*International Journal of Learning, Teaching and Educational Research*
*Vol. 23, No. 8, pp. 643-667, August 2024*
*https://doi.org/10.26803/ijlter.23.8.33*
*Received Jul 2, 2024; Revised Aug 17, 2024; Accepted Aug 31, 2024*

# On-the-Go Android-Based Learning Tool for Mathematics in Geographically Challenged Areas

**Jahfet N. Nabayra***
Aklan State University
Banga, Aklan, Philippines

**Abstract.** One of the important challenges for mathematics educators during the Covid-19 pandemic was ensuring productive mathematics learning despite hindrances. This study explored the mathematics learning experiences of geographically challenged students during the pandemic and developed an on-the-go Android-based learning tool (OTG ALT) for mathematics learning in the challenged areas. The study employed educational design research (EDR) with three phases. A semi-structured in-depth interview guide and student satisfaction survey instrument were utilized. Six geographically challenged university students for interviews and forty students for the tryout of the OTG ALT were purposively selected as participants. Mean and standard deviation scores were used to analyze and interpret the quantitative data. The phenomenographic method was used to analyze the qualitative data. Results show that the experiences of the geographically challenged students in pandemic mathematics education were encapsulated in four different categories: 1) pandemic mathematics learning, a new experience, 2) teachers' agency in mathematics, 3) tribulations and triumphs, and 4) mathematics that works. The developed learning tool for the course Mathematics in the Modern World (MMW) follows the i−SPARK model (introduce, study, practice, assess, reflect, and key to correction), with a video explainer per topic. Students were highly satisfied with the developed learning tool, in general and in terms of all indicators. Hence, the developed OTG ALT met the instructional standards for mathematics learning in the challenged areas. School administrators may improve the quality and effectivity of mathematics education in universities by considering minority perspectives. To make mathematics education inclusive and equitable, policymakers and curriculum designers can review the suitability of teaching materials and adapt them to the level and needs of the students.

**Keywords:** Android-based learning; geographically challenged areas; learning experiences; mathematics learning; on-the-go learning

* Corresponding author: *Jahfet Nabayra, jnabayra@asu.edu.ph*

## 1. Introduction

Among the many challenges that the world's education systems have encountered, the Covid-19 pandemic was one of the most notable and most unexpected. It may even be considered one of the hardest trials of education considering how rapid the situation worsened. As a result, institutions migrated educational activities online (Crawford et al., 2020). The benefits and difficulties of this sudden shift in learning have been thoroughly examined in research. In mathematics teaching, difficulties existed despite educators' best attempts to ensure that students still learned throughout the pandemic (Berkova & Nemec, 2020; Carius, 2020; Sabaruddin et al., 2020). Moreover, disadvantaged students in terms of geographical and financial limitations were also greatly affected. Research has indicated that in impoverished and developing nations, where a significant proportion of students lack Internet connection due to both financial and technological challenges, online education cannot produce its intended outcomes (Adnan & Anwar, 2020; Berkova & Nemec, 2020). Carius (2020) reported that when technology was utilized to address issues in mathematics learning during the pandemic, concerns about access disparities surfaced. Students from geographically challenged areas found it hard to learn mathematics online due to several limitations (Nabayra, 2023a). In mathematics and even other courses, university students had low levels of readiness and satisfaction with online learning during the pandemic (Nabayra & Tambong, 2023).

Mathematics learning and its issues and concerns are already a familiar aspect of education – whether before, during, or after the pandemic. Prior to the pandemic, the majority of students already had a notion that mathematics is a challenging subject because of unfavorable teaching styles, difficulty in understanding the material, and difficulty in learning formulas and techniques for solving problems (Gafoor & Kurukkan, 2015). According to Kunwar (2020), a negative perception of mathematics is one of the fundamental causes of anxiety in the discipline. According to Ariyanti and Santoso (2021), students' positive responses to mathematics were on average higher before the usage of online learning modes compared to after. According to Guansi et al. (2020), a survey conducted among college students in the Philippines showed that students still liked the traditional method of instruction where the instructor teaches the material and then assigns homework. Mamolo (2022) concluded that while maintaining high levels of anxiety, students receiving instruction online saw a marked decline in their motivation for and self-efficacy in mathematics. In other words, mathematics as a subject and area of study is already susceptible to many issues and concerns raised by students and educators. This may be deemed true to all "versions" of education systems – pre-pandemic, pandemic, or post-pandemic. However, the pandemic raised new challenges in the way that mathematics is studied.

The pandemic heightened the need for integrating technology in mathematics learning (Pal & Patra, 2020; Wijaya, 2021). Students' thinking abilities are improved when appropriate learning tools are used (Helsa & Kenedi, 2019). Like other learning tools in mathematics, Android-based learning tools (ALTs) increase students' level of independence in learning (Hendikawati et al., 2019; Kurniasih, 2021). In addition, the use of ALTs positively impacted students' self-

regulation skills (Mahudal et al., 2022). Hidayat et al. (2023) discovered that the learning materials created for Android devices were effective for teaching mathematics. They reported that the Android-based learning media design garnered significant responses based on the students' practicality test results. This indicates that the learning materials were quite useful. The outcomes of the product test demonstrated that students who learn to use Android-based learning materials attain higher levels of mathematical critical thinking skills than those who do not. This has implications on how mathematics learning can be maintained effectively even in a remote or online learning setup. However, this may be difficult to achieve due to various factors, such as students' access to the Internet, students' financial capability, and the teacher's teaching and learning approaches.

Among the many concerns, it is more common to find students in the Philippines with concerns regarding Internet access and connectivity. Jose et al. (2023) reported that many Filipino students have either no or very limited access to the Internet, which is a requirement to attend online classes and use online learning platforms. Meanwhile, in Wenceslao and Felisa's (2021) study, the majority (98%) of university student respondents in the Visayas region of the country owned smartphones. Despite this, Internet connectivity remains a predicament for common Filipino students (Barrot et al., 2021; Dizon & Errabo, 2022; Giray et al., 2022).

These previous studies imply that ALTs may be useful for state university students because most of them have or use smartphones in the new normal learning, while also considering other factors and issues with ALTs. Hence, in this study, the experiences of geographically challenged students in pandemic mathematics education were studied and considered in crafting an on-the-go (OTG) ALT for mathematics education. The tool developed in this study notably diverts from the usual ALTs because the framework for the design and development was based on empirical data of real-life students who had experienced a pandemic. Moreover, the tool was designed to be available, easy to use, and accessible to students situated in geographically challenged areas. The study further presents information on the experiences and satisfaction of students who utilized the OTG ALT.

## 2. Research Questions

This study sought to answer the following research questions:

1. What are the learning experiences of geographically challenged students in the new normal mathematics education?
2. What OTG ALT in the course Mathematics in the Modern World (MMW) can be developed for students in geographically challenged areas?
3. How satisfied are the students with the developed OTG ALT in general and in terms of: (a) learning objectives; (b) content; (c) organization and presentation; (d) format and design; (e) learning activities; and (f) assessment?

## 3. Methodology

### 3.1 Research Design

This study employed educational design research (EDR) following the model of McKenney and Reeves (2012). The model has three phases, namely analysis and exploration, design and construction, and evaluation and reflection. The nature of this research design is focused on gaining a deep understanding of a problem or question prior to designing or developing a prototype solution and having it tested (McKenney & Reeves, 2021). EDR was deemed the most appropriate research design for this study. It allowed the researcher to answer the research questions seeking to determine the learning experiences of geographically challenged students in the new normal mathematics education, identify a tool that can be developed for the said students, and evaluate the students' satisfaction of the learning tool developed. Phenomenography (Marton & Booth, 1997) was used as a method in the qualitative analysis and exploration stage to explore the different experiences of geographically challenged students in mathematics learning in the new normal.

### 3.2 Participants of the Study

The study is a three-phase study involving the following phases: (1) analysis and exploration, (2) design and construction, and (3) evaluation and reflection. The first and third phases involved two sets of participants. In the first phase, the participants of the study were six purposively selected geographically challenged university students who had already taken the MMW course whose experiences in learning mathematics during the pandemic were studied. These six geographically challenged students were chosen purposively and pseudonyms (code names) were used in the discussion to ensure anonymity, namely Jho, Mae, Rose, Lor, Joy, and Mary. In the third phase, 40 students taking the said course participated in the tryout of the developed tool to measure their satisfaction levels. Of these 40 participants in the tryout, three students were selected randomly and interviewed to solicit their experiences after using the tool. They were assigned codenames (i.e., Student A, Student B, and Student C) and were not part of the six participants in the first phase. The data generated by them are discussed in the latter part of the analysis. A set of inclusion criteria was considered in the selection of the participants, which include geographic location, financial status, limited connectivity, and mathematics performance in MMW.

### 3.3 Research Instrument

*3.2.1 Student satisfaction survey instrument*

A student satisfaction survey instrument (reliability coefficient = 0.95) was adapted from Nabayra (2023b) to gather data on the level of satisfaction of the students after using the OTG ALT. The instrument was validated by experts and pilot tested to establish reliability. The validation comprised several criteria, including learning objectives, content, organization and presentation, format and design, learning activities, and assessment.

*3.2.2 Semi-structured interviews*

A semi-structured interview guide was used to gather qualitative data prior to the development of the learning tool. The semi-structured interview guide was used during the analysis and exploration stage as a tool to assess the experiences of

geographically challenged students in learning mathematics during the pandemic. It was composed of open-ended questions to allow follow-up questions for clarification. It was validated by experts prior to the conduct of the study.

**3.4 Data Gathering Procedure**

The data were gathered using the model of McKenney and Reeves (2012) in EDR. For the analysis and exploration stage, the goal was to investigate the mathematics learning experiences of geographically challenged students in the new normal. Six purposefully selected geographically challenged students were interviewed in depth using a semi-structured approach, taking into account the inclusion criteria.

In the design and construction phase, the outline and format of the OTG ALT were created. This OTG ALT is the instructional tool developed by the researcher for learning mathematics in remote areas. The design, structure, and format were based on the results of the analysis stage, the institutional format of the university, and the course syllabus in MMW as recommended by the Commission on Higher Education. In terms of format and structure, the OTG ALT was composed of electronic PowerPoint presentations (PPTs) and embedded video explainers (5–8 minutes) for every sub-topic. However, the researcher personally designed a unique format adhering to the prescribed format of the university with some modifications to further enhance the quality of the tool suited to its target users and their needs. This was called the i-SPARK model, which was coined personally by the researcher. The acronym i-SPARK stands for introduce, study, practice, assess, reflect, and key to corrections. After the thorough validation process by experts in information/educational technology, instructional material development, mathematics, and language, the final prototype of the developed OTG ALT was crafted by the researcher, integrating all the comments of the experts. It was then tried out with 40 purposively selected geographically challenged students taking MMW during that time. In the evaluation and reflection phase, students and experts evaluated the OTG ALT in terms of satisfaction and acceptability, respectively. Students were asked to assess the tool developed based on their experiences, and teacher-implementers were also consulted based on their personal experiences.

**3.5 Data Analysis**

Phenomenographic data analysis was conducted to describe the mathematics learning experiences of geographically challenged students in the new normal and their variations. This was done to identify a set of qualitatively different categories representing variations of individual experience of the phenomenon (Han & Ellis, 2019). Four main categories of description surfaced after the thorough analysis of qualitative data. These results of the analysis were used by the researcher as a springboard on the kind of OTG ALT that could be developed addressing students' identified challenges and needs. The initial design, format, and outline of the OTG ALT were proposed based on the results of the analysis of the interview data and context of the study participants.

Mean and standard deviation statistics were used to analyze quantitative data on satisfaction. Phenomenographic data analysis was used to analyze the

geographically challenged students' experiences of the new normal mathematics education (Han & Ellis, 2019). This involved the following stages: familiarization, condensation, comparison, grouping, articulating, labelling, and contrasting. The analysis was done manually in an iterative way without the use of qualitative data analysis software. This ensured that the researcher would have a first-hand encounter with the data, thereby enriching the analysis, which may not have been the case had software been used.

### 3.6 Ethical Considerations

During the conduct of this study, ethical considerations were established. The personal information and responses of the participants were always kept confidential and private. Only the researcher was able to access this information. The participants' confidentiality was warranted by using pseudonyms all throughout the paper and by storing data securely. During data collection, pandemic health protocols were strictly implemented and followed during interviews, administration of the survey questionnaires, and in all stages of the study.

## 4. Results

### 4.1 Experiences of Geographically Challenged Students during the Pandemic Mathematics Education

In the first stage of the study, four qualitatively distinct categories of the various experiences of the six participants in the new normal mathematics education were identified through the in-depth interviews. After reading and analyzing the transcripts using phenomenographic data analysis, the four categories were identified as follows: 1) pandemic mathematics learning, a new experience; 2) teachers' agency in mathematics; 3) tribulations and triumphs; and 4) mathematics that works. The ways in which the participants experienced, perceived, interpreted, and comprehended the new normal of mathematics instruction during the pandemic were mapped onto these participant description categories.

#### *4.1.1 Pandemic mathematics learning, a new experience*

Students' lives underwent significant alterations because of the Covid-19 pandemic. It completely changed education, replacing traditional in-person instruction with other forms of instruction. Universities decided to develop a variety of flexible learning modalities in response to the demand to help students adjust to the new setup (Crawford et al., 2020; Syauqi et al., 2020). Students had different experiences and narratives that may be attributed to the use of new modalities in mathematics teaching and learning. This is true for one of the interview participants, Rose, who recalled:

> *"Our teacher would just send us learning materials and discuss the lesson when examinations are near. The materials she would provide us are PDF files and other activities that I didn't really understand sometimes."*

Activities were distributed via Google Forms, either in conjunction with or apart from synchronous virtual learning. Some students, however, were unable to view the video files. Some of the students who were able to view the videos had to use

alternate methods such as screen-recording the videos or capturing screenshots of the videos to share these with other students. Joy shared that:

> *"We only had videos and PPTs, as well as activities through Google Forms, but no modules. We needed to watch the videos sent by our teacher because there would be an activity right after the video and the deadline is on the following day already."*

*4.1.2 Teachers' agency in mathematics*

Even though in-person sessions were halted during the pandemic, teaching and learning continued. The arrangement where nearly everything was done online made the mathematics course seem significantly more difficult compared to how it was before the pandemic. Nonetheless, even with the wide range of methods, techniques, and approaches that math educators employ, students still struggle in the course because of different experiences and situations. The expectations and opinions of ordinary students at a remote state university who thought that studying in the new normal would be hard and demanding were also reflected in a previous study reporting on first-year students' assessment of mathematics instruction in the new normal (Nabayra, 2022). In the same paper, the students' answers demonstrated that this point of view was shaped by their prior bad experiences with learning mathematics in the years prior to the pandemic, as well as their worry and fear of the subject (Nabayra, 2022). According to student participant Mae, mathematics was hard because of unclear discussions:

> *"It's hard, yes, and cannot easily be understood since the language is pure English. The discussion is way too fast, making the explanation hard to comprehend. That's why I sometimes adjust the speed of the video in YouTube so that I could understand the discussions well."*

Mary added that hurried conversations, hurried exercises, discussions in pure English, and a failure to keep up with the quick-paced instruction led to exam failures:

> *"After a class, our teacher expects us to turn in any assigned work on that same day. When I write on a hill without a table and using my feet as a desk, I check my phone to respond to activities and increase the brightness to full when it gets too dark."*

*4.1.3 Tribulations and triumphs*

The pandemic severely impacted many facets of society, including the educational system. It has had an impact on students in all areas of their lives, particularly those who have financial and geographic difficulties. Many facets of their lives were severely affected during the crisis, which made learning challenging and stressful. The education of students from underprivileged backgrounds was impacted during the pandemic by a number of factors, including their geographic location, technological know-how and resources, economic capacity, level of personal readiness, and educational resources and materials, among other factors. Bringula et al. (2021) also expanded the theory that students' self-concept in mathematics was impacted by obstacles related to technology, personal and home matters, assessment, pedagogy, consultation, and exam anxiety. Due to the impact of the adversity, students had to figure out how to continue thriving in the new normal education. Rose shared that:

> *"Since I reside at the barrio of Agmailig, Libacao, the Internet signal is very weak. I could not access the links provided. Other times, it's because I didn't have mobile data load. The signal was very unstable that I always had a hard time accessing online resources or joining live classes, up to the point that I did not know that our teacher will give an exam. Because of that, I was behind in the lessons."*

Furthermore, Lor and Jho encountered very similar situations. They both had trouble connecting and had to go to the next barangay to pick up the materials that their teachers had sent. This dilemma is also reflected in the results of Carius' (2020) study in a rural school. It was found that using technology as a strategy to deal with problems with math instruction during the pandemic raises questions about the disparities in access to the Internet due to its broad geographic reach and variety of specificities.

> Lor: *"Both my phone's storage and signal strength are issues for me because they are already using up the provided capacity. I didn't really have adequate storage because I hadn't upgraded my phone since my first year and I didn't have a laptop."*
>
> Jho: *"It was difficult, sir. I could barely use my phone and I couldn't even send an email or use a Google Form before it stops working. My phone's signal strength was also struggling. Because of that, I always submit my activities late. If I cannot arrive early in an area where network coverage is good, I would sometimes go there at night ..."*

*4.1.4 Mathematics that works*

Students' experiences with the new normal mathematics instruction, particularly those who are geographically disadvantaged, have established an idea of what mathematics instruction should look like in the future. Participants advanced certain important characteristics or aspects to be considered for a better learning experience even in the post-pandemic age. These are motivated by their experiences and their feelings about what may have been a better experience of a new normal mathematics education. Individuals who learned during the crisis were able to attest to their varied, extreme, and draining experiences. Thus, their appeal for better mathematics instruction covered a wide range of areas. These include but are not limited to: improving the management of the teaching and learning process by the course instructors; providing instructional support to students, particularly marginalized students; encouraging self-discipline in students; reevaluating due dates and deadlines; and providing appropriate and accessible learning materials for all. This supports the findings of Turan et al. (2022), who discovered several issues that students faced when learning online. These concerned the inadequate range of available materials, the difficulty of accessing the courses, the unreliability of the exams, difficulties in focusing and adapting to the courses, the absence of communication between the students and the instructors, the inefficiency of the applied courses, and the instructors' heavy homework assignments.

In terms of instructional materials, Mary preferred printed modules or any ready-to-use learning materials already saved on a storage device. This is because her cell phone had limited storage as well as connectivity issues.

> *"Printed modules are a better learning material for Mathematics in the Modern World (MMW). When it comes to cell phones, I lack Internet connection and my storage gets full. It is better if the materials are printed. It's hard to get into Zoom meetings. There are available cell phones like Cherry Mobile and Vivo. We are trying to buy a brand new phone. My old cell phone before malfunctioned during MMW: it auto-sends, lags, hangs, types incorrectly, and has defects."*

> Mae: *"It is better if it is saved in storage. The submission of online activities must be scheduled because we are pressured by the deadline. Suddenly, it's deadline already, and I would always experience a power interruption, which makes it hard."*

Joy concurred with Mae's suggestions. However, she felt that modules sent in PDF format must be supplemented by videos for additional clarification. This makes sense, since Bullo (2021) discovered that in the new normal of education, video lessons are more successful than self-learning modules. With a little help from the teacher, students can understand the mathematical concepts through video lessons. For better access, these resources ought to have been stored beforehand on a flash drive, memory card, or SD card. There would be no additional costs for connectivity, and storage issues would be resolved. She said:

> *"I suggest our teachers to provide hard copies of the modular activities for those who cannot attend classes online. The provided videos and modules of our teacher should be saved on an SD card. It is better if there are provided videos or documents in PDF file format because the teacher can thoroughly explain the lesson, unlike learning by just solely reading the module. I can open the video and files provided by our teacher through my cell phone. Through PDF documents and videos that can properly explain the lesson, students will be able to understand and learn easily."*

These findings provide novel information about how students experience online mathematics education. The information gathered provides unique and useful findings because of the in-depth data gathering procedure conducted. The specific experiences of each participant present potential avenues for online mathematics education development. Despite all the challenges faced by the participants, especially considering the new normal, there is always a solution to overcome their learning difficulties. Education can come to them for them to have a bright future by appreciating their experiences. Furthermore, despite the difficulties brought about by the Covid-19 pandemic, there is a desire to master the topic, excitement, and a favorable attitude toward mathematics.

**4.2 The Developed On-the-Go Android-based Learning Tool**

After the analysis of the six geographically challenged students' experiences in new normal mathematics education, the researcher developed the OTG ALT suited to the needs of disadvantaged students in remote areas. Based on the students' accounts and stories, they faced challenges and struggles in the new

normal mathematics education. The students' geographic location where network coverage is extremely low is one example hindering their access to online resources and live classes. In addition, most of them possessed low-specification phones with low-storage capacities, limiting their capability to store bulks of learning materials for use. In terms of the provided instructional materials, the students raised concerns on the comprehensiveness and ease of use of the materials and pleaded to have complete materials with videos that supplement and/or elaborate the lessons. This may be because videos as learning materials provide stronger visual cues that allow maximum efficiency in learning (Sagge Jr, & Bacio Jr, 2024; Sagge Jr & Segura Jr, 2023). However, the students particularly hoped for videos that can be viewed without additional expenses on mobile data or Internet. In general, the students hoped to have access to materials that are readily accessible and which consider their limited resource capabilities and challenged geographic location. Considering the concerns of geographically challenged students, the researcher developed a learning package called the Micro-Mobile Learning Package (MMLP) in an OTG ALT format that satisfies the students' instructional needs to help them learn mathematical concepts independently, efficiently, and effectively.

With this learning material, mathematics learning may become more flexible, accessible, and efficient for geographically challenged students with limited resources. The material is a combination of microlearning and mobile learning instructional approaches catering to the needs of geographically challenged students. It comprises five lessons in PPTs and video explainers adapted from YouTube which were trimmed or shortened by the researcher to suit the video length to the needs of the target users. Moreover, the MMLP is already saved on an OTG USB flash drive which can be distributed to geographically challenged students so that learning can happen anytime and anywhere. The videos and PPTs no longer need to be downloaded because they are already on the OTG USB flash drive. This will address students' need for a material that does not require an Internet connection to be accessed and utilized. This makes the OTG ALT unique and distinct among other instructional materials used by teachers during the pandemic. The tool is already complete with discussion through PPTs, video explainers, and embedded assessment exercises. Accessibility and storage issues were also addressed because the material was developed so that it can be used offline with just smartphones on hand, thereby making learning even mobile. Lessons are also discussed in nuggets and chunks, adhering to microlearning principles. This was done in consonance with the classifications of microlearning materials by Commonwealth of Learning (2021), which call for the covering of short chunks of text, PDFs, presentations, and video explainers.

Furthermore, the developed OTG ALT known as MMLP in the MMW course specifically for the topic on logic has the following parts: Video Explainer as a Special Feature, About the MMLP, About the Lesson, Title, Learning Outcomes, the i-SPARK Model, and References. Figure 1 shows photographs of students working with the MMLP.

**Figure 1: Implementation of the OTG ALT known as MMLP**

*4.2.1 Video Explainer as a Special Feature*

The video explainer is a special feature of the MMLP lesson in the OTG ALT that provides supplementary information, discussion, and elaboration of the topic presented. It can be viewed in every part of the lesson after the discussion of a sub-topic. This will address the need of geographically challenged students for a material that will help enhance their understanding. The videos are clips taken from YouTube, an open access video streaming site; hence, no copyright issues were involved. These embedded video explainers have an average length of 5 to 8 minutes. This is suited to instruction, since shorter videos are found to be more engaging (Doolittle et al., 2015). In addition, the median watching time for videos by students is only 9 to 12 minutes (Guo et al., 2014). This method combines the features of micro- and mobile learning, since the topics are segmented into nuggets or chunks (i.e., five microlessons for five topics) together with the video explainer that promotes mobile learning for the students. The video explainers were downloaded from YouTube and were scrutinized for their suitability to the topics and target users by expert math instructors. Figure 2 is a snapshot of a sample video explainer.

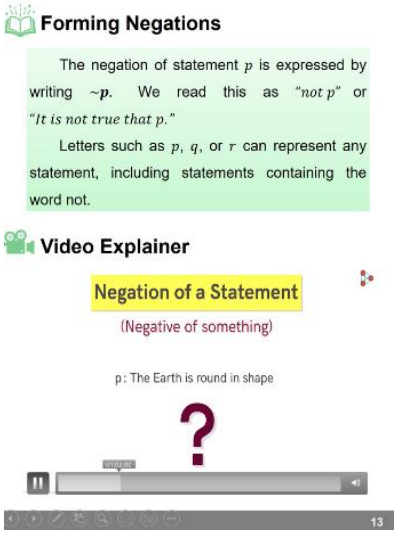


**Figure 2: Sample video explainer in a lesson**

*4.2.2 About the MMLP*

This part of the material highlights the nature and purpose of the MMLP as an offline learning material for geographically challenged students. It also shows the essential elements present in the material (see Figure 3).

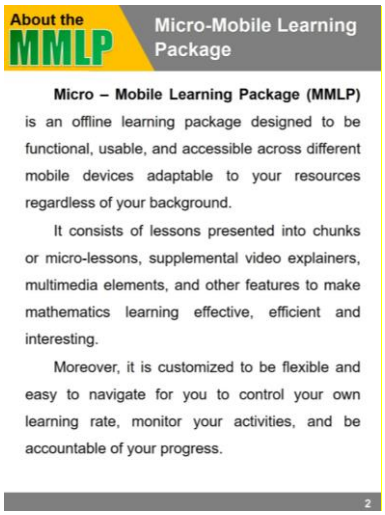


**Figure 3: About the MMLP page**

*4.2.3 About the Lesson*

Figure 4 shows a snapshot of the third slide of the MMLP, About the Lesson. This slide provides an overview of the logic lessons included in the MMLP. It describes logic and its importance in our lives together with the logic lessons from logical statements to Euler diagrams.

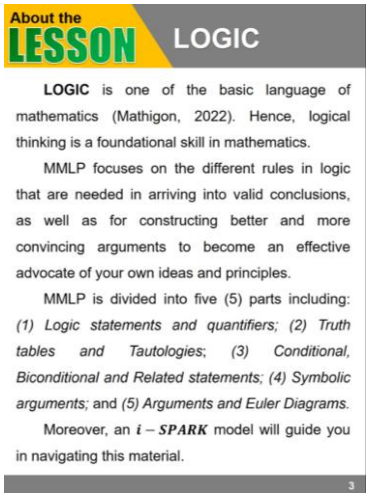


**Figure 4: About the Lesson page**

*4.2.4 Title*

The Title page (Figure 4) presents a brief but comprehensive statement of the entire theme of a specific lesson in the MMLP. It serves as a guide for the students and presents the lessons included. This page can be seen in the sixth slide of all material after a short note from the author.

*4.2.5 Learning Outcomes*

The learning outcomes (Figure 5) are clear and specific statements that guide the students on what exactly are expected of them in going through each lesson in the MMLP and after completing each topic. It can be found immediately below the title of a specific lesson in the material.

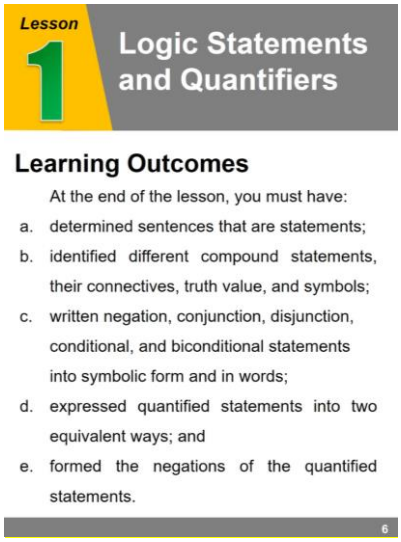


**Figure 5: Sample of the Learning Outcomes page**

*4.2.6 The i-SPARK model*

The i-SPARK acronym stands for introduce, study, practice, assess, reflect, and key to correction. In this part of the lesson in the MMLP, every stage of the model is described to the students to be guided on what to do in each phase in navigating the MMLP. This is a researcher-coined and -designed unique format adhering to the prescribed format of the university (Legaspi et al., 2020). Figure 6 presents a snapshot of the MMLP page explaining the different components.

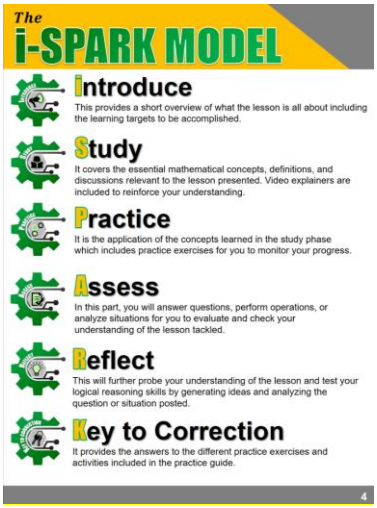


**Figure 6: The i-SPARK Model**

Some modifications were made to further enhance the quality of the MMLP suited to its target users and their needs. The concept was termed *i-SPARK* because in

mathematics, teachers must ignite a spark in the minds and hearts of students to make them excited and interested in learning mathematical concepts. Hence, the MMLP was a hopeful attempt to help rekindle the spark among students for studying mathematics. Each of the components is discussed in more detail below.

**Introduce.** The introduction provides a bird's eye view of the topics to be covered in a certain lesson. It is needed to prepare the minds of the students and to stimulate their interest. It appears immediately after the learning outcomes have been stated.

**Study.** This part of a lesson in the MMLP is the actual lecture where every lesson is presented clearly, comprehensively, and with specific examples. Mathematical concepts, definitions, and examples are presented in this part to elaborate students' understanding. It enriches students' understanding of the topic because of the extensive content included for each lesson. This part follows right after the introduction part.

**Practice.** This part involves the application of the concepts learned from the study phase, which includes practice exercises for the students to monitor their progress in learning. It can be observed after a certain sub-topic in a lesson has been presented.

**Assess.** In this part, students will answer questions, perform operations, and analyze situations for them to evaluate and check their understanding of the lesson tackled in the MMLP.

**Reflect.** This part will further probe students' understanding of the lesson and test their logical reasoning skills by generating ideas, analyzing questions, or examining the situation. This could be a problem, a drill, or a thought-provoking question that would challenge their thinking.

**Key to correction.** In this part, the answers to the different activities and practice exercises included in the practice part of the lesson are provided. This feature in the MMLP lesson will give the students immediate answers to the questions that are posed in the practice section to keep track of their progress. This is very helpful in the feedbacking process of the students during the independent learning process.

*4.2.7 References*

This part of the MMLP lesson includes a list of books, other materials, or guides used in preparing the lesson which may be consulted for further understanding or appreciation of the lesson presented. It can be found in the last part of the slide presentation. Online and video sources are also included for the students whenever they want to view the complete videos. Figure 7 presents some sample pages of the MMLP tool.


**Figure 7: Sample pages of the MMLP tool**

### 4.3 Students' Satisfaction of the On-the-Go Android-based Learning Tool

The mean and standard deviation scores of the analysis are presented in Table 1. The results are also discussed below regarding the satisfaction of the students after using the MMLP.

**Table 1: Student satisfaction of the MMLP**

| Indicator | Mean | SD | Description |
|---|---|---|---|
| Learning objectives | 4.75 | 0.07 | Highly satisfied |
| Content | 4.75 | 0.06 | Highly satisfied |
| Organization and presentation | 4.67 | 0.05 | Highly satisfied |
| Format and design | 4.62 | 0.06 | Highly satisfied |
| Learning activities | 4.61 | 0.09 | Highly satisfied |
| Assessment | 4.54 | 0.09 | Highly satisfied |
| **Grand mean** | **4.65** | **0.08** | **Highly satisfied** |

*Note: Description is based on the following scale: 4.50–5.00 (highly satisfied), 3.50–4.49 (satisfied), 2.50–3.49 (moderately satisfied), 1.50–2.49 (fairly satisfied), 1.00–1.49 (not satisfied)*

In terms of the students' overall satisfaction with the OTG ALT, they had an overall perception of *highly satisfied*, with a grand mean of 4.65 (SD = 0.08). To add, the students were in consonance that they were highly satisfied after using the

OTG ALT, as revealed by the standard deviation scores being lower than 0.10. Specifically, the parts of the OTG ALT rated highest by the students in terms of satisfaction level were learning objectives (M = 4.75, SD = 0.07) and content (M = 4.75, SD = 0.06), followed by organization and presentation (M = 4.67, SD = 0.05), with assessment receiving the lowest mean rating (M = 4.54, SD = 0.09). Nonetheless, the students were highly satisfied in terms of all the indicators after they had used the material in learning mathematical logic (see Table 1).

Based on the results, the students agreed that they were highly satisfied with the OTG ALT as a learning tool in terms of learning objectives, content, organization and presentation, format and design, learning activities, assessment, and overall. This implies that the developed ALT is suited for its target users (i.e., geographically challenged students) as a response to their need of a quality, accessible, complete, and easy-to-understand tool to learn mathematics in the new normal or even in the post-pandemic world. This tool will help students to learn efficiently and effectively, meeting their available resources despite the geographic, financial, and technological limitations. Since topics are presented in chunks, easily transported, and have embedded video discussions, learning is made flexible anytime and anywhere for geographically challenged students.

This is validated by what students expressed after using the OTG ALT. (For confidentiality, the participants' names in the evaluation and reflection stage were replaced by codes [i.e., Student A, Student B, Student C].)

> Student A: "*My experience in using the material makes my work easier. There is no need to find a good signal to connect and watch the video lessons online. Aside from that, MMLP is inexpensive because there's no need to buy load for you to use it if you have an Android phone. To add, this is a complete learning material and no need to download other materials. I am having fun and enjoying the MMLP while using it because it's very useful for students with unstable Internet connection like me.*"

This was corroborated by the experiences of other students. They expressed that the learning material is accessible anytime. They do not need a good Internet connection or to buy load for them to watch the videos and browse the material. They said:

> Student B: "*My experiences after using the MMLP for Mathematics in the Modern World (MMW) were smooth and easy. I can easily access the material when I connected the device to my phone. I was also engaged while navigating the MMLP as it was hassle-free, and it contains supplementary information through video discussion which makes understanding the lesson easier. Having MMLP allowed me to understand and learn without getting frustrated due to poor connection. With the use of MMLP, learning was easy, effective, and convenient for me whose Internet connection is weak.*"

> Student C: "*For me, using this MMLP in learning MMW made it very easy to access and use because of technology, which helped me. At the same time, it can be helpful to me because files need not to use any signal to*

*access. That's why it is compatible and easy to access. It saves time and energy."*

## 5. Discussion

New opportunities sprung up from the first-hand reports gathered on what it was like to learn mathematics in the new normal. A variety of events, including completing Google Forms quizzes before the deadline, borrowing cell phones, taking screenshots and screen recordings to stay up with their peers, and having ambiguous conversations, shaped students' perceptions of learning mathematics in the new normal. Philippine public and private higher education institutions were not ready to introduce an online curriculum. A few of the things they may still need to think about include technical equipment, digital literacy, network accessibility, and financial stability (Toquero, 2020). This aligns with the findings of Talingdan and Alunday's (2023) investigation of college students in the country during a pandemic.

According to the students participating in this study, there were a number of variables that contributed to the difficulty of learning mathematics during the pandemic. The methods, techniques, and teaching philosophies that math teachers employed during the pandemic crisis also greatly influenced the way these students viewed mathematics education. The students cited a number of factors as reasons for their poor performance and course grades: hurried and unclear discussions, missed deadlines for assignments, a lack of examples and illustrations to support their points, and a lack of interaction and communication between teacher and students. This agrees with the finding made by Irfan et al. (2020) in their investigation into the difficulties instructors encountered while introducing e-learning in the pandemic. It was challenging for lecturers accustomed to in-person instruction to have e-learning take its place. Several challenges exist, such as the features that are available on the academic portals of all post-secondary institutions, the restricted communication between instructors and students, and the constraints associated with writing mathematical symbols. Peer connections and teacher–student interactions in online learning activities are hindered by flexible scheduling (Shore, 2020). According to Koul et al. (2018), inadequate learning resources have an impact on the quality of instruction. Teachers mostly rely on the tools offered since they provide them the assurance they need to interact with their students. This means that for teachers to teach a subject more effectively, they require instructional materials that include instructions. Therefore, to optimize students' learning experiences in a flexible learning environment, favorable conditions for learning also need to be taken into account (Hoang & Hoang, 2022).

Success is never impeded by hardship. The experiences of these students who faced geographic issues during the pandemic also shed light on their struggles, strategies for overcoming these obstacles, and sources of motivation for persevering in the face of difficulty. Students never ran out of strategies to deal with difficulties as they surfaced. This is a characteristic of Filipino people, who face difficulties head-on. They are known to be tenacious and unwavering. The most prevalent issues among these students were poor connection stability,

storage issues with cell phones, lack of funds to purchase mobile data load, and the necessity of traveling across hills, mountains, or to another nearby barangay to get a reliable connection. These findings present a new variable in implementing remote learning setups. It particularly defines the scope of online learning and distance education programs with reference to prospective students who aim for education despite their geographical location.

In their study of public university students in the Philippines, Soriano et al. (2022) discovered that the students' level of preparation was low. This indicates that they were not yet completely equipped or ready for online learning. In addition, Friedman (2020) listed several obstacles, including interruptions, lack of drive, responding to new technology developments, and technological issues. Some students believed that they were fighting the battle alone because everyone in the family had their own responsibilities and these students had to confront the realities of online learning by themselves in the mountains, hills, or rivers to be able to attend classes. Unwavering tenacity plays a major role in the success of most students from disadvantaged locations, even in the face of constant challenges. Participants of the study thought that learning could one day or somehow alleviate their well-being and status in life.

Through their stories, the participating geographically challenged students promoted ideas for improved teaching strategies and resources that would undoubtedly benefit students from various backgrounds as well as those who are geographically challenged. They underlined the necessity of educational resources that are easily accessible without requiring an Internet connection, charging for mobile data or load, or requiring the total storage space available. To put it succinctly, students want educational materials that are easily carried and stored on a portable storage device, enabling them to access them at any time and from any location, regardless of their changing circumstances. This is consistent with the findings of Portana et al. (2021) and Torion and Bacio Jr (2024). These scholars found that instructional materials offer a variety of approaches and techniques to facilitate the teaching and learning processes because they are made of tangible materials that even the most reluctant students can comprehend and relate to.

Analyzing the ideas of mobile learning and Android-based learning to see what students would like to propose for the future is an important step to improve mathematical instruction. These attributes describe the kind of learning materials that students require to receive better instruction in mathematics in the new normal or in the future. Pandey (2018) defined mobile learning as "on the go" learning. By enabling access to learning resources from anywhere and at any time, it aims to empower students. They are free to choose when and how quickly to finish the tasks. Students can access the same course on any device—from desktop computers and laptops to tablets and smartphones—showing the multi-device capability of mobile learning. As smartphone technology develops, mobile-based learning becomes a more flexible and effective alternative to instructional design (Sasongko et al., 2017).

In terms of the developed OTG ALT, the format is in accordance with Acuram (2015). The format and style of a learning material may differ depending on its purpose and the institution where it is developed. The purpose of the MMLP is to make mathematics learning efficient and accessible for geographically challenged students. It is anchored on the format of the university. Basically, the components of each material are title, overview, objectives, discussion of content, self-check test and evaluation activities, and references. It also follows the list of components of a typical learning material as enumerated by Aguirre Jr (2015), which include the title, overview, objectives, learning activities, and post-test, in this material the assessment part. Martin et al. (2013) further added that an instructional design is a system of developing a well-structured instructional material using objectives, teaching-related strategies, evaluation, and systematic feedback.

Meanwhile, Pal (2017) agreed that explainer videos are used to gain students' attention and present the content in an interesting way. This conforms with the findings of Insorio and Macandog (2022) that YouTube video playlists help students understand and develop students' mathematics competencies. Watching the said intervention boosts students' confidence in answering the learning activities and performing tasks. However, they suggested to provide more videos with closed captions, illustrative examples, and explanations. Hence, the OTG ALT in this study was enriched with more video explainers for every sub-topic tackled in every lesson. Moreover, video lessons are helpful for struggling students in mastering the course materials.

Moreover, the distinct features of the MMLP, such as the reflection part of the i−SPARK model, are in consonance with the findings of Salleh and Zakaria (2012). Based on the qualitative analysis presented by Salleh and Zakaria (2012), one of the two major common inputs highlighted by the lecturers or respondents is the importance of giving reflective questions after completion of each sub-category in the activities. They emphasized that students need to be given some time to do a reflection on their outputs. These reflective activities can trigger metacognitive awareness among students. It is crucial for technology students to be aware about their thinking skills as they use mathematics to make sense of real-life applications in their related field. Bismala and Manurung (2021) identified several factors that need to be improved in new normal learning, which includes the quality of the instructional materials provided to the students. For Mukuka et al. (2021), education providers should always consider the social and economic status of learners when designing instructional strategies and materials.

Lastly, the findings on the satisfaction of students in using the OTG ALT are consistent with the research conducted by Nabayra and Tambong (2023), which revealed that students expressed a high degree of satisfaction with the way in which their learning was managed throughout the flexible learning mode. The course material, learning activities, teacher tactics, and learning activities were all highly credited for this result. Furthermore, the material's quality is a crucial factor because it positively affects student satisfaction (Aparicio et al., 2017; Sun et al., 2008). It also supports the argument made by Frisnoiry et al. (2022) that learning materials are required that can effectively and engagingly depict every

mathematical item. Furthermore, mobile learning allows educators to enhance their abilities and facilitate students' acquisition of mathematical knowledge (Zefriyenni & Mardhiyah, 2017).

The wide array of insights revealed in this paper presents useful implications to the teaching practice and learning patterns of students. The finding that students have different and specific preferences in learning and studying remotely or online implies that educators should take a look at how an online curriculum or course is designed. The information from this current study could provide important ideas and data that could help establish a more stable and efficient online curriculum.

## 6. Conclusion

The pandemic mathematics education presents a variety of opportunities for students from geographically challenged places. As people pursue education in the new normal, obstacles, including those that are personal, financial, technological, instructional, socioeconomic, and geographical, continue to exist. Positively, students ponder on and reimagine a better mathematics experience in the following normal based on their experiences. This study sought to conduct research on geographically challenged students' experiences of mathematics education in the new normal, to develop a useful learning tool to address the identified challenges and problems, and to determine the satisfaction levels of students in terms of using the developed tool.

The varied experiences of students in studying mathematics in geographically challenged locations presented several useful insights. Establishing an online math course curriculum requires more than just a set of requirements and guidelines. The unique challenges of geographically challenged students were unveiled, which include network coverage limitations, learning material accessibility, financial constraints, and many others. These findings assisted and served as basis in the development of the learning tool.

The developed OTG ALT for geographically challenged students responds to the call for equitable mathematics instruction in the new normal or in post-pandemic education. Its accessibility, appropriateness, and completeness suit its target users. According to assessments from students, the OTG ALT has met both the university's instructional standards and the expectations of the students for a complete, workable, adaptable, and complete instructional resource for online mathematics learning. The key components of the OTG ALT work in concert with its unique feature—the video explainer—to provide a practical and useful learning resource that meets the needs of students across different backgrounds.

School administrators can improve the quality of mathematics education (both online and in-person programs) at universities by taking minority perspectives into account, rather than imposing a single strategy that should work for everyone. To make mathematics education inclusive and equitable, policymakers and curriculum designers can look into how well the teaching materials match the level and needs of the students by considering their learning agencies and

backgrounds. Despite these positive results, the OTG ALT developed in this study may have deficiencies in terms of covering a larger scope of mathematics lessons. It may also present insufficient drills and exercises in the different perspectives of students. It is highly recommended to develop similar learning tools encompassing other areas of mathematics and across levels of learning.

Future researchers may look into the challenges of students from other backgrounds and setups, other than those in remote areas, in navigating online and in-person education programs. This paper recommends for educators and researchers to study and review mathematics education strategies, while considering the educational issues of developing countries such as the Philippines. This could allow future generations to experience a holistic mathematics education program, helping them to become more productive, competitive, and functioning citizens.

## 7. References


Acuram, J. V. (2015, August 12). *Instructional module and its components*. creativeandhumble. https://creativeandhumble.wordpress.com/2015/08/12/instructional-module-and-its-components/

Adnan, M., & Anwar, K. (2020). Online learning amid the COVID-19 pandemic: Students' perspectives. *Journal of Pedagogical Research*, *1*(2), 45–51. https://doi.org/10.33902/jpsp.2020261309

Aguirre, Jr, D. (January 6, 2015). *Instructional materials development manual*. SSRN. http://dx.doi.org/10.2139/ssrn.2703250

Aparicio, M., Bacao, F., & Oliveira, T. (2017). Grit in the path to e-learning success. *Computers in Human Behavior*, *66*, 388–399. https://doi.org/10.1016/j.chb.2016.10.009

Ariyanti, G., & Santoso, F. (2021). The effects of online mathematics learning in the Covid-19 pandemic period: A case study of senior high school students at Madiun City, Indonesia. *Mathematics Teaching Research Journal*, *12*(3), 4–11. https://commons.hostos.cuny.edu/mtrj/wp-content/uploads/sites/30/2020/10/v12n3-The-Effects-of-Online-Mathematics-Learning.pdf

Barrot, J. S., Llenares, I. I., & del Rosario, L. S. (2021). Students' online learning challenges during the pandemic and how they cope with them: The case of the Philippines. *Education and Information Technologies, 26*, 7321–7338. https://doi.org/10.1007/s10639-021-10589-x

Berkova, A., & Nemec, R. (2020). Teaching theory of probability and statistics during the Covid-19 emergency. *Symmetry (Basel), 12*(9), Article 1577. https://doi.org/10.3390/SYM12091577

Bismala, L., & Manurung, Y. (2021). Student satisfaction in e-learning along the COVID-19 pandemic with importance performance analysis. *International Journal of Evaluation and Research in Education (IJERE), 10*(3), 753–759. http://doi.org/10.11591/ijere.v10i3.21467

Bringula, R., Reguyal, J. J., Tan, D. D., & Ulfa, S. (2021). Mathematics self-concept and challenges of learners in an online learning environment during COVID-19 pandemic. *Smart Learning Environments, 8*, Article 22. https://doi.org/10.1186/s40561-021-00168-5

Bullo, M. (2021). Integration of video lessons to Grade-9 science learners amidst COVID-19 pandemic. *International Journal of Research Studies in Education, 10*(9), 67–75. https://doi.org/10.5861/ijrse.2021.670

Carius, A. C. (2020). Teaching practices in mathematics during Covid-19 pandemic: Challenges for technological inclusion in a rural Brazilian school. *American Scientific Research Journal for Engineering, Technology, and Sciences*, *72*(1), 35–43. https://asrjetsjournal.org/index.php/American_Scientific_Journal/article/view/6230/2232

Commonwealth of Learning. (2021). *Introduction to microlearning*. Commonwealth of Learning. https://oasis.col.org/server/api/core/bitstreams/07d80b84-b502-4ed4-8f9f-1504d4613084/content

Crawford, J., Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P., & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*, *3*(1), 1–20. http://doi.org/10.37074/jalt.2020.3.1.7

Dizon, R. J. J., & Errabo, D. D. R. (2022). *Challenges and opportunities of online learning in the Philippine context: Thriving in the new normal* [Conference session]. 2022 13th International Conference on E-Education, E-Business, E-Management, and E-Learning (IC4E). https://doi.org/10.1145/3514262.3514318

Doolittle, P. E., Bryant, L. H., & Chittum, J. R. (2014). Effects of degree of segmentation and learner disposition on multimedia learning. *British Journal of Educational Technology*, *46*(6), 1333–1343. https://doi.org/10.1111/bjet.12203

Friedman, J. (2020, May 4). *Tackle challenges of online classes due to COVID-19*. U.S. News and World Report. https://www.usnews.com/education/best-colleges/articles/how-to-overcome-challenges-of-online-classes-due-to-coronavirus

Frisnoiry, S., Surya, E., Siregar, T., Elfitra, & Frimaulia, S. (2022). *Micro-learning in mathematics learning* [Conference session]. Proceedings of the 4th International Conference on Innovation in Education, Science and Culture, ICIESC 2022, 2022, Oct 11, Medan, Indonesia. http://doi.org/10.4108/eai.11-10-2022.2325513

Gafoor, K. A., & Kurukkan, A. (2015). *Why high school students feel mathematics difficult? An exploration of affective beliefs* [Paper presentation]. UGC Sponsored National Seminar on Pedagogy of Teacher Education, Trends and Challenges, 2015, Aug 18–19, Farook Training College, Kozhikode, Kerala, India. https://eric.ed.gov/?q=Mathematics+as+Difficult+subject&id=ED560266

Giray, L., Gumalin, D., Jacob, J., & Villacorta, K. (2022). Exploring the online learning experience of Filipino college students during Covid-19 pandemic. *Jurnal Ilmiah Peuradeun, 10*(1), 227–250. https://doi.org/10.26811/peuradeun.v10i1.691

Guansi, G., Pal-ec, B., & Orasing, G. (2020). Readiness of students in the new normal learning: An assessment in Baguio City and Benguet province. *American Journal of Engineering Research (AJER), 9*(12), 107–117. http://www.ajer.org/papers/Vol-9-issue-12/M0912107117.pdf

Guo, P. J., Kim, J., & Rubin, R. (2014). *How video production affects student engagement: An empirical study of MOOC videos* [Conference session]. Proceedings of the First ACM Conference on Learning @ Scale Conference, New York, NY, USA (pp. 41–50).

Han, F., & Ellis, R. (2019). Using phenomenography to tackle key challenges in science education. *Frontiers in Psychology, 10*, Article 1414. http://doi.org/10.3389/fpsyg.2019.01414

Helsa, Y., & Kenedi, A. (2019). Edmodo-based blended learning media in learning mathematics. *Journal of Teaching and Learning in Elementary Education, 2*(2), 107−117. https://doi.org/10.33578/jtlee.v2i2.7416

Hendikawati, P., Zahid, M. Z., & Arifudin, R. (2019). Keefektifitan media pembelajaran berbasis Android terhadap kemampuan pemecahan masalah dan kemandirian belajar [The effectiveness of Android-based learning media on problem-solving ability and learning independence]. *PRISMA, Prosiding Seminar Nasional*

*Matematika*, *2*, 917–927.
https://journal.unnes.ac.id/sju/index.php/prisma/article/view/29308

Hidayat, W., Rohaeti, E., Hamidah, I., & Putri, R. (2023). How can Android-based trigonometry learning improve the math learning process*? Frontiers in Education, 7,* Article 1101161. http://doi.org/10.3389/feduc.2022.1101161

Hoang, D. T. N., & Hoang, T. (2022). Ready or not? An exploration of university students' online learning readiness and intention to use during COVID-19 pandemic. *E-Learning and Digital Media*, *20*(5), 442–459.
https://doi.org/10.1177/20427530221117330

Insorio, A. O., & Macandog, D. M. (2022). YouTube video playlist as mathematics supplementary learning material for blended learning. *European Journal of Interactive Multimedia and Education*, *3*(2), e02212.
https://doi.org/10.30935/ejimed/12490

Irfan, M., Kusumaningrum, B., Yulia, Y., & Widodo, S. A. (2020). Challenges during the pandemic: Use of e-learning in mathematics learning in higher education. *Infinity, 9*(2), 147–158. https://doi.org/10.22460/infinity.v9i2.p147-158

Jose, J. P., Juan, K. L. M. P., Tabiliran, J. P. N., Yapo, F. C. D., Gatchalian, J. M., Baluyot, M. K. M., Torrero, K. A. D. C., Blanco, J. A., & Tus, J. (2023). Struggle is real: The experiences and challenges faced by Filipino tertiary students on lack of gadgets amidst the online learning. *Psychology and Education: A Multidisciplinary Journal, 7*, 174–181. https://scimatic.org/show_manuscript/1028

Koul, R., Fraser, B. J., & Nastiti, H. (2018). Transdisciplinary instruction: Implementing and evaluating a primary-school STEM teaching model. *International Journal of Innovation in Science and Mathematics Education*, *26*(8), 17–29.

Kunwar, R. (2020). Mathematics phobia: Causes, symptoms, and ways to overcome. *International Journal of Creative Research Thoughts (IJCRT), 8*(8), 818–822. http://www.ijcrt.org/papers/IJCRT2008103.pdf

Kurniasih, S. (2021). The influence of Android-based mobile learning on students' learning independence on the subject of derivative algebraic functions. *ITEJ (Information Technology Engineering Journals), 4*(2), 67–74.
https://doi.org/10.24235/itej.v4i2.32

Legaspi, C., Lariosa, D., Jamiliarin, P., & Villaruz, J. (2020). *University policy and guidelines manual for the preparation, evaluation, and approval for utilization of the instructional materials produced by the faculty of the Aklan State University.* Aklan State University, Banga, Aklan, Philippines.

Mahudal, I., Nasrullah, A., Mubarika, M. P., Meilisa, R., & Fajari, L. E. W. (2022). Android-based mathematics learning media assisted by smart apps creator on self-regulated learning. *International Journal of Asian Education, 3*(3). https://doi.org/10.46966/ijae.v3i3.292

Mamolo, L. A. (2022). Online learning and students' mathematics motivation, self-efficacy, and anxiety in the "new normal". *Education Research International,* Article 9439634. https://doi.org/10.1155/2022/9439634

Martin, F., Hoskins, O. J., Brooks, R., & Bennett, T. (2013). Development of an interactive multimedia instructional module. *The Journal of Applied Instructional Design*, *3*(3), 5–18.
https://www.researchgate.net/profile/Florence-Martin-7/publication/272151941_Development_of_an_Interactive_Multimedia_Instructional_Module/links/54dba5020cf23fe133ad6a9e/Development-of-an-Interactive-Multimedia-Instructional-Module.pdf

Marton, F., & Booth, S. (1997). *Learning and awareness*. Lawrence Erlbaum Associates.

McKenney S., & Reeves, T. (2012). *Conducting educational design research*. Routledge.

McKenney, S., & Reeves, T. C. (2021). Educational design research: Portraying, conducting, and enhancing productive scholarship. *Medical Education, 55*(1), 82−92. https://doi.org/10.1111/medu.14280

Mukuka, A., Shumba, O., & Mulenga, H. (2021). Students' experiences with remote learning during the COVID-19 school closure: Implications for mathematics education. *Heliyon*, 7, e07523. https://doi.org/10.1016/j.heliyon.2021.e07523

Nabayra, J. (2022). Least mastered topics in mathematics and freshmen students' perception of mathematics learning in the new normal from a state university in the Philippines. *Journal of Positive School Psychology*, *6*(6). https://www.journalppw.com/index.php/jpsp/article/view/6910

Nabayra, J. (2023a). Mathematics education amidst the pandemic: The experiences of freshmen university students challenged at the margin. *MIER Journal of Educational Studies Trends and Practices*, *13*(2), 424–441. https://doi.org/10.52634/mier/2023/v13/i2/2519

Nabayra, J. (2023b). Teacher-made videos as learning tool in elementary statistics during the pandemic. *International Journal of Information and Education Technology, 13*(1), 10–18. http://www.ijiet.org/show-184-2363-1.html

Nabayra, J., & Tambong, C. (2023). Readiness level, satisfaction indicators, and overall satisfaction towards flexible learning through the lens of public university teacher education students. *International Journal of Information and Education Technology*, *13*(8), 1230–1241. https://www.ijiet.org/show-191-2530-1.html

Pal, D., & Patra, S. (2020). University students' perception of video-based learning in times of COVID-19: A TAM/TTF perspective. *International Journal of Human–Computer Interaction*, *37*(4), 1–19. https://doi.org/10.1080/10447318.2020.184816430

Pal, Y. (2017, Dec 13). *Types of educational videos based on the production style*. ETmantra. https://etmantra.com/types-of-educational-videos-based-on-the-production-style/

Pandey, A. (2018, May 18). *Why you should adopt the combination of micro-learning and mobile learning in 2018*. eLearning Industry. https://elearningindustry.com/microlearning-and-mobile-learning-2018-why-adopt-combination

Portana, H. V., Fronda, J. G., Policarpio, D. G. T., Rigat, K. A. R., & Llames, G. (2021). Effectiveness and acceptability of instructional materials in the enhancement of students' academic achievement. *International Journal of Advanced Engineering, Management, and Science, 7*(1), 12–15. https://doi.org/10.22161/ijaems.71.2

Sabaruddin, Marzuki, & Khairunnisak. (2020). Pandemic Covid-19: The opportunities and challenges to using ICT in mathematics learning. *International Journal of Entrepreneurship and Business Development*, *3*(4). https://doi.org/10.29138/ijebd.v3i4.1201

Sagge Jr, R. G., & Segura Jr, R. T. (2023). Designing and developing video lessons in mathematics using code-switching: A design-based research. *International Journal of Information and Education Technology*, *13*(9), 1391–1398. https://doi.org/10.18178/ijiet.2023.13.9.1942

Sagge Jr, R. G., & Bacio Jr, S. P. (2024). Video explainer, e-module, or both: Which is better to improve statistics performance of graduate students? *International Journal of Evaluation and Research in Education (IJERE), 13*(5), 3194–3194. https://doi.org/10.11591/ijere.v13i5.28945

Salleh, T., & Zakaria, E. (2012). Module for learning integral calculus with maple: Lecturers' views. *The Turkish Online Journal of Educational Technology*, *11*(3). https://www.researchgate.net/publication/278848282_Module_for_learning_integral_calculus_with_maple_Lecturers'_views

Sasongko, W., Widiastuti, I., & Harjanto, B. (2017). *Development of mobile learning module based on student's learning style for a mechanical engineering education course*

[Conference session]. International Conference on Teacher Training and Education 2017 (ICTTE 2017). Advances in Social Science, Education and Humanities Research (ASSEHR), 158. Atlantis Press.

Shore, J. (2020). *Problems in online classes*. https://education.seattlepi.com/problems-online-classes-1132.html

Soriano, R., Cagurangan, P., & Escario, C. (2022). Exploring students' readiness in online learning in the new normal. *Asia Proceedings of Social Sciences*, *9*(1), 217–218. https://doi.org/10.31580/apss.v9i1.2299

Sun, P., Tsai, R. J., Finger, G., Chen, Y-Y., & Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers and Education*, *50*(4), 1183–1202. https://doi.org/10.1016/j.compedu.2006.11.007

Syauqi, K., Munadi, S., & Triyono, M. (2020). Students' perceptions toward vocational education on online learning during the COVID-19 pandemic. *International Journal of Evaluation and Research in Education (IJERE), 9*(4), 881–886. http://doi.org/10.11591/ijere.v9i4.20766

Talingdan, J., & Alunday, A. (2023). Students' perspective on the new normal virtual learning. *International Journal of Information and Education Technology*, *13*(2), 392−398. http://doi.org/10.18178/ijiet.2023.13.2.1818

Toquero, C. M. (2020). Challenges and opportunities for higher education amid the COVID-19 pandemic: The Philippine context. *Pedagogical Research*, *5*(4), em0063. https://doi.org/10.29333/pr/7947

Torion, P., & Bacio Jr, S. (2024). Video lessons for the course introduction to computing through online/offline mode (ICOM): Its development and evaluation. *International Journal of Information and Education Technology*, *14*(6), 845–855. https://www.ijiet.org/vol14/IJIET-V14N6-2110.pdf

Turan, Z., Kucuk, S., & Cilligol Karabey, S. (2022). The university students' self-regulated effort, flexibility and satisfaction in distance education. *International Journal of Educational Technology in Higher Education, 19,* Article 35. https://doi.org/10.1186/s41239-022-00342-w

Wenceslao, P., & Felisa, G. (2021). Challenges to online engineering education during the Covid-19 pandemic in Eastern Visayas, Philippines. *International Journal of Learning, Teaching and Educational Research*, *20*(3), 84–96. https://doi.org/10.26803/ijlter.20.3.6

Wijaya, T. (2021). How Chinese students learn mathematics during the coronavirus pandemic. *International Journal of Educational Research and Innovation, 15*, 1–16. https://doi.org/10.46661/ijeri.4950

Zefriyenni, Z., & Mardhiyah, H. (2017) Pengembangan mathematics mobile learning application (MMLA)-sistem persamaan linear dua variabel (Spldv) untuk siswa kelas 8 sebagai sumber pembelajaran mandiri berbasis Android [Development of mathematics mobile learning application (MMLA)-two-variable linear equation system (Spldv) for Grade 8 students as an Android-based independent learning resource]. *Jurnal Teknologi Informasi & Pendidikan, 10*(2), 25–36. https://doi.org/10.24036/tip.v10i2.29