Integrating Technology-Based Learning Material in Mathematics 2

RACQUEL O. ALEJE, MAED[1], ANICIA S. MADARANG, EDD[2]

[1, 2] *Master of Arts in Education, Mabini Colleges, Inc*

Abstract- The study was conducted to develop and evaluate a technology-based learning material in Mathematics 2. The Descriptive-Development-Evaluative method of research was used in gathering information to answer the specific questions in this study. It used document analysis, survey questionnaire, and evaluation rating sheet for non-print materials as the main data gathering instruments. It involved 35 teachers teaching Mathematics 2 as respondents, 5 Master Teachers, and 25 ICT Coordinators as evaluators, all in Labo West District. It was found that there were eight (8) least mastered learning competencies in Mathematics 2. Also, the developed technology-based learning material was named "Aleje's Fun Mathematics". The content along with number sense, and algebra as well as the skills on computational skills and problem-solving skills, and the values of logical reasoning, mental rigor, carefulness, and accurateness found to be integrated into the developed technology-based learning material. The results of the evaluation of the developed technology-based learning material gained a Very Satisfactory score which surpassed the minimum points required to pass a particular criterion. There were twelve (12) recommendations given by the evaluators.

Indexed Terms- Integration, Technology-based Learning, Mathematics, Computational Skills, Problem-Solving Skills

I. INTRODUCTION

Education is one of the susceptible sectors of society. Inevitably, adverse occurrences and dilemmas may cause disruptions or adjustments to education-related operations. One concrete and evident example of these shattering phenomena is the crisis caused by a pandemic. This pandemic has inflicted massive disruptions against school-based operations and has led to temporary closures of schools and restrictions on face-to-face instruction. Thus, the need for alternative learning modalities that are non-school-based becomes more pressing during this pivotal stage of education (DepEd Order No. 012, 2020).

Among the potential modalities, blended learning was one of the most prominent and widely utilized across schools. The ideal combination of pedagogies featured in blended learning made it capable of reaching out to diverse groups of learners with unique levels of learning needs, skills, and demands and, with discrepant backgrounds, and socio-economic status (DepEd Order No. 012, 2020). The scenario in the locale of this study showed that all the teachers in Labo West District considered the use of blended learning modality as the bridge that settles the gap in the new normal education system. This is because students exposed to distance learning or home-based learning still need the guidance and assistance of the teachers even from a distance which is still possible through blended learning.

However, the District consolidated report on the parallel tests conducted in Mathematics 2, School Year 2021-2022 showed that Grade 2 pupils in Labo West District struggled with Mathematics competencies manifesting a below proficiency level of 75%. The researchers observed that the self-learning modules and learning activity sheets were not sufficient to supply the needed information to supplement the mathematical skills being developed. Thus, integrating technology-based learning materials in Mathematics 2 learning model may build links between the necessary resources on the internet and the real world, and the development of personal expertise as well as the transformation of the newly obtained knowledge into elaborate learning. The technology-based learning material was in the form of offline resources which could respond to the need for

learning materials in developing Mathematics skills by presenting content such as texts, graphics, and audio. This is based on the idea of Green and Donovan (2018) that access to technology enables learning anytime, anywhere with anybody; contextualization of learning; allows for individual analysis; and real-time assessment, feedback, and reporting.

The researchers believed that it is high time to develop this kind of learning material since pupils were also learning outside the school premises. Making learning fun motivated pupils to pay attention and stay focused on the subject. The pupils could use this to supplement the printed self-learning modules, learning activity sheets, and online classes in Mathematics 2. Thus, this study on integrating technology-based learning material in Mathematics was conducted in Labo West District for School Year 2021-2022.

II. METHODS OF RESEARCH

The Descriptive-Development-Evaluative method of research was used in in this study. It involved thirty-five (35) teacher-respondents who are teaching Grade 2 mathematics. The evaluators were composed of two sets, the total enumeration of all the 25 Information Communication Technology (ICT) coordinators of Labo West District and the purposive sampling wherein only Master Teachers teaching Mathematics for Grade 2 were included, having five (5) Master Teachers. Document analysis, survey questionnaire, and evaluation rating sheet for non-print materials served as the main data gathering instruments.

Population, Sample Size and Sampling Technique.
The primary sources of data in this study were the result of the documentary analysis and the evaluators' responses in the evaluation rating sheet for non-print materials. The documentary analysis was conducted to determine the least mastered skills in Mathematics 2 based on the results of parallel tests as well as the content, skills, and values needed to address the identified least mastered competencies. This served as the main basis for the topics included in the technology-based learning material.

The document analysis of the parallel test in Mathematics 2 was based on the identified least mastered skills in Mathematics 2 sourced from the consolidated reports of parallel tests in Mathematics 2 from the district guidance office. Meanwhile, the content, skills, and values were based on the list of least mastered skills in Mathematics 2 sourced from the MELCs consolidated district least mastered competencies result.

On the other hand, the evaluation rating sheet for non-print materials as indicated in the LRMDS evaluation guidelines was used in determining the conformity of the developed technology-based learning material with the curriculum and subject matter it is intended to use. This was evaluated in terms of content quality, instructional quality, technical quality, and other findings. If the developed technology-based learning material failed in at least one of the four factors in this evaluation rating sheet, it should not be recommended for possible use in public schools.

Moreover, it was used to reveal the given recommendations and other findings by the evaluators to further improve the developed technology-based learning material. The feedback from the evaluators served as guide for further enhancement of the developed technology-based learning material to better serve its purpose.

- Description of the Respondents

The purposive sampling and total enumeration methods were used in choosing the respondents and evaluators in this study. The purposive sampling was used in determining the target population. The respondents are chosen based on their knowledge of the information desired. In the case of the present study, this was used to determine the thirty-five (35) teacher-respondents who are teaching Grade 2 mathematics. They answered the survey on the different learning competencies and each indicator. Further the least mastered competencies for Mathematics 2 were taken from the result of the parallel tests they conducted.

For the evaluators, these were composed of two sets. The total enumeration of all the 25 Information Communication Technology (ICT) coordinators of Labo West District. For the second group, purposive sampling was used. Only Master Teachers teaching Mathematics for Grade 2 were included having five (5) Master Teachers. In all, thirty (30) evaluators

evaluated the developed technology-based learning material.

The evaluators of the technology-based learning material have knowledge of the competencies of Mathematics 2 and/or have attended seminars and training on the K to 12 Curriculum and the competencies included in the subject. They have knowledge about technology-based learning material and/or have previously been informed about using the Kotobee application in teaching. Finally, they have no conflict of interest like not being a writer, contributor, consultant, or editor of the developed technology-based learning material.

Also, two (2) external IT experts were sought to participate in the study by evaluating the technical quality of the developed technology-based learning material. The two IT experts were affiliated with the education-related sector. One is a college instructor at AMA and the other is an instructor at Microsystems College Foundation. They have knowledge about developing material using the Kotobee application and are aware of the guidelines and specifications for developing non-print materials.

- Research Instruments

This study used document analysis, a survey questionnaire, and an evaluation rating sheet for non-print materials as the main data-gathering instruments. The study adopted the LRMDS evaluation rating sheet for non-print materials to evaluate the acceptability of the developed technology-based learning material as to content quality, instructional quality, technical quality, and other findings. This was used to determine the total points given by the evaluators. This was also used to determine the recommendations and other findings/observations to further improve the developed technology-based learning material. This was interpreted as either passed or failed depending on the score given by the evaluators.

The documentary analysis was used to determine the least mastered skills in Mathematics 2. The data was taken from the District Consolidated Report on the Least Mastered Competencies in Mathematics 2.

The survey questionnaire consisted of indicators that show the content, skills, and values integrated in the technology-based learning material based on Curriculum Guide for Mathematics 2. This was in the form of a checklist where the respondents placed a check mark on the content, skills, and values in Mathematics 2, which they perceived needed to be included in the technology-based learning material.

- Data Gathering Procedure

The procedures followed in the conduct of this research included the following steps: (a) sought permission to conduct the study from the SDS; (b) secured consent from the respondents; (c) conducted document analysis of least mastered skills in Mathematics 2 based from the district consolidated report; (d) developed the technology-based learning material; (e) document analysis of content, skills and values integrated in the technology-based learning material sourced from the MELCs based on the result of district least mastered competencies; (f) sought consent from the evaluators; (g) evaluated the developed technology-based learning material along: content quality, instructional quality, technical quality and other findings; (h) determined the recommendations and other findings/observations given by the evaluators to further improve the developed technology-based learning material; and (i) prepared report writing and results presentation.

The evaluation of the technology-based learning material was done face–to-face on the most convenient time of the evaluators and/or online via zoom or google meet wherein the researcher presented the salient features of the technology-based learning material as well as demonstrated how to use it supported with user's manual sent to the evaluators prior to the schedule of the evaluation.

III. ANALYSIS AND INTERPRETATION OF DATA

The findings of the study revealed that "Aleje's Fun Mathematics", the developed technology-based learning material which is designed to address the 8 least mastered learning competencies gained very satisfactory which met the minimum points required to pass the criterion. There were 12 recommendations given by the evaluators.

Table 1 presents the summary of the content, skills, and values to be integrated in the technology-based learning material.

Table 1
Summary of the Content, Skills, and Values Integrated in the Technology-Based Learning Material

Least Mastered Learning Competencies	Content	Skills	Values
Reads and writes money in symbols and in words through Php 100.00. M2NS-If-20.1	Number Sense	Computational skills	Carefulness
Illustrates the properties of addition and apply each in appropriate and relevant situations. M2NS-Ig-26.3	Number Sense	Computational skills	Logical Reasoning Carefulness
Visualizes, represents, and add 2-digit by 3-digit numbers with sum up to 1000 without and with regrouping	Algebra	Computational skills	Mental Rigor Carefulness
Perform orders of operations	Algebra	Computational skills	Carefulness
involving addition and subtraction of small numbers. M2NS-IId-34.3			Logical Reasoning Accurateness
Solves multi-step routine and non-routine problems involving addition and subtraction of 2- 3- digit numbers including money using appropriate problem-solving strategies and tools	Algebra	Computational skills Problem-Solving	Accurateness Mental Rigor Logical Reasoning Carefulness
Visualizes, represents and subtracts 2-3 digit numbers with minuend up to 999 with or without regrouping. M2NS-IIa-32.5	Algebra	Computational skills	Carefulness Logical Reasoning Accurateness
Illustrates and writes related equation for each type of multiplication: repeated addition, array counting by multiples	Number Sense	Computational skills	Logical Reasoning Carefulness

and equal jumps on the number line			
Visualize commutative property of multiplication and use it in relevant situations. M2NS-IIi-42.1	Number Sense	Computational skills	Accurateness Carefulness

The findings implied that the content, skills, and values identified are necessary in addressing the least mastered learning competencies. The study of Saenz (2019) and Rittle et al. (2019) argues that integration of learning areas should be integrated in teaching Mathematics which showed positive effects on multiple mathematical ability areas. Meanwhile, Madosi et al. (2020) regarded the value of hard work and effort when doing Mathematics. Their studies affirmed the findings of the present study.

- Evaluation of the Developed technology-based learning material.

Table 2
Evaluation of the Developed technology-based learning material.

Factor A. Content Quality	VS 4	S/N A 3	P 2	NS 1
1. Content is consistent with topics/skills found in the DepEd learning competencies for the subject and grade level it was intended	12 0			
2. Concepts developed to contribute to	12 0			
enrichment, reinforcement, or mastery of the identified learning objectives				
3. Content is accurate	12 0			
4. Content is up to date	96	18		
5. Content is logically developed and organized	12 0			
6. Content is free from cultural, gender, racial, or ethical bias	12 0			
7. Content stimulates and promotes critical thinking	12 0			
8. Content is relevant to real-life situations	84	27		
9. Language (including vocabulary) is appropriate to the target user level	12 0			
10. Content promotes positive values that support formative growth	92	21		
Subtotal	1,1 12	66		
	1,178÷30= 39.3			
Total Points	39.3			

Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a checkmark on the appropriate box Legend: 4-Very Satisfactory (VS) 3–Satisfactory (S) 2-Poor (P) 1-Not Satisfactory (NS)

Passed ☑

Failed ☐

Source: LRMDS For Non-Print Materials

Factor B. Instructional Quality	VS 4	S/NA 3	P 2	NS 1
1. Purpose of the material is well defined	120			
2. Material achieves its defined purpose	120			
3. Learning objectives are clearly stated and measurable	120			
4. Level of difficulty is appropriate for the intended target user	104	12		
5. Graphics/colors/sounds are used for appropriate instructional reasons	104	12		
6. Material is enjoyable, stimulating, challenging, and engaging	120			
7. Material effectively stimulates creativity of target user	120			
8. Feedback on target user's responses is effectively employed	120			
9. Target user can control the rate and sequence of presentation and review	120			
10. Instruction is integrated with target user's previous experience	120			
Subtotal	1,168	24		

$1192 \div 30 = 39.7$

Total Points	39.7

Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a checkmark on the appropriate box	Passed	/
	Failed	

Factor C. Technical Quality	VS 4	S/NA 3	P 2	NS 1
1. Audio enhances understanding of the concept	120			
2. Speech and narration (correct pacing, intonation, and pronunciation) is clear and can be easily understood	120			
3. There is complete synchronization of audio with the visuals, if any	120			
4. Music and sound effects are appropriate and effective for instructional purposes	100	15		
5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing	84	27		

6. Visual presentation (non-text) is clear and easy	96	18
7. Visuals sustain interest and do not distract the user's attention	120	
8. Visuals provide an accurate representation of the concept discussed	120	
9. The user support materials (if any) are effective	120	
10. The design allows the target user to navigate freely through the material	88	24
11. The material can easily and independently be used	96	18
12. The material will run using minimum system requirements	120	
13. The program is free from technical problems	96	18
Sub-Total	1400	120
		1520÷30=50.6
Total Points		50.6

Note: Resource must score at least 39 points out of a maximum 52 points to pass this criterion. Please put a checkmark on the appropriate box

Passed ☑

Failed ☐

Factor D. Other Findings Note down observations about the information contained in the material, where the following errors are found:	Not Present 4	Present but Very Minor & Must Be Fixed 3	Present & Requires Major Redevelopment 2	Do Not Evaluate 1
1. Conceptual Errors	4			
2. Factual errors	4			
3. Grammatical and/or Typographical errors	4			
4. Other errors (ie computational errors, obsolete information, errors in the visual, etc)	4			

Total Points	16

Note: Resource must score at least 16 points out of a maximum 16 points to pass this criterion. Please put a checkmark on the appropriate box

Passed ☑

Failed ☐

Legend: 4 Not Present   3-Present but Very Minor   2- Present & Required Major Redevelopment   1- Do Not Evaluate
Source: LRMDS For Non-Print Materials

The findings were supported by the study of Mamolo (2019) on the developed Digital Interactive Math Comics (DIMaC) as an instructional material. Both materials used technology which aimed to meet learners' needs to better understand Mathematics concepts.

- Recommendations to Improve the Developed Technology-Based Learning Material

Table 3
Recommendations of the Evaluators for the Enhancement of the Technology-Based Learning Material

The evaluators of the developed technology-based learning material were asked to give their recommendations to further improve the said material.

Recommendations	Frequency n=30	Percentage	Rank
1. Change the font style of one chapter of the digital workbook, it should not be cursive	30	100	1
2. Be consistent with the font style and font size	23	77	2
3. Include the values in the introduction part of the digital workbook that can be inherited	9	30	3

from the subject matter			
4. Be consistent with the medium of instruction used ex. Pre-test – panimulang pagsubok, etc	7	23	4.5
5. Be consistent with the template used from skill 1 to 8	7	23	4.5
6. The material should give warning indicator to the user when there is/are activity/ies not yet answered	5	17	6
7. Provide user-support material (user's manual)	4	13	7
8. See to it that it can be used in any windows	3	10	8
9. Make the narration clear in some parts of the chapter	2	7	9.5
10. Make an adjustment or balance the use of graphics, sound, and colors to augment the content	2	7	9.5
11. Change some of the non-texts visual presentation to make it clear	1	3	11.5
12. Limit the amount of text on the screen area	1	3	11.5

The recommendations were integrated in the final revision of the technology-based learning material. The results have an impact on the quality assurance team of the LRMDS. The study conducted by Calatrava (2022) affirmed the findings of the present study. In his study, he also revealed the recommendations given by the evaluators on his developed e-learning materials. Both studies integrated the recommendations given in the final revision of their developed material.

IV. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Based on the findings the study shows that there were 8 least mastered skills in Mathematics 2 as revealed in the documentary analysis of parallel tests. The developed technology-based learning material was named "Aleje's Fun Mathematics" which uses kotobee application. There were also content, skills, and attitude that were found to be integrated in this material. Furthermore, the developed technology-based learning material for Mathematics 2 met the minimum points required to pass all the criteria in the evaluation rating sheet set in the LRMDS guidelines in evaluating non-print materials.

There were also recommendations given by the evaluators to further improve the developed technology-based material.

V. FINDINGS

The findings of the study were summarized as indicated below:

1. The least mastered competencies revealed in the parallel tests conducted were: Solves multi-step routine and non-routine problems involving addition and subtraction of 2-3 digit numbers including money using appropriate problem-solving strategies and tools; Visualizes, represents and subtracts 2-3 digit numbers with minuend up to 999 with or without regrouping; Illustrates and writes related equation for each type of multiplication: repeated addition, array counting by multiples and equal jumps on the number line; and Perform orders of operations involving addition and subtraction of small numbers; Visualize commutative property of multiplication and use it in relevant situations; Visualizes, represents, and add 2-digit by 3-digit numbers with sum up to 1000 without and with regrouping; Illustrates the properties of addition and apply each in appropriate and relevant

situations; and reads and writes money in symbols and in words through Php 100.00.

2. The developed technology-based learning material is named "Aleje's Fun Mathematics" designed to address the least mastered learning competencies in Mathematics 2. Basically, it used the Kotobee application. It has five major parts, such as Introduction, Discussion, Practice Exercise, Application, and References. Also, it has audio, a chat mechanism, an auto-correct feature, and exit confirmation.

3. There were content, skills, and values found to be integrated into the technology-based learning material. Along with content, the number sense, and algebra. Along skills, computational skills, and problem-solving skills. Along with values, logical reasoning, mental rigor, carefulness, and accuracy. The results of the evaluation of the developed technology-based learning material gained a Very Satisfactory score which surpassed the minimum points required to pass a particular criterion. Along with content quality, it gained a total score of 39.6 as rated by the Master Teachers and 39.2 as rated by the ICT Coordinators out of a maximum of 40 points to pass this criterion. Along with instructional quality, 39.8 as rated by the Master Teachers and 39.72 as rated by the ICT Coordinators out of a maximum of 40 points to pass this criterion. Along technical quality, 50.8 as rated by the Master Teachers and 50.64 as rated by the ICT Coordinators out of a maximum of 52 points to pass this criterion. Along with other findings, 16 points were rated by the Master Teachers and ICT Coordinators, respectively out of a maximum of 16 points to pass this criterion.

4. There were twelve (12) recommendations given by the evaluators. The recommendations given were: Change the font style of one chapter of the digital workbook, it should not be cursive, 30; Be consistent with the font style and font size, 23; Include the values in the introduction part of the digital workbook that can be inherited from the subject matter, 9; Consistency with the medium of instruction used, 7; Consistency with the template used from skill 1 to 8, 5; The material should give warning indicator to the user when there is an activity not yet answered, 5; Provide user-support material (user's manual), 4; See to it that it can be used in any windows, 3; Make the narration clear in some parts of the chapter, 2; Make an adjustment or balance the use of graphics, sound, and colors to augment the content, 2; Change some of the non-texts visual presentation to make it clear, 1; and Limit the amount of text on the screen area, 1.

CONCLUSION

Based on the results of this research, the following conclusions were stated by the researchers:

1. There are eight (8) least mastered learning competencies in Mathematics 2 as revealed in the documentary analysis of parallel tests. This implies the need to be engaged in the appropriate and relevant application of technology that may help pupils enhance skills on the least mastered skills.

2. The development of the technology-based learning material is based on the District consolidated report on least mastered learning competencies in Mathematics 2 for School Year 2021-2022 such as visualizing commutative property of multiplication and solves multi-step routine and non-routine problems using addition and subtraction including money. The design and features of the technology-based learning material can contribute towards addressing the least mastered learning competencies in Mathematics 2.

3. All the content, skills, and values in Mathematics 2 for the first and second quarter are to be integrated into the developed technology-based learning material.

4. The developed technology-based learning material for Mathematics 2 met the minimum points required to pass all the criteria in the evaluation rating sheet set in the LRMDS guidelines in evaluating non-print materials.

5. There are recommendations given by the evaluators to further improve the developed technology-based learning material. The recommendations are integrated in the final revision of the technology-based learning material.

RECOMMENDATIONS

Based on the conclusions cited by the researchers, the following recommendations were provided:

1. The researcher suggests that the developed technology-based learning material may be uploaded to the LRMDS and catalog for future access by DepEd personnel via the LRMDS portal.

2. The technology-based learning material for Mathematics 2 may be uploaded in the LRMDS portal since it has already been evaluated and may be run for trials in the field to test its quality to address the least mastered learning competencies in Mathematics of Grade 2 pupils.

3. It is recommended to include positive values in the technology-based learning material.

4. The developed technology-based learning material may be recommended for use at the school level as intervention material to address the least mastered learning competencies in Mathematics 2.

5. Future researchers may consider the variables not included in this study such as the effectiveness of the developed technology-based learning material in improving the performance of grade 2 pupils in Mathematics using experimental research design.

ACKNOWLEDGMENTS

REFERENCES

BOOKS

[1] Calderon, Jose F. and Expectacion C. Gonzales (2011). Methods of Research and Thesis Writing. Mandaluyong City: Cacho Hermanos Inc.

[2] Webster Dictionary of the English Language (USA: Trident Press International, 2002).

[3] Webster Dictionary of the English Language. USA: Trident Press International, 2002. Accessed on August 30, 2022, from https://books.google.com/

[4] Zulueta, Francisco M. (2004). Methods of Research and Applied Statistics. Mandaluyong City: National Bookstore.

JOURNAL

[5] Baring, J. J. A., & Berame, J. S. (2022). Supporting Conceptual Comprehension of Newton's Laws of Motion of Grade 8 Students through Kotobee Interactive E-Module. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *4*(3), 209-232.

[6] Buckley, M. and Tritt, D. (2019). E-Book approval plans: integration to meet user needs. Computers in libraries, 31(3), 15-18.

[7] Calatrava, J. A. R. (2022). Development and Evaluation of E–Learning Materials with Kotobee Application in Physical Science for Grade 11 Students. *International Journal of Multidisciplinary: Applied Business and Education Research*, *3*(10), 1913-1920.

[8] Chen, H.Y and Jang, S.J. (2018). Exploring the reason for using electronic books and technologic pedagogical and content knowledge of Taiwanese elementary mathematics and science teachers.

[9] Dio, R. V. (2020). Exploring vertical coherence of content topics in Philippine spiral Kto10 mathematics curriculum. *International Journal of Learning, Teaching and Educational Research*, *19*(11), 259-282.

[10] Dumigsi, P., M., & B Cabrella, J. B. (2019). Effectiveness of strategic intervention material in Mathematics as remediation for grade 9 students in solving problems involving quadratic functions. *Asian Journal of Education and Social Studies*, *5*(1), 1-10.

[11] Ereno, Rona E. and Benavides, Noel G. (2021). Reflections of the Least Learned Competencies in Mathematics. Jupi National High School. Jupi, Gubat, Sorsogon. United International Journal

for Research & Technology. Vol. 03, Issue 08, 2022, ISSN:2582-6832.

[12] Flashman, Jennifer (2018). Academic achievement and its impact on friend dynamics. Journal articles, reports, evaluative 85 (1), pp 61-80.

[13] Luzano, J. F. (2020). Development and Validation of Strategic Intervention Materials (SIMs) of the Selected Topics in Trigonometry of Precalculus Discipline in Senior High School. *Journal of Mathematics and Statistics Studies*, *1*(2), 26-37.

[14] Madosi, Tendai and Spangeberg, Erica and Ramdhany, Viren (2020). The values learners consider as important in the learning of mathematics. Perspectives in education. 38. 181-196.10.18820/2519593X/pie.v38i1.13.

[15] Madrazo, A. L., & Dio, R. V. (2020). Contextualized Learning Modules in Bridging Students' Learning Gaps in Calculus with Analytic Geometry through Independent Learning. *Journal on Mathematics Education*, *11*(3), 457-476.

[16] Mamolo, L. (2019). Analysis of senior high school students' competency in general mathematics. College of Education, Visayas State University, Philippines. *Universal Journal of Educational Research*, *7*(9), 1938-1944.

[17] Mamolo, L. A. (2019). Development of digital interactive math comics (DIMaC) for senior high school students in general mathematics. *Cogent Education*, *6*(1), 1689639.

[18] Mirabueno, J. A. S., & Boyon, M. C. L. (2020). Senior high school academic progression in mathematics. *PEOPLE: International Journal of Social Sciences*, *5*(3), 840-849.

[19] Otico, M., Pasion, M., & DONES, J. R. (2023). Utilization of e-Book Kotobee Reader as an Interactive Learning Tool in Developing 8th Grade Mathematical Skill. *AJARCDE (Asian Journal of Applied Research for Community Development and Empowerment)*, *7*(1).

[20] Perante, W. (2022). Mathematical Readiness of Freshmen Engineering Students (K-12 2020 Graduates) in Eastern Visayas in the Philippines. *Asian Journal of University Education*, *18*(1), 191-204.

[21] Perocho, A. M., Ampong, L., & Blazer, A. (2023). Digitalized Modules Through KOTOBEE Application: A Teaching Intervention on Improving Pupils' Performance Level in Science Subject. *Spring Journal of Arts, Humanities and Social Sciences*, *2*(03), 01-11.

[22] Piaget, Jean (1960). The child's concept of Number. New York: Humanities Press.

[23] Prabowo, A., Anggoro, R. P., Adiyanto, R., & Rahmawati, U. (2018, September). Interactive multimedia-based teaching material for trigonometry. In *Journal of Physics: Conference Series* (Vol. 1097, No. 1, p. 012138). IOP Publishing.

[24] Ramadhani, R., & Fitri, Y. (2020). A Project-based learning into flipped classroom for ePUB3 electronic mathematics learning module (eMLM)-based on course design and implementation. *Universal Journal of Educational Research*, *8*(7), 3119-3135.

[25] Rittle-Johnson, B., Zippert, E. L., & Boice, K. L. (2019). The roles of patterning and spatial skills in early mathematics development. *Early Childhood Research Quarterly*, *46*, 166-178.

[26] Saputra, E., & Fahrizal, E. (2019). The development of mathematics teaching materials through geogebra software to improve learning independence. *Malikussaleh Journal of Mathematics Learning (MJML)*, *2*(2), 39-44

[27] Segarino, G. M., Labisig, J., Calmerin, L., & Cabello, C. (2022). SIMS as Intervention in Enriching the Teaching of Fundamental Operations in Mathematics: An Action Research. *Psychology and Education: A Multidisciplinary Journal*, *5*(1), 11-20.

[28] Shem-Tov, N. (2011). Improvisational teaching as mode of knowing. Journal of Aesthetic Education, 45(3), 103-113.

[29] Siano, L., and Potane, J., & (2021). Using Interactive E-books to Improve Students' Academic Achievement in Mathematics. *Siano, L & Potane, JD (2022). Using Interactive E-books to Improve Students' Academic Achievement in Mathematics. United International Journal for Research & Technology (UIJRT)*, *3*(5), 30-36.

[30] Siemens, Downes (2005). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology and Distance Learning, 2(1), 3-10.

[31] Skinner, B. F. (1954). The Science of Learning and the Art of Teaching. Harvard Educational Review, 24 (2), 85-97.

[32] Uncad, C. (2022). Intervention Material Utilizing Kotobee Application as an Aid for Modular Distance Learning for Grade 10 Mathematics. *Psychology and Education: A Multidisciplinary Journal*, *5*(3), 179-185.

[33] Yulianto, G. (2022). Developing Interactive English E-book Using Kotobee Author For SMAS Pelita Raya 10th Grade Students. *Journal of English as a Foreign Language Education (JEFLE)*, *3*(1), 38-47.

DOCUMENTS/REPORTS

[34] Article XIV, Section 2 of 1987 Philippine Constitution.

[35] DepEd Order No. 12, s. 2020 otherwise known as "Adoption of the Basic Education Learning Continuity Plan for School Year 2020-2021 in Light of the COVID-19 Public Health Emergency", June 19, 2020.

[36] Guidelines and Processes for LRMDS Assessment and Evaluation Manual, March 2009.

[37] Hernandez, M.W., Estrela, E., Markovitz, C.E., Muyskens, P., Bartley, G., Bollman, K., Kelly, G. & Silberglitt, B. (2018). Uses of technology to support early childhood practice. OPRE Report. Washington, DC: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health, and Human Services.

[38] K to 12 Mathematics Curriculum Guide. LRMDS Portal. May 2016.

[39] The Sustainable Development Goals, otherwise known as Global Goals for Sustainable Development 2030, Goal 4. Report of the Secretary-General, The Sustainable Development Goals Report 2018.

UNPUBLISHED MATERIAL

[40] Abuda, B. F., Oraller-Balazo, G. F., Orque, J. C., Cabili, M. C. D., & Maestre, M. (2019). Struggling learners' mathematics achievement level using quick response embedded strategic intervention material. *Struggling Learners' Mathematics Achievement Level Using Quick Response Embedded Strategic Intervention Material.*

[41] Bonifacio, A. (2013). Developing Information Communication Technology (ICT) Curriculum Standards for K to 12 Schools in the Philippines. University of the Philippines.

[42] Ectuban, J. and Pantinople, L. (2018). The Effects of Mobile Application in Teaching High School Mathematics. University of Cebu, Cebu City.

[43] Lynch, Michael (2019). Evolutionary Layering and the limits to cellular perfection. Department of Biology. Indiana University, Bloomington.

[44] Mengorio, T. and Dumlao, R. (2019). The Effect of Integrating Mobile Applications in Language Learning: An Experimental Study. College of Education. Rizal Technological University, Mandaluyong City, Philippines.

[45] Nueva, M. (2019). A Literature Review on the Current Technology in Education: An Examination of Teachers Use of Technology and its Association to Digital Inequality in School. De La Salle University, Manila.

[46] Sáenz-López, J. M., Sevillano-García, M. L., & Vazquez-Cano, E. (2019). The effect of programming on primary school students' mathematical and scientific understanding: educational use of Bot. *Educational Technology Research and Development*.

[47] Tomaro, Queenie V. (2018). ICT Integration in the Educational System of Philippines. Mindanao State University, Iligan Institute of Technology. Iligan City.

ELECTRONIC MEDIA

[48] Albano, G. and Pierri, A. (2018) Mathematical Competencies in a Role-Play Activity. (2018). ERIC.

[49] American Heritage® Dictionary of the English Language (2011) Houghton Mifflin Harcourt Publishing Company, Fifth Edition.

[50] Benzinga, Victorkarm (2014). Online Gaming - Advantages, Disadvantages, Threats, and Their Solutions.

[51] Callao, M. and Uy, L. (2021). Technology-Based Instructions. (2018). Elementary Education Online. Retrieved April 10, 2023, from

https://www.ilkogretim-online.org/fulltext/218-1643520245.pdf.

[52] Clarkson, P. (2019). *Values and Valuing in Mathematics Education*. OAPEN Library.

[53] Dasgupta, J. (2019) What is mathematical competencies and how is it related to 21st-century skills? LinkedIn. Retrieved April 10, 2023, from https://www.linkedin.com/pulse/what mathematical-concepts-how related- 21st - dasgupa.

[54] Farlex, Inc. (n.d) "The Free Dictionary", Accessed on August 30, 2013, from http:/ www. The freedictionary.com/innovation.

[55] Farlex, Inc., "The Free Dictionary," Accessed on August 30, 2022 from http:/ www. The freedictionary.com/innovation.

[56] Green, Tim and Donovan, Loretta (2018). Learning Anytime, Anywhere through Technology.

[57] K to 12 Mathematics Curriculum Guide. May 2016.Retrieved from https://www.deped.gov.ph.

[58] Koller, V., Harvey, S., and Magnotta, M. (2018). *Technology-Based Learning Strategies*. Employment and Training Administration (ETA). Retrieved April 10, 2023, from https://www.doleta.gov/reports/papers/tbl paper final.pdf.

[59] Lockee, B. B. (2021). Online education in the post-COVID era. Nature Electronics, 4(1), 5–6. https://doi.org/10. 1038/s41928-020-00534-0.

[60] Nurkaeti (2018). Polya's strategy: An analysis of mathematical problem-solving difficulty in 5th grade elementary school

[61] Program for the International Student Assessment (PISA), 2019. National Center for Education Statistics. Retrieved from https://nce.ed.gov/ survey/pisa.

[62] Skentelbery, H. (2019). "Online vs Offline. Gaming Influence on Modern Society.

[63] Sutherland (2020). "7 Reasons why Students Need Technology in the Classroom." Explorance. https://explorance.com/blog/7-reasons-students-needtechnology-classroom/

[64] The Importance of Technology in Education in the Philippines. (2021). Child Hope Philippines.

[65] Transforming Our World: The 2030 Agenda for Sustainable Development. United Nation, 2015