Web-based Module in Mathematics (WBMTF) in the aspect of technology. As manifested in table item 1, "The screen layout is balanced, and graphics are positioned appropriately" got the highest mean of 4.4 described as "Very Highly Acceptable, and item 4, "Instruction materials can be downloadable or printed out in a clear layout got the lowest mean of 3.2 described as " Moderately Acceptable. Moreover, the obtained section mean was 4.03 described as "Highly Acceptable". The result implies that the developed module was highly acceptable in terms of technology features. This result also confirmed the claim of others [13], that screens should visually stimulate, be easy to read and exhibit no annoying or distracting features. Elsewhere, some found that one way to develop an effective educational website is to make the website accessible and user-friendly [14].

Table 2. IT Experts' Assessment on Web-Based Module in Trigonometric Functions in terms of Design of Technology

Design of Technology	Mean	Interpretation
1. The web is appropriate for performing this activity.	4.5	Very Highly Acceptable
2. Technology skills needed for the activity match learners' developmental level.	4.1	Highly Acceptable
3. Interface design is appropriate to the level and the topic.	4.0	Highly Acceptable
4. The organization of resource links matches the activity processes.	4.0	Highly Acceptable
5. Use of multimedia matches the objectives of the lesson.	4.3	Very Highly Acceptable
6. The design approach matches task processes and objectives.	4.2	Highly Acceptable
7. The interactivities are designed to meet the learning objectives.	4.6	Very Highly Acceptable
SECTION MEAN	**4.24**	**Very Highly Acceptable**

Table 3. Mathematics Experts' Assessment on Web-Based Module in Trigonometric Functions in terms of Relevance to Curriculum

Relevance to the Curriculum	Mean	Interpretation
1. The content is consistent with learning standards in mathematics.	4.2	Highly Acceptable
2. The content is consistently accurate and up-to-date.	3.8	Highly Acceptable
3. The content is complete in scope without missing important information.	3.6	Highly Acceptable
4. The objectives are clear, attainable, and appropriate to the	4.3	Very Highly Acceptable
5. It incorporates real-world mathematical situations.	4.1	Highly Acceptable
6. The material facilitates innovative teaching and learning complex	4.3	Very Highly Acceptable
7. It develops higher-order thinking skills.	3.9	Highly Acceptable
8. The content is relevant and interesting to learners	4.1	Highly Acceptable
SECTION MEAN	**4.04**	**Highly Acceptable**

Table 2 presents the assessment of experts in the acceptability level of Web-based Module in Mathematics (WBMTF) in the aspect of the design of technology. As shown in table item 7, "The interactivities are designed to meet the learning objectives" obtained the highest mean of 4.6 described as "Very Highly Acceptable and item 3 and 4, "Interface design is appropriate to the level and the topic"; "The organization of resource links

matches the activity processes" obtained the lowest mean of 4.0 described as "Highly Acceptable. Moreover, the obtained section mean was 4.24 described as "Very Highly Acceptable". The results indicate that the developed module was very highly acceptable in terms of the design of technology. It further revealed that the interactivities meet the learning objectives of the module. Elsewhere, [14], it was found that for an e-learning environment to be successful, one attribute to be considered is the user interface design. Some others, [16], claimed that an effective user interface in Web-based learning environments is important because it determines how easily learners can focus on learning materials without having to make an effort to figure out how to access them. Also, elsewhere it was stressed that authentic activities can be incorporated into the design of Web-based courses to enhance learning online [15].

Table 3 shows the assessment of Mathematics Experts in the acceptability level of Web-based Module in Trigonometric Functions (WBMTF) in terms of relevance to the curriculum. As reflected in the table item 4 and 6 "It incorporates real-world mathematical situations" and "The material facilitates innovative teaching and learning complex concepts" got the highest mean of 4.3 described as "very highly acceptable" and item 3, "The content is complete in scope without missing important information" got the lowest rating of 3.6 describes as "highly acceptable". Further, the obtained section mean was 4.04 with a qualitative description of "highly acceptable". This means that the developed module was highly acceptable in terms of relevance to the curriculum. The result revealed that the material has clear and attainable objectives appropriate to the user. Also, it facilitates innovative teaching and learning of complex concepts. It is innovative in the sense that the presentation of the material incorporated 4A's approach that is, (Activity, Analysis, Abstraction, and Application), it uses some digital tools to enhance learning that is suitable for online learning and provides instruction and assessment and feedback. This finding conformed to [21] who stressed that innovative learning materials should provide instruction and practice and feedback to make it interactive, which allows students to learn the material presented. [17] concluded that to have an effective e-module, the learning objectives must be clear, measurable, and achievable.

As shown in table 4, the items "The material is presented with clarity, focus, and organization", "The material incorporates 4A's approach effectively", "The material provides hands-on and interactivities that stimulates learning",

"The material is easy to be utilized in an online learning environment" and "The material promotes independent learning" were rated "very highly acceptable". Furthermore, the item "The material incorporated appropriate digital tools to enhance learning was rated "moderately acceptable". Moreover, the obtained section mean was 4.09 described as "Highly Acceptable". The results revealed that the Web-Based Module in Trigonometric Functions is easy to be utilized in an online learning environment, presented in ways that are familiar to students and easy to navigate, with clarity, focus, and organization, incorporates 4A's approach in learning effectively,

Table 4. Mathematics Experts' Assessment on Web-Based Module in Trigonometric Functions in terms of Organization and Structure

Organization and Structure	Mean	Interpretation
1. The material is presented with clarity, focus, and organization.	4.3	Very Highly Acceptable
2.The material is easy to understand and employs appropriate vocabulary.	4.0	Highly Acceptable
3.The information is presented in ways that are familiar to students and easy to navigate.	4.4	Very Highly Acceptable
4. The material offers appropriate user control, self-explanatory and intuitive to use.	4.0	Highly Acceptable
5.The layout of the materials is well organized without distracting elements.	4.0	Highly Acceptable
6.The material incorporates 4A's approach effectively.	4.3	Very Highly acceptable
7.The material incorporates appropriate digital tools	3.4	Moderately Acceptable
8.Audio-visual quality of the images, sounds, illustrations, videos, etc. is presented.	3.6	Highly Acceptable
9.Buttons and other icons function according to their purposes.	4.1	Highly Acceptable
10.Incorporates activities that are appropriate and engaging for students.	4.0	Highly Acceptable
11.The material provides hands-on and interactivities that stimulate learning.	4.3	Very Highly Acceptable
12.The material presented is appropriate and suited for the target user.	4.1	Highly Acceptable
13.The material is easy to be utilized in an online learning environment.	4.5	Very Highly Acceptable
14.The material promotes independent learning.	4.3	Very Highly Acceptable
SECTION MEAN	**4.09**	**Highly Acceptable**

provides hands-on and interactivities that stimulates learning and promotes independent learning. The findings suggest that the integration of 4A's approach in the learning material enhanced student learning since it leads to discovery learning. Also, WBMTF incorporates self-paced /independent activities and assessments that can be taken at the learner's preference time. This is following [19], who mentioned that self-paced learning can teach the learner appropriately, providing the right skills at the right time. Moreover, [20] found out that

Independent learning activities based on guided discovery learning provide opportunities for students to form their knowledge effectively.

Table 5. Mathematics Experts' Assessment on Web-Based Module in Trigonometric Functions in terms of Instructional Quality

Instructional Quality	Mean	Interpretation
1. The material is a teaching tool following educational standards.	4.0	Highly Acceptable
2. Targeted learners will be able to achieve the learning objectives effectively using the material.	4.2	Highly Acceptable
3. The material accommodates multiple learning styles.	3.9	Highly Acceptable
4. Incorporates strategies for engaging all students to stimulate student thinking.	3.9	Highly Acceptable
5. Assessment methods are appropriate to expected learning outcomes.	4.3	Very Highly Acceptable
6. The features enhance the learning experience and facilitate the achievement of	4.4	Very Highly Acceptable
7. The material provides students with greater motivation to solve mathematical problems	4.0	Highly Acceptable
8. The material helps in clarifying concepts quickly.	4.0	Highly Acceptable
9. The material provides access to online resources.	4.1	Highly Acceptable
10. The material provides immediate feedback which	4.5	Very Highly Acceptable
11. The material makes teachers spend less time in assessing learning.	4.5	Very Highly Acceptable
12. The intended use of the material can be replicated based on the information	4.3	Very Highly Acceptable
SECTION MEAN	4.18	Highly Acceptable

Table 5 shows the assessment of Mathematics Experts in the acceptability level of Web-based Module in Trigonometric Functions (WBMTF) in terms of instructional quality. As reflected in the table item 10 and item 11 " The material provides immediate feedback which encourages students to be an independent learner" and "The material makes teachers spend less time in assessing learning" respectively got the highest mean of 4.5 described as "very highly acceptable" and item 3 and 4, "The material accommodates multiple learning styles" and " Incorporates strategies for engaging all students to stimulate student thinking" got the lowest rating of 3.9 describes as "highly acceptable". Further, the obtained section mean was 4.18 with a qualitative description of "highly acceptable". This means that the developed module was highly acceptable in terms of instructional quality. It further implies that an effective educational website must encourage active learning i.e., self-assessment, reflection, self-directed learning, problem-based learning, learner interaction, and feedback [14,.18] recommended having a management/feedback to have a successful learning environment.

4. CONCLUSION AND RECOMMENDATIONS

The researchers concluded that Web-Based Module in Trigonometric Functions is highly acceptable in terms of technology and very highly acceptable in terms of the design of technology as assessed by Information Technology (IT) Experts. Also, this module is highly acceptable in terms of relevance to curriculum, organization and structure, and instructional quality. Thus, it is highly acceptable as a learning material for online learning and teaching. As recommended, restrictions to wrong inputs must be considered, insertion of tutorial videos and varied digital tools to supplement learning. Moreover, mathematics instructors are encouraged to adopt the Web-Based Module in Trigonometric Functions as a learning material for online learning and teaching and future researchers may conduct parallel studies that will incorporate another pedagogy to maximize learning and teaching.

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