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Enhancing Academic Performance via Web-Based Learning Material Development in Mathematics

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ABSTRACT

This study aimed to assess the least-mastered skills of the students, develop web-based instructional materials in General Mathematics, and validate the web-based instructional materials based on the comments and suggestions of the teacher-experts. The researchers employed a developmental research design developed by Richey and Klein Model (2005). The researchers conducted needs analysis to determine the least-mastered skills of the Grade-11 GAS students of Kalilangan National High School. The results revealed that the Grade 11 GAS students received a low score, with a total mean percentage of 26.67 out of 60 items with 30 takers. Findings revealed that the leading cause of students' poor performance is a lack of interaction and engagement in Mathematics due to the new normal education landscape. The researchers then developed web-based mathematics instructional materials (WBL2M) with TURON features to address problems on students' least-mastered skills. The results further presented that the researcher's web-based mathematics teaching materials are acceptable, effective, and impactful for GAS learners to to enhance students' academic performance in General Mathematics.

KEYWORDS: *development, least-mastered skills, web-based learning materials, Mathematics, academic performance*

INTRODUCTION

In the 21st century, technology has become the most useful both in the personal and professional lives of individuals (Luzano & Ubalde, 2023). During the pandemic, traditional classroom has shifted to adoption of technology or flexible learning modality. In turn, technology helps and provides instruction and instructional support during the situation. The traditional instruction posed limited resources to give instructional access to the students. However, it has found out the positive impact of web-based instructional materials, which offered unparalleled access to contextualized educational resources (Oslon & Wisher, 2002).

Web-based instructional materials, or WBL2M, is a technology-based learning tool in teaching and learning mathematics during the new normal and beyond. According to Govindasamy (2002), web-based learning materials have the potential and ability of assisting learners asynchronously. It helps students acquire the necessary knowledge and skills to function as productive, self-reflective, and inclusive learners. WBL2M has the capability to create an educational environment in which students can learn new things and improve mathematical comprehension.

The mentioned insights above are just some of the appeasements why the researchers are eager to develop web-based instructional materials to support learning losses and gaps during the pandemic (Pang-an, et al, 2022). The new educational setting has become a massive problem for every institutions on how to cope up and provide interventions on the effect of the pandemic, especially in Mathematics (Luzano, 2020). Teaching and learning adjustments have experienced by teachers (Eran & Caingcoy, 2019) and difficulties in coping with the competencies set by the Department of Education have enormously affect instructional setup in Mathematics (Aranzo, et al, 2023). Through the web-based materials, the teacher can then capture the mathematical competencies and establish rigorously to the students the interplay between conceptual understanding and problem-solving skills since they have the access already with materials anytime they wanted (Luzano, 2023). Research suggested and found out that web-based instructional materials have significant effect to the academic performance of students in mathematics (Staskevica, 2019). Thus, through the existing instructional condition, the researchers developed web-based instructional materials as intervention to learning losses in mathematics.

The general objective of this study is to design and develop web-based learning materials in mathematics. Specifically, the study aims to: (1) assess the least mastered skills of students in General Mathematics; (2) design and develop web-based learning materials in Mathematics based on the needs analysis results; and (3) validate the web-based learning materials based on the comments and suggestions of the teacher-experts.

FRAMEWORK

The development of web-based learning material is anchored on Cognitive Flexible Theory. Cognitive Flexibility Theory is concerned with the nature of learning in complex and poorly structured domains. It highlights enhanced active learning, which enables the flexible reassembly of preexisting knowledge to fit the needs of a new situation (Spiro, et al, 1991).

As a source of instruction, the web-based learning instruction can provide learners and educators with a broader range of new and exciting learning experiences and teaching environments that are impossible in traditional in-person learning (Khan, 1997). Accordingly, web-based instruction enhance learners' mathematical skills and increase the accessibility to the e-learning environment, which they can gain knowledge through multiple sources of evidence. It also includes real-life interactive circumstances that expose them in various authentic situations. Web-based instruction is often alluded to as a media that uses hypermedia and multimedia technology to provide learners with a learning environment over which the user has control (Kern & Warschauer, 2000).

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Shown in Figure 1 is the schematic diagram of the study.

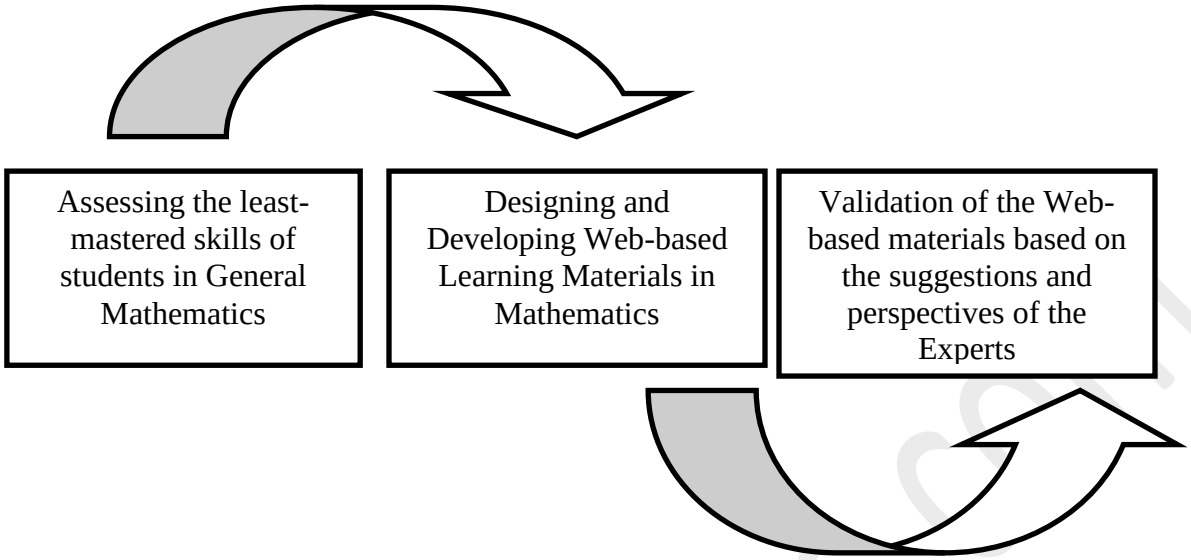

Figure 1. *Schematic Diagram of the Study*

METHODS AND PROCEDURES

The study employed developmental research design developed by Richey and Klein Model (2005). The adopted instructional design model is considered to be a systematic study of designing, developing, and evaluating instructional programs. It also includes processes and products that must meet internal consistency and effectiveness criteria.

The needs assessment of the study was conducted to the thirty (30) Grade 11 GAS students at Kalilangan National High School, Bukidnon, Philippines. Then, four (4) mathematics faculty of Bukidnon State University served as teacher-experts of the developed web-based materials.

In gathering the essential data, the researcher conducted various research protocols before collecting the necessary data, sending a letter to the principal to secure approval and permission, availability, and convenience of the participants.

For the researchers to gather essential data needed for the completion of the research, the researchers conducted first needs analysis to identify the least mastered skills of the students as basis in designing and developing WBL2M or Web-based learning materials in mathematics. Teacher experts validated the WBL2Ms using the instrument.

There are two instruments used in the study. The test questionnaire or traditional test for the needs analysis that consists of sixty (60) items, which are used to identify the least mastered skills of the students as basis in developing the web-based instructional materials in mathematics. The second instrument is the validation tool of Baya'a (2008), which is used to assess and evaluate the developed web-based instructional materials in mathematics.

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The validation sheet outlined the following criteria, namely: (1) Usability criterion; (2) Content criterion; (3) Educational value; and (4) Vividness criterion. Each criterion consists of sub-indicators.

The evaluation or validation sheet was composed of the participants' names as content validators, guidelines for validating web-based instructional materials, criteria for validating web-based instructional materials, and section for comments and suggestions for improving web-based instructional materials. The qualitative data gleaned from the comments and suggestions were analyzed using thematic analysis.

To ascertain the quantitative values and descriptive equivalent of the data received from the validation of web-based instructional materials, the researchers used the five-point rating scale.

Table 1. *Numerical Values and Verbal Interpretation of Web-based IM's Validation of Teacher-Experts*

Scale	Mean Range	Verbal Interpretation
5	4.21-5.00	Outstanding
4	3.41-4.20	Very Satisfactory
3	2.61-3.40	Satisfactory
2	1.81-2.60	Unsatisfactory
1	1.00-1.80	Very Poor

Students' participation was necessary for the study, and their safety and dignity were confidential. Carter (2006) claim that it is critical to consider the foundational principles of ethical research with human subjects. The researchers carefully assess whether the research questions or topics are appropriate for the participants. Participants receive a thorough explanation of both the research study and the methodology and they are free to withdraw from the study anytime.

RESULTS AND DISCUSSION

Needs Assessment of the Least-Mastered Skills

This phase includes data gathering for need analysis. The researchers conducted needs analysis to determine the least-mastered skills of the Grade 11 students of Kalilangan National High School. Students were given 2 hours to answer the test questionnaire, which consists of 60 questions anchored to their General Mathematics subject. Thirty (30) General Academic Strand students participated in the study. Based on the needs analysis, the result showed that most of the Grade 11-GAS students got a low score, having a total mean percentage of 26.67 out of 60 items test with 30 takers. Afterward, the researchers conducted an interview with the five students of Grade 11-GAS. The researchers found out that the cause of the students' low scores was because of the lack of interaction or engagement between the students and the teacher due to the abrupt changes of the educational landscape.

The rapid changes in the educational system inspired the researchers in developing web-based instructional materials to support the flexible learning implementation and increase students' performance (Unger, et al, 2020).

The findings of the needs analysis and with all the problems stated, the researchers found solutions and discovered the least-mastered topics and competencies. Thus, the researchers came up with an

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idea to create web-based instructional materials in mathematics to address the problems and the area of the least-mastered skills of the students. It was established in this phase the preparation of the design and format used in the development of the WBL2M.

Designing and Developing Web-based Learning Materials in Mathematics

The development of the web-based instructional materials was anchored to the specific least—mastered skills of the Grade 11 students in General Mathematics subject. Thus, this phase focused on the design and development of Web-based Instructional Materials.

According to Kern & Warschauer (2000), web-based instructional materials are media or technology that provides learners with a medium for learning in an active learning environment.

With that, the WBL2M contains an interactive design, interactive discussion and assessment, games, and other interactive activities. The researchers observed that when the students were provided with a plain lesson document, they were not interested in learning. So, to make the instructional materials more interactive. This Web-based Instructional Materials (WBL2M) have the following features, which known to be the *"TURON"* model.

1. "Teachers' discussions" present the topic under the subject. The presentation of the lesson is in this part. Thus, it transforms the traditional teacher's discussion into a web-based or online class setup.
2. "Understanding" part helps the learner assess their mastery and knowledge upon completing the discussion.
3. "Real-life situation" part guides the students to learn real-life problems in connection to the topic via problem solving.
4. "Outside the box" part extends learning by providing new concepts and exercises for further application.
5. "Nimble wit" part provides enjoyment and entertainment to the students while learning the topic.

Table 2. *Blueprint of the Web-based Instructional Material in General Mathematics*

Competencies	Topics	WBL2M No.
Evaluates a function and Find the domain and range of different types of function (M11GM-Ia-2)	Algebra: Domain and Range of the Function	1
Distinguishes between simple and general annuities. M11GM-IIc-2Finds the future value and present value of both simple annuities and general annuities (M11GM-IIc-d-1)	Business Mathematics: Future Value of Simple Annuity	2
Illustrates the different forms of conditional propositions (M11GM-IIh-2)	Logic: Implication	3

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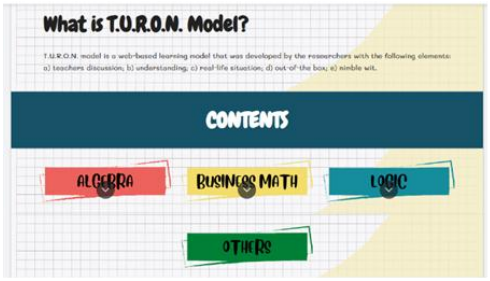
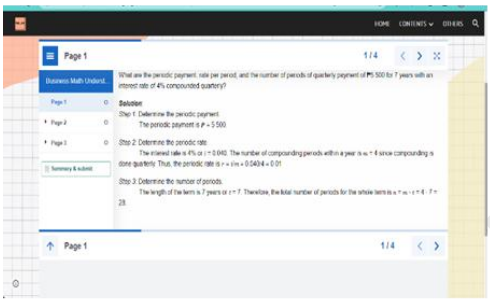
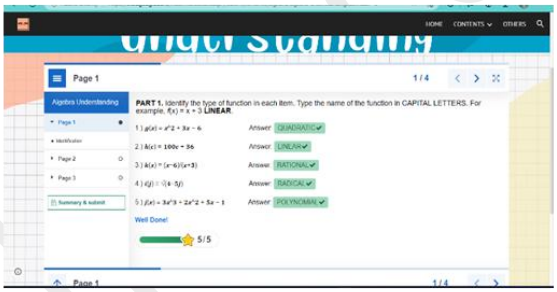
The validators pre-evaluated the first draft of the developed web-based instructional materials in Mathematics (WBL2M) for further revision and enhancement of the WBL2M and their feedback and recommendations were considered.

Presented below are the highlights of the Web-based Instructional Materials in Mathematics.







Validating the Web-based Learning Materials in Mathematics

In this phase, the developed web-based instructional materials were validated. The basis of validating the content and technical quality of the developed web-based instructional materials in mathematics was anchored on the four (4) criteria with the corresponding indicators, namely: (1) Usability criterion; (2) Content criterion; (3) Educational value; and (4) Vividness criterion. The comments and suggestions part were utilized further to improve the different features and content of the WBL2M.

Table 3 shows the result of the validation of the experts for the WBL2M regarding Criterion 1 (Usability). The table below shows that all criteria got high weighted mean of 4.5 and 4.25, descriptively interpreted outstanding. Thus, all indicators got a weighted mean of 4.42 and have an

outstanding description. The result of Criterion 1 describes that the developed web-based instructional materials in mathematics are usable.

Table 3. *Results of Usability Criterion from the Teacher-Experts' Validation*

Indicators	Mean	Qualitative Description
1. Purpose	4.50	Outstanding
2. Homepage	4.25	Outstanding
3. Navigation	4.50	Outstanding
4. Design	4.50	Outstanding
5. Enjoyment	4.25	Outstanding
6. Readability	4.50	Outstanding
Overall Mean	**4.42**	**Outstanding**

Table 4 presents the teacher-expert's validation result from Criterion 2 (Content). In this criterion, only one indicators became very satisfactory with a weighted mean of 4.00, which is Accuracy. However, the other four (4) criteria got a high weighted mean of 4.50 and 4.25, and descriptively interpreted as outstanding. The 4.30 total weighted mean with an outstanding description only means that the content of the WBL2M is informative and appropriate to the learners. Thus, it also means that the content is dependent on the authentic organization and dependable resources in the web-based instructional materials.

Table 4. *Results of Content Criterion from the Teacher-Experts' Validation*

Indicators	Mean	Qualitative Description
1. Authority	4.50	Outstanding
2. Accuracy	4.00	Very Satisfactory
3. Relevance	4.50	Outstanding
4. Sufficiency	4.25	Outstanding
5. Appropriateness	4.24	Outstanding
Total Mean	**4.30**	**Outstanding**

Table 5 shows the result of the validation of the teacher experts for the WBL2M Criterion 3 (Educational value). The table shows that resources surmount the other indicators with a weighted mean of 4.5, with an outstanding qualitative description. However, the weighted mean of the lowest criteria was 3.75 (communication and helping tools), but it still falls under a very satisfactory qualitative description. In addition, Criterion 3 has a total weighted mean of 4.28 that falls under

outstanding description. It describes that the WBL2M provides learning activities that provide students with new information and assistance to the learners to gain more knowledge.

Table 5. *Results of Educational value Criterion from the Teacher-Experts' Validation*

Indicators	Mean	Qualitative Description
1. Learning Activities	4.25	Outstanding
2. Activity Plan	4.25	Outstanding
3. Resources	4.50	Outstanding
4. Communication	3.75	Very Satisfactory
5. Feedback	4.25	Outstanding
6. Rubric	4.00	Very Satisfactory
7. Helping tools	3.75	Very Satisfactory
Overall Mean	**4.29**	**Outstanding**

Table 6 presents the result of the validation of the teacher-experts for the WBL2M for the last criterion (Vividness). There are two indicators in this criterion, which are links and updating that garnered a total weighted mean of 4.25, which descriptively interpreted as outstanding. Thus, it shows that the WBL2M links are adequate and enriching.

Table 6. *Results of Vividness from the Teacher-Experts' Validation*

Indicators	Mean	Qualitative Description
1. Links	4.25	Outstanding
2. Updating	4.25	Outstanding
Overall Mean	**4.25**	**Outstanding**

Table 7 presents the summary of the validation of the teacher experts of the four criteria (1) Usability, (2) Content, (3) Educational value, and (4) Vividness. The table shows the grand weighted mean of the advanced web-based instructional materials in mathematics, which reached 4.28, which interpreted as outstanding. The result just demonstrated that the developed web-based instructional materials in mathematics have a great potential to help students learn in an online setup, especially in mathematics.

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Table 7. *Results of the four (4) Criterion from the Teacher-Experts' Validation*

Criteria	Mean	Qualitative Description
1. Usability	4.42	Outstanding
2. Content	4.30	Outstanding
3. Educational value	4.29	Outstanding
4. Vividness	4.25	Outstanding
Grand Mean	**4.28**	**Outstanding**

Moreover, the overall validation of the teacher experts of the developed web-based instructional materials in mathematics proves that the WBL2M provides an excellent help to Grade 11 students with poor performance in the General Mathematics subject.

Emerging Themes from the Comments and Suggestions of the Teacher-experts

There were three (3) changes to the developed Web-based Instructional Materials in Mathematics based on the comments and suggestions of the teacher-expert, namely:

a. Content and Organization

On the advice of the teacher-expert, the content and the organization of the discussion were modified. Although the information is accurate, it may be preferable to attach it to the Most Essential Learning Competencies (MELCS) to achieve the competency standard. As a result, by adhering to the MELCS, the learner is provided with an orderly and understandable content flow.

b. Home page: Icons and Direction

The teacher-experts suggested that the homepage icons and navigation must be properly placed so there would be no doubt about where the learners should click or where they should begin navigating the topics.

c. Assessment

Assessment is crucial to the learning and motivation processes. In the assessment part, the teacher experts recommended that activities will be crafted following the spiral progression.

CONCLUSION

This study demonstrated how using web-based instructional materials in mathematics can significantly improve students' learning and engagement in online learning environment in General Mathematics. The validator was, therefore, pleased with the WBL2M. The developed web-based instructional materials in mathematics were found to be acceptable and suitable in an online classroom environment.

Based on the findings, results revealed that the web-based teaching materials in mathematics are acceptable, effective, and impactful for General Academic Strand learners to improve their performance in General Mathematics.

RECOMMENDATION

Based on the overall findings of the study, the following suggestions were made:

- ✓ Researchers may have created or utilized web-based instructional materials in other areas to validate the study further.
- ✓ Mathematics teachers may use the created web-based instructional materials as teaching resources for the students.
- ✓ The researchers may improve the created offline-downloadable web-based mathematics instructional materials for the benefit of other disciplines.

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