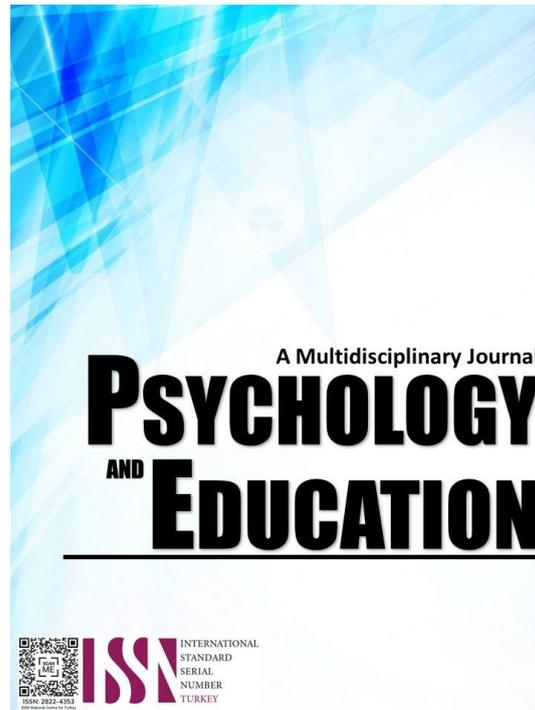


**DEVELOPMENT, VALIDATION, AND TESTING OF  
THE INTERACTIVE ELECTRONIC METROBANK-  
MTAP-DEPED MATH CHALLENGE (E-MMC)  
REVIEW MATERIAL FOR GRADE 5 LEARNERS**



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## Development, Validation, and Testing of the Interactive Electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) Review Material for Grade 5 Learners

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### Abstract

The researcher worked on the development, validation, and testing of the interactive electronic Metrobank-MTAP-DepEdMath Challenge (e-MMC) review material for Grade 5 learners. As a result of this research, an offline mobile review material was made, validated, and tested. This material was used by grade 5 students in the Lopez East and Lopez West districts to help them improve their MMC test scores. Students in Grade 5 from both districts who got an average of 90 and above in Mathematics during their previous year and who might be interested in competing in MMC were asked to take part in the study. With the use of the Cochran Formula and a population size of 116 and 119, a total of 235 from both districts, a confidence level of 95%, and a 5% margin of error, the study used 147 respondents. This study employed three sets of research instruments intended for the development of the material, the validation of the review material, as well as a pretest and posttest for Grade 5 examinees of MMC, respectively. This research also utilized two statistical tools: the arithmetic mean used in the validation process and the paired t-test used in testing the significant difference between the pretest and posttest. After a thorough validation of the developed interactive e-MMC review material in terms of its content quality, instructional quality, and technical quality, the developed material was said to be very satisfactory and highly valid, with an average of 3.76, and is ready to be used as a review material by Grade 5 learners in improving their test scores in the Metrobank-MTAP-DepEd-Math Challenge (MMC). Based on the results of the pretest and posttest, which show that there is a significant difference between the results of Grade 5 learners in MMC, the null hypothesis is rejected. This means that the developed interactive e-MMC review material for Grade 5 learners is a valid way to help learners do better on the said test.

**Keywords:** *development, validation, testing, interactive, electronic*

### Introduction

Learners' success is one of the primary goals of educators. As such, human engineers continue to develop programs, interventions, and activities to ensure one's learning.

In view of this, the Department of Education (DepEd), in collaboration with the Metropolitan Bank and Trust Company (Metrobank), continuously launches the Metrobank-MTAP-DepEd Math Challenge (MMC), which aims to ensure the country's success in mathematics. It is an annual mathematics competition aimed at improving elementary and middle school students' competitiveness. Every year, over 500,000 students from public and private schools take qualification exams across the country. It has developed national champions over the years who can compete and eventually win international competitions. The competition's overarching goal is to improve the quality of mathematics education in the Philippines. Additionally, it aims to encourage students to strive for excellence in mathematics, encourage students to strive for mastery of basic mathematical skills, discover mathematical talents among elementary and high school students, and provide students with opportunities in leadership and cooperative learning. The competition is divided into

four stages: division eliminations, division orals, regional finals, and national finals. Divisional eliminations are first held among schools within a specific division or city. Participants from both public and private schools form triumvirates for a one-hour written test consisting of 50 difficult math problems. Papers are checked the same day, and schools are notified within a week if their students advance to the division orals. The two students from the triumvirate with the highest scores would compete in the Division Orals round. The challenge consists of answering easy problems in 15 seconds or less using mental calculation, followed by a round of 30-second and one-minute questions using pen and paper calculation. Only winners of the Grade 6 and 4th year categories should compete for the regional, and if they are successful, they will advance to the national finals.

In the recent MMC last year, out of 403,707 participants all over the country, only 22 students qualified to reach the national finals, wherein Lopez East and West Districts were not able to reach. According to the recent data from MMC 2019, only three and two students from Lopez East and West, respectively, for a total of five students, were able to compete in the Division Team Finals. However, two participants from Lopez East District were able to reach rank 1 and qualify for the 2019 MMC Division Team Finals. The following year, Lopez East and West

Districts were both able to join the 2020 MMC Elimination Round in Quezon Province, conducted at Don Emilio Salumbides Elementary School in Lopez East District. Another milestone was again achieved by Lopez East District, as three participants qualified for the 2020 MMC Division Team Finals.

In the interim, as per Advisory 001 s. 2023 dated January 4, 2023, the Mathematics Teachers Association of the Philippines (MTAP) Inc., in support of learners who will be taking the exam, offered 2023 MTAP Saturday Programs in Mathematics for Regular and Talented Learners, which will be held every Saturday from January 7 to March 25, 2023. This program aimed to provide the learners with the opportunity to explore mathematics without the threat of tests, review the materials from the previous school year to enable them to prepare for the mathematics subject for the present school year, and train them for the Metrobank-MTAP-DepEd-Math Challenge Competition.

In the local setting of Lopez East and West District, Grade 5 coaches in the locale revealed that there is no existing review material accessible for MMC at the present time, thus they only access the previous sets of test questions as well as from the internet to serve as their review materials. The learners cannot also participate in the aforementioned review sessions due to internet and other operational expenses.

Meanwhile, the researcher is a mathematics teacher presently handling Grades 4, 5, and 6. He is currently designated as the coordinator for mathematics at the elementary level in the Lopez West District. Along with this, he is tasked with monitoring and ensuring the mathematics proficiency of the learners in the district.

E-learning became one of the viable ways to enhance education. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) believes that information and communication technology (ICT) can supplement, enrich, and improve education to achieve Sustainable Development Goal (SDG) 4, that is, to provide equitable, inclusive, and high-quality education and training opportunities for lifelong learning.

In fact, based on the study by Besana et al. (2022), after being exposed to various supplementary materials, the learners' knowledge increased. A series of activities were used to help them improve their numeracy skills. It tested their cognitive abilities. As a result, teachers are encouraged to use supplementary materials in mathematics on a regular basis in order to

improve the teaching and learning process.

Thus, review material incorporating ICT to improve Grade 5 learners' test performance in MMC should be developed by the researcher, validated by the validators, and be tested. In this regard, the researcher intends to work on the development, validation, and testing of the interactive electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) review material for Grade 5 learners.

### Research Questions

This study aimed to work on the development, validation, and testing of the interactive electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) review material for Grade 5 learners. Specifically, this study sought answers to the following research questions:

1. How is the interactive e-MMC review material developed in terms of:
  - 1.1 Work Breakdown,
  - 1.2 Project Risk Management, and
  - 1.3 Project Costs?
2. How is the interactive e-MMC review material validated in terms of:
  - 2.1 Content quality,
  - 2.2 Instructional quality, and
  - 2.3 Technical quality?
3. How is the interactive e-MMC review material tested based on the results of pretest and posttest before and after its use?
4. Is there a significant difference on the test results of the Grade 5 learners in pretest and posttest?
5. What interactive electronic review material may be developed to improve MMC test performance based on the results of the findings?

### Literature Review

#### Material Development

Everyone finds it challenging to learn new skills. It's even more difficult in a formal learning setting, where your attention is being pulled in a dozen different directions at once. While classroom-based learning has many advantages, it is not the most natural method for humans to learn. As a result, we must find effective ways to use technology to aid learning and drive engagement. With the proper tools, technology can be used to make learning faster, easier, and more engaging for both teachers and pupils.

Allison Academy published an article in 2022 about how incorporating technology into the classroom has benefited both younger pupils and teachers. In other words, the sudden arrival of a plethora of different devices and the internet provided students with the opportunity to make learning much simpler and more enjoyable. Making learning and teaching more interactive, providing students and teachers with an unlimited amount of up-to-date information and data from a variety of sources, teaching students how to use technology, lowering educational costs, giving teachers a better idea of how their students are doing, and allowing students and teachers to learn at the same time and at different times are all key benefits of technology in education. People have different ideas about how these changes to the educational system should be implemented, particularly if they are implemented rapidly and in such a short period of time. However, one must remain realistic because the advantages continue to outweigh the disadvantages. In this way, many educational institutions use e-learning to enhance education quality. The e-learning trend has pushed academic institutions to offer courses via the internet. During the online teaching and learning process, however, many issues emerge for both teachers and students. With all of the issues and limited experience with a rapidly evolving technology, there is an urgent need to evaluate e-learning to obtain a better grasp of its impact and effectiveness on educational activities.

Meanwhile, the Department of Education (DepEd) developed a standard format for creating materials. Work breakdown, project risk management, and project costs were among the indicators that should be examined. Someone has a much higher chance of success if they have a detailed list of tasks to complete. According to White and Hassan (2019), even if the job has no deadline, knowing what tasks are to be completed can help someone plan their day and ensure they complete everything that needs to be done. This reduces the need for overtime while also ensuring that someone has enough time to create high-quality work.

The aim of risk management is to identify potential problems before they occur or capitalize on opportunities to make them occur. Risk-management tasks can be implemented at any point in the project's life cycle. Mitigating risks to avoid their occurrence is less expensive than dealing with issues that emerge if the risk does occur. Unmanaged risks can easily prevent a project from meeting or even failing to achieve its objectives. Risk management, as IST Project Management Office stated in 2018, is essential during project inception, planning, and execution;

well-managed risks greatly increase the likelihood of project success.

A project's success can also be measured by how well its expenses are managed. An accurate cost estimate for the project is essential. It is necessary to comprehend the different types of project costs involved in the project in order to arrive at an accurate cost estimate. The project will suffer serious consequences if the overall project cost is not precisely estimated. It will have an immediate effect on the timeline, quality, and scope of the undertaking. This will cause an expense overrun. Keeping these factors in mind, as IST Project Management Office mentioned in 2018, would contribute to the success of the review material development.

### Material Validation

Validity and trustworthiness of the scales to be used in research are keys to getting good results. Thus, validity testing will be performed during the validation phase. The validity of a research study is how well the results from the people who took part in the study match the results from similar people who did not take part in the study. As Patino and Ferreira say, validity is a subjective decision based on the researcher's feelings, thoughts, and intuition about the operation of the measuring instrument. The assessment of validity is performed by expert or academic staff based on the structure that the measuring instrument is attempting to determine. Different criteria are included in the evaluation criteria, such as the purpose of each statement is appropriate for the measuring instrument; the statements in the scale are clearly understood by the participants; the readability of all statements in the measuring instrument; the attractiveness of the questionnaire created; and the difficulty of each item is appropriate for the level of the participants.

On the other hand, the DepEd Learning Resources Management and Development System (LRMDS) aims to improve how learning, teaching, and professional development resources are distributed and made available at the DepEd region, division, and school/cluster levels. When looking at the criteria for evaluating non-print materials, the quality of the content, how well it teaches, and how well it works are all important. Content quality means that the material matches the topics and skills in the DepEd Learning Competencies for the subject and grade/year level it was made for. The ideas that are made should also help to improve, reinforce, or master the learning goals that have been set. The content should also be correct, up-to-date, logically developed and organized, free of

cultural, gender, racial, or ethnic bias, encourage critical thinking, and be relevant to real-life situations. Language (including vocabulary) is appropriate for the target user, as is the content, which promotes positive values that support formative growth.

For instructional quality, the validation material from LRMS will validate the material's purpose, the achievement of its defined purpose, learning objectives that are clearly stated and measurable, and the level of difficulty that is appropriate for the intended target user. It would also evaluate whether the graphics, colors, and sounds used are appropriate for instructional purposes; whether the material is enjoyable, stimulating, challenging, and engaging; whether feedback on the target user's responses is effective; and whether the target user can control the rate and sequence of presentation and review, as well as whether instruction is integrated with the target user's prior experience.

For technical quality, it would measure audio that enhances understanding of the concept, speech or narration (with correct pacing, intonation, and pronunciation) that is clear and easy to understand, complete synchronization of audio with the visuals, if any, and music and sound effects that are appropriate and effective for instructional purposes; screen displays (text) that are uncluttered, easy to read, and aesthetically pleasing; and visual presentations (non-text) that are clear and easy to understand. These are the underpinning descriptors that should be met to validate the material in terms of validity.

### Material Testing

A t-test is a statistical measure that examines the means of two groups, according to Bevans in 2020. It is often used to find out if a procedure or treatment affects the population of interest or if there are any differences between two groups. The t-test can only assess two groups' averages. Because the t-test is a parametric difference test, it uses the same data concepts as other parametric tests. The t-test assumes that the researcher's data are independent, normally distributed, and have a comparable quantity of variance within each group being compared. When selecting a t-test, a researcher must consider two factors: whether the groups being compared are from the same population or two different populations, and whether the difference should be tested in a specific direction. If the groups are from the same neighborhood, use a paired t-test. This is a design that incorporates themes within topics. Meanwhile, if the groups are from different communities, run a two-

sample t-test. This is a composition with two subjects. When comparing only one set to a standard number, use a one-sample t-test. If a researcher is only interested in whether the two populations vary, a two-tailed t-test should be used. If a researcher wants to know whether one population mean is larger or smaller than the other, he or she should use a one-tailed t-test. The interactive electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) review material for Grade 5 pupils was validated and tested to see how well it functioned by adhering to the rules outlined in the underlying texts.

### Methodology

Moreover, a developmental research design was employed in this study, for its purpose was to obtain information about the validity and test the effectiveness of the developed interactive e-MMC (electronic Metrobank-MTAP-DepEd Math Challenge) review material in improving the MMC test results of Grade 5 MMC examinees in the Lopez East and West districts in the Division of Quezon.

### Research Design

Dannels (2018) emphasizes research design as a method for determining how to select participants, which variables to include and how to manipulate them, how to collect and analyze data, and how to control external variability in order to solve the overall research problem. The researcher used the quantitative research method for this study, which focused on new data collection from a population in accordance with the problem and data analysis.

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Quezon is a province of the Philippines in the CALABARZON Region located in the south of Luzon island. Its capital is Lucena. Quezon province was named after former President Manuel L. Quezon who was born in Baler, a town which was then part of Tayabas. Quezon is famous for coconut-based cuisines, lambanog, longganisang Lucban, and pansit habhab.

## Research Population and Sample

### Material Validation

Table 1. *Distribution of Validators for Measuring the Validity of Interactive e-MMC Review Material*

	<i>Number of Validators</i>	<i>Percentage</i>
District LR Coordinators Lopez East District MMC Coaches in Intermediate Grade Level	2	20
Lopez West District MMC Coaches in Intermediate Grade Level BSEd Mathematics Teachers	3	30
	3	30
	2	20
<b>Total</b>	<b>10</b>	<b>100</b>

This investigation was conducted in the districts of Lopez from the fourth parliamentary district of Quezon province, namely, Lopez East and Lopez West. The researcher selected this district, for it has been noted for years that there are very few top-performing examinees in MMC who come from Lopez East and West districts. According to the recent MMC 2019 data, only three and two Lopez East and West students, for a total of five students, were able to compete. Thus, the researcher believed that the best location for this study on developing a review material were the districts of Lopez, not only to serve as a review material for the competition participants but also to motivate learners to participate in the said event.

### Participants

For the validation process, the researcher asked experts to check the validity of the interactive electronic review material based on its content, instructional, and technical qualities. Experts include two District Learning Resource coordinators from Lopez East and West District, three Lopez East District MMC coaches in Intermediate Grade Level, three Lopez West District MMC coaches in Intermediate Grade Level, and two Mathematics Teachers, that constituted 10 validation experts.

For the testing process, using the Cochran Formula to show the results, the study had 147 respondents from a population size of 235 from both districts, a 95% confidence level, and a 5% error margin. This study involved target respondents who received a GWA of 90% or higher in Mathematics last school year. This identified data would serve as the study's population because these are the students who would be interested in participating in the competition. Samples were drawn proportionally from each group to represent the population. As a result, each of the districts presented herein had 73 and 79 respondents respectively.

The researcher asked experts to check the validity of the interactive electronic review material based on its content, instructional, and technical qualities. Experts include two District Learning Resource coordinators from Lopez East and West District, three Lopez East District MMC coaches in Intermediate Grade Level, three Lopez West District MMC coaches in Intermediate Grade Level, and two Mathematics Teachers, that constituted 10 validation experts.

### Material Testing

Table 2. *Distribution of Respondents for Testing the Interactive e-MMC Review Material*

	<i>Population</i>	<i>Sample Respondents</i>	<i>Percentage</i>
Grade 5 Lopez East District learners	116	72	49
Grade 5 Lopez West District learners	119	75	51
<b>Total</b>	<b>235</b>	<b>147</b>	<b>100</b>

Using the Cochran Formula to show the results, the study had 147 respondents from a population size of 235 from both districts, a 95% confidence level, and a 5% error margin. This study involved target respondents who received a GWA of 90% or higher in Mathematics last school year. This identified data would serve as the study's population because these are the students who would be interested in participating in the competition. Samples were drawn proportionally from each group to represent the population. As a result, each of the districts presented herein had 73 and 79 respondents respectively.

### Research Instrument

This research undertaking employed three sets of

research instruments intended for the development of the material, the validation of the mobile application, as well as a pretest and posttest for Grade 5 examinees of MMC, respectively.

The first set is a data retrieval form identifying the essential steps in the development process adopting the DepEd format for project development, focusing the entries on why someone is doing this project, what someone will be doing, how someone will be doing it, who will be doing it, where it will be done, how long it will take, and how much it will cost. As planned, the researcher developed the review material that is compatible with mobile phones and other electronic gadgets for universal access. It is divided into three levels: easy, average, and difficult. Each level contains questions with accompanying solutions and explanations. It is a multifaceted mobile application where users can freely navigate and enjoy its features, and learn as well, in their available time for review.

The second set is a validation questionnaire to be completed by the selected group of validators to establish its validity that employed a 4-point Likert scale, adopting the LRMDS evaluation tool for non-print materials, focusing on its content quality, instructional quality, and technical quality, along with its respective indicators. The material's content quality includes its consistency with topics and skills found in the DepEd learning competencies for the subject and grade/year level for which it was intended. The concepts created should also help enrich, reinforce, or master the identified learning objectives. In addition, the content should be accurate, up-to-date, logically developed and organized, free of cultural, gender, racial, or ethnic bias, stimulate and promote critical thinking, and be relevant to real-life situations. Language (including vocabulary) and content are appropriate for the target user, as is the promotion of positive values that promote formative growth. For instructional quality, the LRMDS-adopted validation material validated the material's purpose, the achievement of its defined purpose, learning objectives that are clearly stated and measurable, and the appropriate level of difficulty for the intended target user. It would also assess whether the graphics, colors, and sounds used are appropriately for instructional purposes; whether the material is enjoyable, stimulating, challenging, and engaging; whether feedback on the target user's responses is effective; and whether the target user can control the rate and sequence of presentation and review. For technical quality, it measured audio that enhances understanding of the concept; clear and easy-to-understand speech or narration (correct pacing, intonation, and

pronunciation); complete synchronization of audio with visuals, if any; and music and sound effects that are appropriate and effective for instructional purposes; screen displays (text) that are uncluttered, easy to read, and aesthetically pleasing; and visual presentations (non-text) that are clear and easy to understand.

And lastly, the third instrument is for the testing process of the material which consisted of a pretest and a posttest adopted from the recent MMC elimination rounds in 2019 with the goal of determining the effectiveness of the technology-aided educational material as a review material for Grade 5 MMC.

### Data Gathering Procedure

Several steps were taken to facilitate the study's conduct, beginning with determining the need for the development of review material up to the desired improvement of MMC results of Grade 5 learners in the Lopez East and West Districts in the Division of Quezon. The researcher wishes to contribute by providing useful material for the MMC review. The initial step was seeking permission to conduct the study from the Dean of Graduate Studies at Quezonian Educational College Inc. and the Chair of Extended Programs at Marinduque State College. Following approval, the proposed e-MMC began. The three phases that was followed are as follows:

**Material Development.** A communication letter was sent to the Lopez East and Lopez West district offices, properly addressed to the Public Schools District Supervisors, requesting the data of previous Grade 4 learners in both districts who achieved a GWA of 90% or higher last school year, as these students are the potential competitors in the event. This was followed by completing the data retrieval form, identifying the necessary steps in the development process, and completing the DepEd format for project development proposal, with entries focusing on why someone is doing this project, what someone will do, how someone will do it, who will do it, where it will be done, how long will it take, and how much will it cost. The mobile application review material is then divided into three levels: easy, average, and difficult, with accompanying graphics and instructions on how to solve them.

**Material Validation.** A group of ten carefully chosen experts were asked to check the proposed review materials. Two Lopez East and West Learning Resource Coordinators, six intermediate-grade level

MMC coaches from the Lopez East and West Districts, and two Bachelor of Secondary Education: Major in Mathematics teachers served as validators for the e-MMC. The validators were asked to complete the validation questionnaire while scanning and observing the e-MMC, as they were provided with validation sheets to evaluate its various features. The validation material employed a 4-point Likert Scale adopted from the DepEd LRMDs Evaluation Tool for Non-Print Materials having 4 as very satisfactory and highly valid, 3 as satisfactory and valid, 2 as poor and less valid, and 1 as not satisfactory and not valid. The validity of the material was established by computing its mean. Comments and suggestions were also considered for future revisions.

**Material Testing.** The testing process was based on the MMC elimination rounds in 2019 for Grade 5. The pretest was given to everyone in the sample group. The use of the e-MMC begun after the data collection of the pretest results, which was kept for future reference. Following the series of offline reviews, the posttest was given using the same material in the pretest. Following that, calculations were performed to test the effectiveness of the e-MMC by examining the significant difference through a paired t-test between the pretest and posttest results.

### Ethical Considerations

Generally speaking, morality is a set of written and unwritten rules, which determine our expectations of ourselves and others' behavior. They basically determine how we treat others and why. Although there is a broad consensus on some moral values (for example, killing is bad), there are also major differences in how these values should be interpreted in practice. During the study period, the following ethical principles were established ensuring the dignity and well-being of students are continuously protected. Furthermore, research data will be kept confidential throughout the research process.

## Results and Discussion

This chapter presents how the data for the development, validation, and testing of the interactive electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) review material for Grade 5 students were analyzed and interpreted. For the presentation to make sense, the researcher presented the data in the following order: a description of the specific problems, a table, and then an interpretation and analysis of the data collected.

## Development of the Interactive e-MMC Review Material

### Work Breakdown

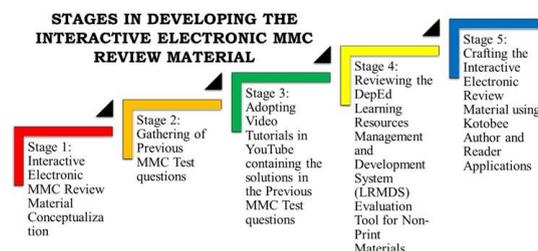


Figure 4. Work Breakdown in Developing the Interactive e-MMC Review Material

Figure 4 presents the stages performed by the developer for this study. The process began with the initial stage of conceptualizing the interactive electronic MMC review material. In this stage, the developer has considered all the possible ways to make the desired output, starting from the supposed to be manipulatives, into interactive electronic MMC review material. After settling on the idea of developing electronic review material, the second stage which involves the gathering of previous MMC test questions, has been conducted. This was accomplished by requesting copies of the review materials available (if any) and copies of questions from previous MMC years from former coaches of Grade 5 MMC in the locale. These gathered data were used by the developer as the primary content of the interactive electronic MMC review material.

Subsequently, stage three began with the developer's adoption of YouTube video tutorials containing the solutions to the previous MMC test questions gathered as well as some routine mathematical exercises aimed at improving the targeted learners' quick-thinking skills. For the fourth stage, the developer reviewed the DepEd Learning Resources Management and Development System (LRMDS) evaluation tool for non-print materials, which served as the foundation for creating any instructional material that will be available electronically. These include the various standards that must be met in terms of the content quality, instructional quality, and technical quality of the material.

And lastly, the final stage is the crafting of the interactive electronic MMC review material using

Kotobee Author and Reader applications. In this stage, the developer utilized a free application maker accessible via Google Play Store to facilitate the crafting of the material. Kotobee Author was used to program the appearance and content of the material, while Kotobee Reader was used to view the material itself and look for inconsistencies that it may possess. In the entirety of the development process, it took 23 days for the researcher to develop this interactive electronic review material.

So, when making technology-assisted learning materials, it's important to spend time gathering supporting materials and references, making real video tutorials, and focusing on the needs of the material to be made. This supported the idea of White and Hassan (2019), which they said that understanding how long a task will take can help someone plan their day and ensure that they complete everything that needs to be done. This reduces the need for extra time and ensures that everyone has enough time to perform well at work. An accurate task estimate is particularly important for project management. Project timelines are estimates, so if the estimates are accurate, the project will likely be completed on time. When a project is completed on time or ahead of schedule, it increases the probability of its success and, in many cases, the professional reputation of the person who completed it. In this part, a detailed project schedule was created. Furthermore, as Dewi, Supriadi, and Latie in 2020 mentioned, which supported the study's results, work breakdown is a hierarchical breakdown of the scope of work that the project team must perform in order to accomplish the goals and provide the necessary results.

### **Project Risk Management**

In terms of the review material, one of the risks for review material users is the capacity of a cellular phone, or other electronic gadgets such as tablets, laptops, and personal computers, to hold 1 gigabyte of data. With today's cellular phone brands and models, it would be simple for the device to hold a large file, but students who are still using previous versions of smartphones with limited storage capacity will have a difficult time installing the application. Additionally, some learners may not know how to manipulate and/or navigate the review material, which could affect its effectiveness. To make it more accessible to all learners, the developer made it easy to click and work on, so it does not require too much technical knowledge. Another risk that was seen was the length of time of the review using e-MMC, thus, to ensure the effectiveness of the material, a schedule was set on the

ideal dates of pretest, review, and posttest.

In this way, the developer was able to manage the risks that came up before and during the implementation of e-MMC. As the literature reviews show, the goal of risk management is to either find potential problems before they happen or take advantage of opportunities to make them happen. Risk-management activities can be implemented at any point in the project's life cycle. Mitigating risks to avoid their occurrence is less expensive than dealing with problems that arise if the risk does occur. Unmanaged risks can easily prevent a project from meeting or even failing to meet its objectives. In 2018, the IST Project Management Office reiterated, which supports the results, that risk management is critical during project inception, planning, and execution; well-managed risks significantly increase the likelihood of project success. Moreover, practitioners use risk management on the belief that it adds value to projects, as Willumsen et al. (2019) claims and supports. They also demonstrated that project risk management may be used to generate revenue. In this regard, the study discovered the hazards that might be encountered as well as ways to mitigate them.

### **Project Costs**

In terms of funding for the development of the review material, the developer did not spend any amount on this project. This was due to the availability of free software on the internet which can be easily downloaded such as the Kotobee Author and Reader which are free from the Google Play Store or the Apple Store, which served as the main mechanism software that the developer used to create the review material.

However, certain costs can also be considered including the supposed to be professional fee for the developer of the electronic material wherein the standard rate of building a mobile application is at an estimated amount of Php 400,000.00 and could run as much as Php 4 million depending on the complexity of the app to be built., as well as the internet and electrical expenses. This is in accord to Hansen in 2021, where he stated that cost management is a tremendously significant yet difficult activity, indicating the great benefit of knowing cost management since correctly understanding and controlling its multiple costs can make the difference between success and failure. The effectiveness of a project's cost management can also affect its success. It is critical to arrive at an accurate project cost estimate. It is necessary to understand the various



types of project costs involved in the project in order to arrive at an accurate cost estimate. The project will suffer serious consequences if the total project cost is not precisely estimated. It will have an immediate impact on the timeline, quality, and scope of the project.

### Validation of the Developed Interactive e-MMC Review Material

After a thorough evaluation of the developed material's content quality, instructional quality, and technical quality, it was found to be very satisfactory and highly valid as well, with an average of 3.76, and ready to be used by Grade 5 students to improve their Metrobank-MTAP-DepEd-Math Challenge scores. (MMC).

### Content Quality

Table 3. Mean Scores of the Developed Interactive Electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) Review Material in terms of Content Quality

Indicator	Frequency				Mean	Description	Descriptive Interpretation
	4	3	2	1			
1. Content is consistent with topics / skills found in the DepEd Learning Competencies for the subject and grade/year level it was intended.	8	2	0	0	3.80	VS	HV
2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.	8	2	0	0	3.80	VS	HV
3. Content is accurate.	8	2	0	0	3.80	VS	HV
4. Content is up-to-date.	8	2	0	0	3.80	VS	HV
5. Content is logically developed and	8	2	0	0	3.80	VS	HV
6. Content is free from cultural, gender, racial, or ethnic bias.	7	3	0	0	3.70	VS	HV
7. Content stimulates and promotes critical thinking.	8	2	0	0	3.80	VS	HV
8. Content is relevant to real-life situations.	9	1	0	0	3.90	VS	HV
9. Language (including vocabulary) is appropriate for target user.	9	1	0	0	3.90	VS	HV
10. Content promotes positive values that support formative growth.	8	2	0	0	3.80	VS	HV
Overall Mean	N = 10				3.81	VS	HV

The aspects of the material in terms of its content were rigorously checked and validated by selected validators using the Department of Education's (DepEd) Learning Resources Management and Development System's (LRMDS) standard for non-print materials on content. Table 3 shows that the overall mean for the content quality of the developed interactive electronic MMC review material is 3.81, interpreted as very satisfactory and highly valid. It can also be traced that the criteria, such as the content is relevant to real-life situations, and that the language (including vocabulary) is appropriate for target user got the highest mean of 3.90, interpreted as very satisfactory and highly valid. Furthermore, the criteria such as content is consistent with topics / skills found in the DepEd Learning Competencies for the subject and grade/year level it was intended, concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives, content is accurate, content is up-to-date, content is logically developed and organized, content stimulates and promotes critical thinking, and content promotes positive values that support formative growth were proven to be valid in the material. However, the criteria for content being free from cultural, gender, racial, or ethnic bias got the lowest mean of 3.70, still interpreted as very satisfactory and highly valid. Thus, it is very crucial that validity should be established, as Yusoff in 2019 have mentioned, to further certify its relevance, and as in this case, the validity of the content of the review material.

These data further certify the validity of the material in terms of its content. Thus, it can be noted that the material is consistent with topics found in the Learning Competencies (LC) for the subject and grade/year level for which it is intended. The material can also be related to and support the development of skills related to the Learning Competencies. The material also supports and compliments the achievement of the learning objectives of the subject area and grade/year level for which it is intended. The presentation of factual content is also accurate and up-to-date; there is no outdated information, improper use of figures, inaccurate graphs, or overly simplified models or diagrams. The logic of the presentation and organization of the content is clear to the target audience. Content is also presented in a well-organized, consistent, and predictable fashion. The structure is also apparent. There are also no ideological, cultural, religious, racial, or gender biases or prejudices found in the material. Comprehension and application of the content knowledge also require cognitive effort and not just chance selection of responses. The material also promotes higher order



thinking skills. The learning activities also include one or more of the six facets of learning (explain, interpret, apply, have perspective, empathize, and have self-knowledge). The content also has application to real-life situations through authentic simulations. The use of language is also appropriate for the target user's age and stage of learning. The vocabulary used is also suitable or appropriate to the target users' level. New or complex words and terms are also clearly and consistently explained or defined. And lastly, it also considered the amount of technical vocabulary use and the devices used to interpret, explain, and define technical terms, as well as the general level of difficulty and density of non-technical words used in terms of familiarity and abstractness. The overwhelming results of very satisfactory rating can be traced from the fact that the content of the material was already designed by experts. However, a greater emphasis should be put on the presentation of controversial social content to make it balanced and structured to promote an educated understanding of differing points of view. All social content should also be fairly presented and not violate the social content guidelines.

### Instructional Quality

Table 4. Mean Scores of the Developed Interactive Electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) Review Material in terms of Instructional Quality

Indicator	Frequency				Mean	Description	Descriptive Interpretation
	4	3	2	1			
1. Purpose of the material is well defined. (i.e., implicitly or explicitly defined)	10	0	0	0	4.00	VS	HV
2. Material achieves its defined purpose.	8	2	0	0	3.80	VS	HV
3. Learning objectives are clearly stated and measurable.	10	0	0	0	4.00	VS	HV
4. Level of difficulty is appropriate for the intended target user.	4	6	0	0	3.40	VS	HV
5. Graphics / colors / sounds are used for the appropriate instructional reasons.	5	5	0	0	3.50	VS	HV
6. Material is enjoyable, stimulating, challenging, and engaging.	8	2	0	0	3.80	VS	HV
7. Material effectively stimulates creativity of target user.	8	2	0	0	3.80	VS	HV

7. Material effectively stimulates creativity of target user.	8	2	0	0	3.80	VS	HV
8. Feedback on target user's responses is effectively employed.	6	4	0	0	3.60	VS	HV
9. Target user can control the rate and sequence of presentation and review.	6	4	0	0	3.60	VS	HV
10. Instruction is integrated with target user's previous experience.	8	2	0	0	3.80	VS	HV
Overall Mean	N = 10			3.73	VS	HV	

Table 4 depicts the material's validity, for it garnered an overall mean of 3.73, interpreted as very satisfactory and highly valid in terms of instructional quality. Furthermore, criteria such as purpose of the material is well defined. (i.e., implicitly or explicitly defined), and that the learning objectives are clearly stated and measurable, got the highest mean of 4.00, interpreted as very satisfactory and highly valid.

These data further confirm the material's validity in terms of instructional quality. As Blömeke et al. (2020) have supported this ideal, instructional quality reflects observable instructional practices that are implemented. Similarly, it focuses on the material's ability to teach its intended audience, in this case, Grade 5 learners. Thus, it can also be noted that content also relates to the achievement of learning purpose through the clear instructions, information and graphics contained therein. Opportunities are also provided for different levels of instruction. Content chunking, sequencing and time spent on content are also appropriate. Illustrations and visuals are also effective and appropriate as it makes balanced use of graphics, sound, and color to augment the content. Pedagogy is also innovative through scaffolding which also challenges students' level of understanding. The design, presentation, and representation of information also promote user engagement and encourages creativity. Feedback is also non-threatening, immediate, positive, motivational, user sensitive and appropriate based on the users' previous responses. Users can revisit and replay active content and can also decide when to progress to the next step. Access to different information or concept chunks is also either logical or intuitive; if random, there is a clear indication of the relationship between the chunks and the various paths available for exploring them. Instructional prerequisites are also stated or easily inferred. Users are also encouraged to review their prior knowledge and understanding. And lastly, where prior knowledge or experience is required, this is also clearly identified, and a summary is provided. However, the criteria on level of difficulty is



appropriate for the intended target user, which got the lowest mean of 3.40, still interpreted as very satisfactory and highly valid, scope, should also be considered in relation to the level of the target user’s range, and depth of content and topics. Thus, this still needs to be addressed properly by further tapping the prior knowledge of the targeted users.

**Technical Quality**

Table 5. Mean Scores of the Developed Interactive Electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) Review Material in terms of Technical Quality

Indicator	Frequency				Mean	Description
	4	3	2	1		
1. Audio enhances understanding of the concept.	10	0	0	0	4.00	VS
2. Speech / narration (correct pacing, intonation, and pronunciation) is clear and can be easily understood.	8	2	0	0	3.80	VS
3. There is complete synchronization of audio with the visuals, if any.	8	2	0	0	3.80	VS
4. Music and sound effects are appropriate and effective for instructional purposes.	8	2	0	0	3.80	VS
5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	5	5	0	0	3.50	VS
6. Visual presentations (non-text) are clear and easy to interpret.	5	5	0	0	3.50	VS
7. Visuals sustain interest and do not distract reader’s attention.	8	2	0	0	3.80	VS
8. Visuals provide accurate representation of the concept discussed.	6	4	0	0	3.60	
9. The user support materials (if any) are effective.	6	4	0	0	3.60	
10. The design allows the target user to navigate freely through the material.	8	2	0	0	3.80	
11. The material can easily and independently be used.	9	1	0	0	3.90	
12. The material will run using minimum system requirements.	7	3	0	0	3.70	
13. The program is free from technical problems.	7	3	0	0	3.70	
Overall Mean	N = 10				3.73	

Indicator	Frequency				Mean	Description
	4	3	2	1		
1. Audio enhances understanding of the concept.	10	0	0	0	4.00	VS
2. Speech / narration (correct pacing, intonation, and pronunciation) is clear and can be easily understood.	8	2	0	0	3.80	VS
3. There is complete synchronization of audio with the visuals, if any.	8	2	0	0	3.80	VS
4. Music and sound effects are appropriate and effective for instructional purposes.	8	2	0	0	3.80	VS
5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	5	5	0	0	3.50	VS
6. Visual presentations (non-text) are clear and easy to interpret.	5	5	0	0	3.50	VS
7. Visuals sustain interest and do not distract reader’s attention.	8	2	0	0	3.80	VS

Table 5 depicts the material’s technicality as shown by the overall mean of 3.73 interpreted as very satisfactory and highly valid. Among the criteria, audio enhances understanding of the concept and got the highest mean of 4.00, interpreted as very satisfactory and highly valid. However, the criteria on screen displays (text) are uncluttered, easy to read, and aesthetically pleasing, and visual presentations (non-text) are clear and easy to interpret, garnered the lowest mean of 3.50 though still interpreted as very satisfactory and highly valid.

These data confirm the material's technical validity even further as Samosa et. Al (2021) have utilized the same instrument in evaluating non-print materials’ instructional quality. It can be noted that the audio, which come as spoken instruction, is used to enhance understanding and comprehension. The voiceover or speech is clear and can be easily understood which also supports vocabulary development. The user can also replay, stop, and start audio. The audio and visuals are also synchronized. Music and sound effects are also used effectively. Dynamic content can also be revisited and replayed by the user if required. Graphic visualizations are employed to complement textual information which also attracts attention, aid retention, enhance understanding, or create context. The visuals are also accurate and do not misrepresent the concepts presented. The user support material also provides adequate and clear instructions for using the material. User support materials are also relevant and effective.



Navigation is also clearly linked to the instructional purpose and learning design which does not interfere with users' engagement in the content. Any time spent learning the interface or control functions is small compared to the time spent on task functions. The material also allows and encourages students to work independently. It can also run on all platforms. And lastly, no technical problems were seen in the material.

However, even though the screen displays are pleasing, uncluttered, and easy to read, the screen area limits the amount of text on screen and so rather than requiring continuous scrolling, longer text employs pagination techniques to navigate forward and back through the text, and the visuals although clear and easy to interpret, still needs improvement.

Table 6. Summary of the Mean Scores of the Developed Interactive Electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) Review Material

Criteria	Mean	Description	Descriptive Interpretation
Content Quality	3.81	Very Satisfactory	Highly Valid
Instructional Quality	3.73	Very Satisfactory	Highly Valid
Technical Quality	3.73	Very Satisfactory	Highly Valid
Overall Mean	3.76	Very Satisfactory	Highly Valid

Table 6 presents the overall evaluation of the developed material in terms of its content quality, instructional quality, and technical quality, which garnered an overall mean of 3.76, which meant that the developed material is found to be very satisfactory and highly valid, and is now ready to be utilized by Grade 5 learners as a review material in improving their test scores in Metrobank-MTAP-DepEd-Math Challenge (MMC). Like what Connell et al. (2018) stressed on about the importance of service users' viewpoints on the acceptability and validity of items for use in designing a new measure in regard to material validation.

Meanwhile, even though the result is overwhelming, with an overall mean of 3.76, the results of the instructional and technical qualities still lie below the mean of the three indicators of validity. Having said that, there is a strong urge that the developer should act immediately on the findings of the validation in instructional and technical qualities before handing it over to the respondents to ensure that the material is at its best performance as a review material. Those

comments and suggestions given by the validators are of high importance.

### Testing of the Developed Interactive e-MMC Review Material

Table 7. Pretest and Posttest Results Before and After the Use of the Developed Interactive Electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) Review Material

Level of Performance	Pretest			Posttest			Mean Gain	Percentage Gain	Remarks
	Frequency	Percentage	Mean	Frequency	Percentage	Mean			
Outstanding	0	0.00		61	41.50			+41.50	Increase
Very Satisfactory	2	1.36		82	55.78			+54.42	Increase
Satisfactory	2	1.36		3	2.04			+0.68	Increase
Fairly Satisfactory	12	8.16	14.28	1	0.68	37.18	22.9	-7.48	Decrease
Did Not Meet Expectations	131	89.12		0	0.00			-89.12	Decrease
	N = 147		100.00	N = 147		100.00			

Students in the fifth grade who had garnered a GWA in math of at least 90% the previous year were asked to take part in this study. These are the pupils who have expressed an interest in participating in the tournament. Table 7 presents the results of the pretests taken by 147 fifth grade students in the Lopez East and West Districts. As can be seen from the table, 131 out of 147 or 89% of the respondents have not met the expectations, while 12 out of 147 or 8% have performed fairly satisfactorily, as based on the descriptors stated in DepEd Order 8, Series 2016, entitled Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Programme of Grade 5 Learners in MMC before the conduct of the review process, showing a mean score of 14.28, which further indicates that the respondents have not met the expectations. In addition, it was found that the scores are more dispersed and distant from the mean than was previously thought.

This data was supported by Pan and Sana in 202 which reiterated that pretesting entails taking practice tests prior to learning information rather than after. This method is also known as an erroneous creation or pre-questioning. Due to the fact that the pretest contains information that the students still need to learn, it is not always possible to ensure that they will perform well on the pretest. Because of this, it is still permissible for the students to have a low performance in the pretest.

Meanwhile, Table 7 further reveals that 82 out of 147 or 55.78% of the respondents in the survey performed very satisfactory after the evaluation process, and 61 out of 147 or 41.50% of them even performed outstandingly in their respective roles with a mean



score of 37.18, which further suggests that the respondents have performed extremely satisfactorily and have met the expectations, with the mean score indicating that the respondents have fulfilled the expectations. In addition, it was discovered that the results are more dispersed and distant from the mean than previously thought.

In 2021, Pan and Sana supported this idea and emphasized the effectiveness of post testing that seemed to depend on how well learners could remember what they had been taught. According to this point of view, the excellent performance of the learners may be linked back to their talents in memorizing the information that was taught to them; therefore, learners will perform well on the posttest because it incorporates material that was previously taught.

In this regard, it can be traced that after the posttest, a +22.9 increase was obtained in the same group. Furthermore, it can be noticed that the learners in very satisfactory level has increased from 1.36% to 55.78% which shows 54.42% of learners who achieved very satisfactory rating.

**Significant Difference of the Pretest and Posttest Results of Grade 5 Learners Before and After the Use of the Developed Interactive e-MMC Review Material**

Table 8. *Significant Difference Between the Pretest and Posttest Results of Grade 5 Learners Before and After the Use of the Developed Interactive Electronic Metrobank-MTAP-DepEd Math Challenge (e-MMC) Review Material*

Test	Mean	SD	p-value	Difference
Pretest	14.28	4.39	4.19259906234424 <sup>-132</sup> or <0.0001	Significant
Posttest	37.18			4.54
Gain	22.90			

Table 8 presents the results of the paired t-test employed in order to assess whether or not there is a statistically significant difference between the pretest and the posttest. As can be seen from the table, it demonstrates that the exam scores of the participants improved by a total of 22.90 points. The table also provides information on the improvement in performance that the students demonstrated in the pretest and the posttest. Initially, in the pretest conducted the students’ performance did not meet

expectations having a mean of 14.28 and a standard deviation of 4.39 which indicates that the scores in the pretest are even more away from the mean of 14.28, and that the students have fared poorly in comparison to the mean.

Meanwhile, after going through the review material, these students were able to improve their performance to satisfactory level in the posttest. As reflected with a mean of 37.18 and a standard deviation of 4.54, it indicates that the results are even further from the mean and that the students have performed better than the mean.

Furthermore, after the use of the paired t-test to compute for a significant difference between the pretest and posttest results, the computed p-value of the study is 4.19259906234424<sup>-132</sup> or is less than 0.0001. Considering the alpha of 0.05, and by comparing the results of p-value that is less than 0.0001, the study has identified a significant difference between the pretest and posttest scores, for the it is a rule that in order to conclude a significant difference among the two variables, it computed p-value should be lower than its given alpha of 0.05.

**Conclusion**

The following are the conclusions made by the researcher based on the findings of the study:

1. The researcher concluded that the work breakdown, risk management, and project costs were properly handled thus resulting to a successful developed interactive e-MMC review material.
2. Following a thorough validation of the developed material in terms of content quality, instructional quality, and technical quality, the developed material was found to be very satisfactory and highly valid, and it is ready to be used as a review material by Grade 5 students in order to improve their test scores in the Metrobank-MTAP-DepEd-Math Challenge (MMC).
3. Because the pretest contains information that the students have yet to learn, it is feasible that they will perform poorly on it. As a result, students may still perform poorly on the pretest. Meanwhile, the learners’ strong performance in posttest may be related to their skills to memorize the knowledge that was given to them; hence, learners may score well on the posttest since it integrates previously taught material.
4. Based on the results of the pretest and posttest, which show that there is a significant difference between the results of Grade 5 learners in MMC, thus, the null hypothesis is rejected. This means that the

developed review material for Grade 5 learners in MMC is a valid way to help those learners do better on the test.

5. The researcher-developed interactive e-MMC review material is a valid way to increase the MMC test scores of Grade 5 learners.

The following are the recommendations by the researcher based on the conclusions drawn:

1. It is the recommendation of the developer to continue to devote time in gathering supporting materials and references, making authentic video lessons, and focusing on the specifications of the material to be generated while developing technology-aided learning material. Furthermore, the developer recommends to continue to identify potential hazards as well as solutions to mitigate them. To get a good estimate of how much a project will cost, the researcher also recommends to continue to understand the different kinds of costs that will be involved, for, if the whole project cost is not accurately estimated, the project will have major implications, and thus, it will have a direct influence on the project's timeframe, quality, and scope.

2. The researcher recommends that in terms of validating educational material, a standard must continue to be followed so that the developer will be assured of its qualities in enhancing or enriching a learner's skill.

3. The researcher recommends that to continue to test educational material's validity as a supplemental material, a learner's performance before and after its utilization should continue to be administered. By doing that, a teacher will know for sure if a student's performance has improved after using the material.

4. The researcher recommends that educational institutions, more specifically, elementary schools to utilize the researcher developed interactive e-MMC review material as a supplementary review material for their Grade 5 learners who would be joining the MMC, as well as, to the regular students to further enhance their mathematical skills.

5. The researcher recommends to the future researchers to develop parallel learning material like this in various learning areas such as in English, Science, and other disciplines, to further enhance the quality of education in our country.

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