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Unveiling the Power of Educational Mathematics Applications as Formative Assessment Tools: A Multiple Case Study

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Abstract

This study explored the experiences of the second-year students of Bukidnon State University on their utilization of Symbolab and Photomath applications as formative assessment tools in their calculus studies. This study utilized the data source triangulation method in collecting data based on interviews, observation of interaction, and document analysis (Carter, Bryant-Lukosius, DiCenso, Blythe & Neville, 2014). The data were collected through face-to-face and virtual interviews using a semi-structured interview guide. Thematic analysis was utilized for data analysis. Findings revealed four (4) themes: (1) Learning Support in Mathematics, (2) Ethical Use of Math Applications, (3) User-Friendly Math Application Features, and (4) Accessibility and Inclusivity of Math Applications. This study recommends that students and teachers are urged to actively utilize these two (2) applications to enrich their learning experiences and expertise in calculus respectively.

Keywords: *case study, Symbolab application, Photomath application, Calculus*

INTRODUCTION

In various educational systems, the significance of student's academic performance in college is widely acknowledged (Brew, 2021). This acknowledgment stems from the understanding that students' efforts during exams are directly correlated with their overall academic success. The determination of academic success often involves considering factors that influence students' Performance (Eze et al., 2016). Assessment of academic accomplishment frequently involves analyzing average grades from previous semesters and overall cumulative grades.

Scholarly interest across different disciplines has focused on investigating the variables that impact student Performance. Researchers have diligently worked towards identifying both positive and negative factors influencing student performance. This research pursuit has extended globally, involving academics from numerous nations and regions. A range of research studies has been conducted on this subject (Garkaza et al., 2011; Tailab, 2013; Sugahara and Boland, 2014; Steenkamp and Baard, 2009; Cheung and Kan, 2002; Kruck and Lending, 2003).

Moreover, in the context of enhancing academic performance, the educational landscape has been significantly influenced by the rise of innovative digital tools available online (Haleem, 2022). These tools have revolutionized learning approaches and have showcased a substantial impact on the educational system. An illustrative example of such a tool is the Symbolab and Photomath applications, which play a pivotal role in supporting mathematics education across various levels.

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Symbolab Application, a powerful digital resource, facilitates the learning, practice, and exploration of mathematical concepts, spanning algebraic, trigonometric, and calculus topics from middle school through college (Makhdum, 2023). It encompasses a comprehensive range derivative, limits, and solving linear and quadratic equations, among others. Functioning as a web-based platform, Symbolab.com offers a diverse array of tools and functionalities for solving and calculating mathematical problems. While on the other hand, Photomath is a free mobile application, for both iOS and Android platforms, which uses computer vision and image understanding technology to scan math equations using the mobile camera to subsequently provide worked solutions.

This app uses image-capturing technology to scan math equations using the mobile's camera and provides a step-by-step solution for any math equation, ranging from basic arithmetic to advanced calculus. By harnessing state-of-the-art text recognition and image understanding, both printed and handwritten, Photomath is able to provide solutions in both calculations and graphical methods in a matter of seconds, with an option for feedback from the user to the developer for continuous improvement of the app.

Consequently, within mathematics education, technology is perceived as a valuable tool, the affordances of which allow mathematics learning to be reshaped and practiced in distinctive ways (Abidin & Hunter, 2017; Torressibille, Cloquellballester, & Darton, 2009). Besides, the integration of such advanced digital tools, exemplified by the Symbolab and Photomath Applications, has brought about a transformative shift in the way educational systems approach teaching and learning, ultimately bolstering academic Performance.

Aligned with the notion of independent learning, which empowers learners to explore their capabilities, take control over their learning processes, and tailor their approaches to their styles (Rahimi, van den Berg, & Veen, 2015), a specific avenue of exploration emerges. This exploration centers around the utilization of innovative tools such as the Symbolab and Photomath applications and its potential impact on student learning.

With learners possessing diverse styles of skill and knowledge cultivation, the opportunity to engage with tools like Symbolab and Photomath can lead to the identification of learning styles that best suit their individual needs. To this end, the researchers recognized the value in investigating the differential significance that arises from employing the Symbolab and Photomath application. The central aim here is to ascertain the actual effectiveness of the two (2) applications and its potential to yield tangible outcomes in students' calculus performance.

Research Objective

Aiming to delve into the educational technology domain, this study's definitive goal was to explore the experiences of students with the Symbolab and Photomath applications in calculus courses, prompting the question: How do students perceive and utilize these applications as formative assessment tools in their studies?

RESEARCH METHOD

This study builds on the Cognitive Load Theory (CLT), introduced by John Sweller, holds significant relevance in the realm of technology-enhanced learning (TEL). TEL, which harnesses various technological tools to enhance educational experiences, benefits from CLT principles in several ways. In multimedia design, CLT guides the structuring of content to minimize extraneous cognitive load, ensuring clarity and relevance. Interactive learning environments in TEL align with CLT by facilitating

guided problem-solving and providing immediate feedback. Adaptive learning systems, prevalent in TEL, can utilize CLT to tailor content appropriately, balancing challenge and cognitive load. Online instructional materials, guided by CLT, present information in a cognitively accessible manner, enhancing overall learning experiences. Furthermore, the incorporation of gamification and simulations in TEL is informed by CLT to strike a balance between engagement and cognitive demands. Through the application of CLT principles, TEL designers can create more effective and learner-friendly environments that optimize the cognitive efficiency of the learning process. Moreover, despite the widespread growth in practice, concerns continue to be expressed about the extent to which effective use is being made of technology to improve the learning experience of students (Guri-Rosenblit 2009).

This framework centers on the integration of technology, in this case, the Symbolab and Photomath applications, to augment and enrich the learning experience in mathematics. It posits that well-designed technological tools have the potential to enhance comprehension, problem-solving skills, and overall proficiency in specific subject areas.

Research Design

This study utilized multiple case studies to determine the preferred application among second-year mathematics students for formative assessment tools when studying calculus 1. A case study involves exploring an individual, situation, organization, or phenomenon to gain insight into a broader category of cases (Creswell, 2003). In qualitative case study approaches, the number of cases can vary from a single instance to up to 12 cases (Gerring, 2006). These analyses aim to explore unique contexts while contributing to a broader understanding. Specifically, a particularistic case study delves into specific issues within a particular situation, location, or bounded phenomenon, such as a program, person, or process (Merriam, 1998). Hence, employing a case study research design in this inquiry allows a focus on the strategies utilized by junior high school teachers to address challenges within the teaching profession.

Research Setting

Bukidnon State University is a sector of development in teacher education offering the four-year degree course, Bachelor in Secondary Education Major in Mathematics which is now considered as a CHED priority course. Currently the BSEd Mathematics program achieved 100% passing rate in the Licensure Examinations for Teacher for two consecutive years.

Participants of the Study

The participants of the study were the thirty (30) BSE Mathematics students 2nd year from the Bukidnon State University, aged between 18 and 30, who were enrolled in a Calculus course. These participants were chosen purposefully based on their relevance to the research and represented 23% of the total population. This approach was taken to ensure that the participants were well-suited and credible for the study. The study employed a purposive sampling technique. Qualitative research typically used this non- random sampling method in which specific features or characteristics of the participants are chosen deliberately due to the qualities they possess (Etikan, Musa & Alkassim, 2016). Recruitment of the participants was voluntary with the informed consent as proof of their voluntary participation.

Research Instrument

This case study utilized the data source triangulation method in collecting data based on three (3) perspectives: interview, observation of interaction, and document analysis (Carter, Bryant-Lukosius, DiCenso, Blythe & Neville, 2014). Which means that this case study, the researchers serve as the primary research instrument, it also utilized data from quizzes and lastly, the researcher develop interview. The researcher established an Interview Schedule used in face-to-face interview. The said interview schedule is composed of engaging, exploratory, and exit questions intended to discover student experience and preference on utilizing Symbolab and Photomath application on learning Calculus 1.

Data Gathering Procedure

In gathering the data, this triangulation approach involves using multiple sources ensuring that the data are sufficient to gather information on the same topic, ensuring and enhancing the credibility and validity of the data. (Creswell, 2009). The data source triangulation method the collection of data based on an interview, observation of interactions, and document analysis (Carter et al., 2014).

The researcher collected the data through face-to-face and virtual interviews and utilizing the semi-structure interview guide.

Aside the individual meeting, the researcher gathered data through observations of participants' before, during and after interactions and document analysis. Using the quizzes as a document, the inquirer highlights the quiz score from integrated application to obtain robust data.

The interview and quizzes as document began in November 2023 and concluded in December 2023. Each meeting lasted for 20 - 30 minutes. After receiving approval, the researcher used a video recorder to capture the interviews in order to ensure proper transcription. In addition to recording interactions throughout each interview, the researcher also took notes.

Before beginning the interview, the researcher gave the participants an explanation of the study's objectives, methodology, and confidentiality policies. The researcher introduced himself to them in an effort to build rapport and earn their confidence. Throughout the interviews, open-ended questions were utilized to encourage respondents to answer questions honestly and freely. Asking follow-up and probing questions enabled participants to elucidate or explain their answers.

After every interview, the transcribing procedure was carried out. The researcher listened to the audiotapes and went over each transcript to make sure it was accurate. After that, the exact transcription of the interview replies was sent back to the participants for member verification as a kind of confirmation. After then, inductive data analysis and notes were used to create meanings.

Data Analysis

The collected data was reviewed and classified in order to discover patterns and meanings inherent in the case study. Thematic analysis led trend analysis, implications determination, and conclusion formulation. This study followed the research's five stages of data analysis (Ajjawi and Higgs, 2007). Stage 1 Immersion to facilitate coding, duties include structuring the data set into texts, repetitive reading of texts, and early interpretation of texts. Stage 2 Understanding, the tasks include detecting first-order constructs and data coding. Stage 3 Abstraction highlights identifying second-order constructs and grouping second-order constructs into sub-themes. Stage 4 Synthesis and Theme Development put emphasis on cluster of sub- themes into themes and further explanation of ideas. Lastly, Stage 5 Illumination and Illustration of Phenomena includes linking the literature to the items identified, synthesizing the phenomenon, and developing the model.

Ethical Considerations

To maintain the research integrity, the researcher observed ethical considerations in this exploration. The guidelines served to protect the interests of individuals by looking at ethical concerns such as protection of confidentiality, nature of participation and informed consent as a process.

Protection of Confidentiality. The anonymity of participants' identity and confidentiality of the participants were fundamental to the conduct of this exploration. The researcher ensured participants that the data they provide could not be traced back to them in all means and forms of dissemination.

Nature of Participation. The inquirer ensured the voluntary participation of the research participants without coercion. The researcher oriented the participants about their right to withdraw any time from the research should they want to.

Informed Consent. The researcher employed no deceptive practices in administering informed consent from the potential research participants. The researcher read the written letter to the participants. This form presented the researcher's identity, defined the purpose of the research, and described the ethical guidelines used in the study. The participant affixed his/her signature on the form, indicating consent to participate in the study.

RESULTS AND DISCUSSION

Students' Experiences on Utilizing Symbolab and Photomath Application in Calculus: Case Analysis

Case 1. Research Participant 2 is a female sophomore at Bukidnon State University, pursuing a Bachelor's degree in secondary education with a focus on mathematics, shared her varied encounters with using the Symbolab app. She expressed that the app is user-friendly and offers clear, step-by-step guidance for solving mathematical equations, making the learning process much more accessible. She stated that this app is the best.

> For me, this app is an absolute game-changer. I consider it the best application, particularly for grasping concepts like limits. Its intuitive interface and the way its breakdown solutions step-by-step have not only made learning about limits bearable but have also convinced me that this app perfectly caters to my learning style and needs. (RP1)

She also articulated how Symbolab application help in different challenges and its disadvantage if not use in a right way.

> Utilizing Symbolab would be great help for students in order for them to further understand mathematical equations, but some of the students depends on the application, they use to submit their answers without understanding. (RP1)

Case 2. Research Participant 1 is 19 years of age, a male second year student in Bukidnon State University, currently taking a bachelor's degree in secondary education major in mathematics. He stated his different experiences on utilizing the Symbolab application as a formative assessment tool, such as it is much easy to use, it provides clear steps on how to solve a mathematics equation. He also articulated that utilizing this kind of application does depend on people's level of understanding.

> Symbolab produces highly detailed steps in its solutions, offering explicit guidance. However, comprehending its processes and gaining understanding depends on an individual's level of comprehension. (RP2)

He also emphasized the advantage of utilizing the Symbolab application and its help in different challenges upon using it right.

> By using Symbolab, it's important to ensure that students who utilize these apps comprehend the concepts presented in the solutions provided. (RP2)

Case 3. Research Participant 3 is 21 years of age, a second-year female student from the Bachelor of Secondary Education Major in Mathematics. She has challenging journey on learning calculus because she doesn't have background on the subject but she found inspiration learning it.

> For me, I find it challenging because I don't have a background in this kind of subject, but I know that being dedicated in studying, practice and perhaps seeking additional resources or assistance, I will be able to master the concepts of calculus in general (RP3)

She also specified different experiences upon utilizing the applications on the class.

> Symbolab and Photomath do similar things but in slightly different ways. Symbolab is good at giving detailed step-by-step solutions for many math problems, like calculus and algebra. On the other hand, Photomath is more about quickly solving problems by recognizing them from a photo. While Photomath does provide step-by-step explanations for some problems, it might not be as detailed as Symbolab. That's why I prefer using Symbolab to Photomath. (RP3)

Moreover, she suggested certain things that the applications may be a great help.

> If I were suggesting how a math app could help with different challenges, I'd say it should give clear step-by-step solutions for problems, cover various math topics, include interactive learning features, track progress, and show real-life examples. For teachers using Symbolab or Photomath, it could be a great extra tool for students to practice, reinforce lessons, and learn at their own pace. Teachers can use these apps during class discussions, encourage students to use them for homework, and foster collaboration by discussing solutions together. This way, math becomes more engaging and accessible for everyone. (RP3)

Case 4. Research Participant 4 is from Quezon Bukidnon. He is 21 years of age, a male student taking up a bachelor's degree in Secondary Education majoring Mathematics at Bukidnon State University. He stated on how he struggles in his studies and what he felt during the semester. He also articulated that learning calculus is a moderate task and needs a lot of self-study.

> College has not been easy, particularly in the final week. My grades used to frustrate me, but now that the first semester is finished, I feel relieved and accomplished. (RP4)

> Figuring out and learning limits is doable, but it requires a lot of self-study. I'd say it's a moderate task since there are many rules to consider. But, once you get the hang of them, solving, grasping, and understanding become easier. (RP4)

He then stated his experiences on utilizing the applications as a formative assessment tool on their calculus task.

> In my experience, Photomath excels in promptly resolving problems using image recognition, while Symbolab offers a broader spectrum of mathematical solutions alongside understandable step-by-step

> explanations. Symbolab stands out for its emphasis on providing user-friendly, detailed solutions, focusing not only on the final answer but also on the process used to arrive there. For me, Symbolab is the preferred choice among the two. It's a fantastic app, especially for students like us, as it not only offers correct solutions but also facilitates learning by guiding us through the problem-solving process. Symbolab's dedication to helping users understand how to tackle problems makes it an invaluable learning resource on top of being a proficient problem-solving tool. (RP4)

Moreover, Case 4 also suggests things that a applications can help in different challenges most especially in mathematics.

> It's a great way to use these mobile applications, especially for someone like me who is more involved in self-study. Trying trial and error problems makes it easier for me to know what the exact answer is, and I'll just utilize it to figure out how it is done with the help of its app platform. (RP4)

Case 5. Research Participant 5 is a female second-year student from the Bachelor of Secondary Education Major in Mathematics. She is 20 years of age. She struggled in several ways, such as the capacity of her learning is at a slow phase thus learning calculus in a phase faster than hers is difficult to cope up with.

> I often struggle to keep up with what my instructor is teaching, finding it challenging to grasp the concepts being explained. There are instances when I encounter problems that prove to be particularly difficult to solve, causing a considerable setback in my understanding. However, on the flip side, there are also problems that I find relatively easy to tackle, providing a sense of accomplishment and aiding in boosting my confidence within the subject matter. This fluctuation between challenging and simpler problems presents a varied learning experience, wherein some concepts require more effort and time to comprehend while others come more naturally. (RP5)

Research participant 5 also stipulated her experiences on utilizing applications in her studies in calculus.

> Photomath is a handy app that lets you take a picture of a math problem to solve it easily. You don't have to type anything - just snap a photo, and it gives you the answer. On the other hand, Symbolab needs you to type out the math problem manually before it helps you solve it. So, with Photomath, you save time by not having to type out the problem, while Symbolab requires you to type it all in before getting an answer. Photomath's picture-taking feature makes it super simple for anyone who prefers a quick, visual way to solve math problems. (RP5)

> Apps such as Symbolab and Photomath are really useful for math. They explain how to solve problems step by step on many math topics. These apps make learning and practicing math fun. Teachers who use Symbolab or Photomath find them helpful for students to practice and understand lessons. Teachers can use these apps during lessons and for homework to make math more enjoyable and simpler to learn. When students use these apps together, math becomes more exciting and easier for everyone to understand. (RP5)

Case 6. Research Participant 6 is from Malaybalay City Bukidnon. She is 20 years of age, a female student taking up a bachelor's degree in Secondary Education majoring Mathematics at Bukidnon State University. She talked about his academic difficulties and his feelings throughout the semester. She also says that since she was an ABM student in her final year of high school, calculus is new to her. She says it's difficult but also enlightening and enjoyable.

> My learning on Calculus 1 specifically on limits is very challenging yet enlightening. It was a little bit challenging for me because it was my first time to encounter topics on Calculus since I am an ABM student when I was in senior high school. Furthermore, I could say that learning calculus is hard but it is fun if you will learn to love this subject. (RP6)

> Honestly, I could say that learning calculus in general is hard, but in learning limits, I could say that it is moderate as long as we understand it, know the theorems and apply it when evaluating limits, and then we could surely provide the correct answers. (RP6)

She went on to discuss her experiences using the applications as a tool for formative assessment during their calculus task.

> I will choose Photomath since this app provides a clear step by step solutions. (RP6)

> Honestly, when I install both apps during the intervention of Symbolab and Photomath, I tried to use symbolab once and I think their difference is that the Photomath provides a clear step by step solutions and the symbolab is something like a shortcut version of the solution. I think the best app that helps me improve in learning calculus is the Photomath because aside from it is easy to navigate, it also provides a clear step by step solutions.

Moreover, Case 6 also suggest things that an application is use during lecture to help understand step-by-step aside from the teaching from the teacher themselves.

> - I think the best app that helps me improve in learning calculus is the Photomath because aside from it is easy to navigate, it also provides a clear step by step solutions. Since students have a diverse learning style, maybe my suggestions are to allow students use Symbolab and Photomath during discussions so aside from their teachings, students could learn something from the step-by-step solutions given by these apps. (RP6)

Case 7. Research Participant 6, a sophomore pursuing a Bachelor's degree in Secondary Education majoring in Mathematics, is a 20-year-old female. Her college journey has been marked by numerous challenges, including a slower pace of learning. This difficulty has made it challenging for her to keep up with the accelerated pace of learning calculus.

> College has been challenging for me, and I've faced numerous setbacks that I never experienced before. More so, my learning in calculus is tough initially, but the more you understand, it becomes manageable. It gets easier with learning. For me, learning calculus is moderate because some problems are straightforward, while others remain challenging. (RP7)

Research participant 7 also stated some of her experiences with the applications that has been utilized on their class.

> I believe Symbolab is the top choice because it serves as a comprehensive online calculator and learning platform, offering step-by-step solutions. Its standout feature lies in its user-friendly interface, ensuring ease of access and understanding for users of all levels. Symbolab's capability to provide comprehensive solutions while maintaining an accessible interface sets it apart as the preferred app for me. (RP7)

Moreover, she articulated suggestions on how this kind of applications helps in different challenges in mathematics.

> I want a math app with varied challenges, progress tracking, and clear explanations. Teachers can use Symbolab/Photomath in lessons for practical learning. (RP7)

Case 8. Research Participant 8, a 20-year-old male sophomore pursuing a Bachelor's degree in Secondary Education with a focus on Mathematics, His college life has been tough, entering the campus with only three hours of sleep and no breakfast. However, he expressed that grasping calculus is a manageable challenge that demands a solid foundation in algebra.

> On my own experience, learning limits in calculus 1 is moderate, as it requires your foundation in algebra to be able to solve a certain problem. But once you already have a concrete knowledge of algebra, you'll grasped the concept immediately. (RP8)

Research Participant 8 also shared his encounters with the applications used in their classes.

> Both applications perform well, especially in getting the final answer. But for me, I would choose the photomath because it's very convenient to use, you just have to take a picture of the problem and it will show you the entire gradual process of solutions on how to arrive at the final answer. Photomath shows the systematic solution of a certain math problem whereas the symbolab requires premium access to see the gradual solution. (RP8)

Furthermore, he offered suggestions on how these types of applications can be effectively utilized in teaching mathematics.

> Appropriate use of the math mobile application would be great, however, in an objective type of math test, these kinds of math apps should be discouraged as it provides the answer directly and it corrupts the learning of the student. Instead, it can be used in more proficient way such as checking the final answer or as a guide to arrive to the final answer. (RP8)

Case 9. Research Participant 9, a male student from the Bachelor of Secondary Education Major in Mathematics, is 21 years of age. He is currently a second-year student on the said course. He struggled with his current studies as he has a low comprehension when it comes to mathematical concepts. Accordingly, he manages to get cope with this task with help of various resources he had such as internets and old books.

> My college life recently does not go as what I planned. I admit that it has been so difficult for me to comprehend with mathematical concepts most especially the advance ones. Subsequently, my calculus learning is not that good but I have tried my best to deal with this as I have been into researching how to be great in mathematics with the help of internet and books I have. (RP9)

He also stipulated his experiences on utilizing the two (2) applications in his studies in mathematics.

> Maayo nalang gyud naay mga ingani na apps, dako jud kaayog tabang I swear (It is so good to have this kind of applications, it really helps a lot I swear). With the help of this kind of applications that gives step by step solution for instance Symbolab aid my mathematical concept hardship. Ang dile nako gakasabtan before mas nasabtan and nabal-an na nako pag-solve (The things that I don't understand before turns out so easy to understand and I also learned how to solve it. All in all, I love Symbolab as it offers a much clearer solution than Photomath. (RP9)

Moreover, he also stated suggestion about the ways on how this kind of tools would help in mathematics area.

> To help with math studies, apps like Symbolab and Photomath are super helpful. They show clear steps to solve problems on lots of different math topics. These apps also have fun ways to learn and practice math. For teachers using Symbolab or Photomath, these apps are great for students to practice and understand lessons better. Teachers can use these apps in class and for homework to make math more fun and easier to learn. When students work together using these apps, math becomes more interesting and easier for everyone to understand. (RP9)

Case 10. Research Participant 10, 22 years of age, is a female from the Bachelor of Secondary Education Major in Mathematics and a current second-year. She had difficulty on coping with her college life recently, which worries her about her grades most especially in calculus.

> I am not that type of person who would actually react about my current state whatever worse state I may have been but this time I cannot contain myself to worry, since I don't want to be a disappointment to my parents (RP10)

She also expressed her several experiences upon studying with the utilization of Symbolab and Photomath applications.

> I felt the utmost gratitude that I have used these applications as it makes mathematics equations simple and understandable. For instance, when I use Symbolab mas nasabtan nako if unsaon pagsolve ang equation nga lisod labi na didto dapit sa sine and cosine nga limit (For instance, when I use Symbolab I was able to undertand how to solve a certain equation most especially on the utilization of sine and cosine in the limits). (RP10)

More so, she also stipulated suggestions on how would applications such as Symbolab and Photomath helps in facing different challenges in math.

> Apps such as Symbolab and Photomath are really useful for math. They explain how to solve problems step by step on many math topics. These apps make learning and practicing math fun. Teachers who use Symbolab or Photomath find them helpful for students to practice and understand lessons. Teachers can use these apps during lessons and for homework to make math more enjoyable and simpler to learn. When students use these apps together, math becomes more exciting and easier for everyone to understand. (RP10)

Case 11. Research Participant 11 is from Malaybalay City Bukidnon. He is 21 years of age, a young man pursuing a Bachelor's degree in Secondary Education with a major in Mathematics at Bukidnon State University shared his academic challenges and feelings throughout the semester. He expressed that grappling with learning calculus proves to be moderately difficult and demands dedicated effort.

> College has been so difficult most especially when studying calculus where it gives me headaches sometimes due to the fact that I learn in a slow phase and I cannot cope up with the phase of our instructor. (RP11)

Research Participant 11 stated his experiences on utilizing tools such as Symbolab and Photomath on his learning in calculus.

> Learning calculus with these tools is easy, where in fact when I used Photomath I just taken a picture of the equation using my phone and then Photomath offers the answer that is why it's been a great help for me as a student that is slow (RP11)

Moreover, he also stipulated some suggestions about ways on how these tools would help mathematics and facing different challenges.

> Symbolab and Photomath can really help students understand math better. It shows step-by-step solutions, which is great for learning. But some students only use it to get the answers without learning how to solve the problems themselves. Depending too much on the app might stop them from really learning and understanding the math concepts behind the equations. It's important for students to use Symbolab and Photomath as a tool to learn, not just to get the right answers. (RP11)

Case 12. Research Participant 12 is from Malaybalay City Bukidnon. He is 24 years of age, a male student taking up a bachelor's degree in Secondary Education majoring Mathematics at Bukidnon State University. He talked about his academic difficulties and his feelings throughout the semester. He also mentioned mathematics is a challenging subject, fun and enjoyable. He also mentioned that leaning calculus is not that hard if the basic concept learned.

> My learning I calculus one is probably actually a challenging one. I know, I myself I am not a very intelligent or would I say, I not a typical type of person that master of mathematics when I entered actually with is course, I am quite confuse if I made the right decision, then eventually with the help of my instructors as well as my friend, I was able to realize that I was in the right course I just need to take on and focus on my goal because that is important. Anyway, I find learning calculus fun especially the topic on limit fun, especially when you have introduced the used of this application since I helps a lot. (RP12)

> I will be on moderate one, why because I myself if I am aware of the different basic concepts relative to mathematics especially in calculus way back. We are learning actually different concept before we entered calculus and we have algebra our trigonometry and other basic foundation actually we are already aware so, once we aware of those things I think learning calculus would not be that hard especially I know the basic concepts in mathematics since if you are aware of those if you have a good foundation then learning calculus 1 would be not hard since we are known how we going to attack the topic (RP12)

He went on to discuss his experiences using the applications as a tool for formative assessment during their calculus task. He mentions about premium access and the software interface of Symbolab and Photomath.

> - Based on the experience that I have with the two applications. I think I am choosing Photomath because Photomath actually show you a step by step process in solving a particular problem in calculus especially involving limits unlike Symbolab you need to have a premium access compared to Photomath although Photomath also offers a premium access in terms of providing the step by step process on how your arrive the answer Photomath is actually more detailed compare to the Symbolab application that is why I going to be choosing Photomath over Symbolab in terms of their functionality when you don't have the premium access. (RP12)

> - I think the main different between the two application is the software interface because Photomath and Symbolab though they can be use using our camera application, I thinks the Photomath will provide more detailed that why I said earlier the Photomath will provide a better step by step process and I think it just that Symbolab has a more a should I say user friendly interface compare to the Photomath application

because the Photomath is quite confusing sometimes especially dealing trigonometric ratios or identity there may be confusion when you are using those features in Photomath especially if we are not aware of different identities while on the Symbolab I think it is more user friendly interface because the software interface is quite more easy to understand compare to Photomath. (RP12)

Moreover, Case 12 also suggest things that an application is use during lecture to help understand the concept but he also mentions that the application must be used in the right place and in a right time.

For my own point of view appropriate used of this mobile application Photomath and Symbolab must be observe at all times especially this time that the student already embedded with technology. I see it as powerful too actually because it helps us to better understand especially dealing with the different or I should say complex problem in mathematics it is just that we need to know the limits of using it because I could actually make our productive but it could also make us lazy because when the student will rely on this application, they won't be able to learn actually if they will rely on. This application must only be used when we try to deal with complex problem like we need to verify our answer we need to check our answer if it is right but it should not be solely used in finding the answer because we need develop competency and mastery among our student especially in future especially if we become educator in the field of mathematics, we should encourage the use of this application in order to enrich or empower our student especially dealing with complex problem in mathematics. They have to learn how to solve own their own because it is the key of being mathematics educator. (RP12)

Students' Experiences on the Utilization of Symbolab and Photomath Applications in Learning Calculus: Themes Across Cases

Theme 1: Learning Support in Mathematics

A prevalent theme among all participants was their utilization of these applications to enhance their understanding and grasp of mathematical concepts. They highly value the intricate and detailed solutions, personalized learning methods, and comprehensive explanations that significantly enhance their overall comprehension. Students commonly regard both Symbolab and Photomath as supplementary resources for acquiring information and knowledge. Research indicates the importance of tailoring the learning process to suit individual student needs, thereby enabling them to unlock their full potential (Ordu, 2021). These resources play a pivotal role in fostering students' interest in the subject matter, consequently leading to improved academic performance (Manthra Prathoshni, Vishnu Priya & Gayathri, 2018).

Moreover, mobile technologies like Photomath and Symbolab make education more flexible, and individualized. Learners may gain knowledge whenever they need it by using personal technology (Figueiredo et al., 2016). Students can instantly scan mathematical equations or capture scientific diagrams, receiving immediate step-by-step solutions and comprehensive explanations. This on-demand access to knowledge empowers them to tackle challenges at their own pace, delve deeper into specific concepts that pique their curiosity, and forge personalized learning paths that cater to their unique strengths and weaknesses. Mathematics application like Photomath and Symbolab represent a paradigm shift in education, promoting flexibility, accessibility, and individualized learning. By placing the power of knowledge directly in the hands of learners, these tools pave the way for a future where education is no longer confined by classroom walls.

Theme 2: Ethical Use of Math Applications

One theme immerge is ethical used of math application. Respondent express their concern after using application for their privacy and its effect of on their learning. Individuals who use technological devices to make life easier are likely engaging with artificial intelligence (AI), which has computers performing tasks that traditionally required human intelligence (Congressional Research Service, 2018). Consequently, concerns have arisen alongside the integration of mobile application into educational settings, which can be traced back to the emergence of mobile learning initiatives in the early 2000s. It is clear that the design attributes inherent in mobile application play a crucial role in these concerns (Andrews, Dyson, & Wishart, 2015). Mobile devices and its installed application like Symbolab and Photomath go beyond their physical mobility and serve as gateways to cyberspace and virtual domains, surpassing traditional tools.

Moreover, the rise of math applications like Symbolab and Photomath in education has sparked concerns about the ethical implications of their use. While these tools offer convenience and potential learning benefits, users worry about privacy breaches and the potential for students to become overly reliant on technology at the expense of developing fundamental mathematical skills. A study implemented a mobile tutorial thru application over 24 weeks found that students had a decline in their test scores over the course of the intervention (Roberts and Vänskä, 2011). This dependence could raise ethical concerns around fair assessments and hinder the long-term learning goals of education. To address these concerns, it's crucial to promote the responsible and ethical use of math applications. This means ensuring data privacy, fostering critical thinking skills alongside technology use, and encouraging students to approach these tools as valuable learning aids, not crutches. In doing so, we can harness the potential of math applications to enhance education while safeguarding the ethical considerations at stake.

Theme 3: User-friendly Math Application Features

Prominent among all participants based on their experience on utilization of said application was preference by the participants and functionality of both applications. Responds shows they value the feature that both and either can offer, desirable features, comprehensive solution, clarity of steps, and user interface. The respondent's appreciation for Symbolab's comprehensive solutions and learning approach, particularly their focus on understanding the underlying concepts of math problems, suggests a strong alignment with Symbolab's capabilities, also research show activities and practice work using the 'Practice' feature on Symbolab app were also captured (Makhdum, 2023). In contrast, Photomath is recognized for its clear step-by-step solutions, animations, and user-friendly interface, demonstrating the distinct advantages of each app.

Teachers must choose a teaching device for students to achieve well in class such as using mobile apps in teaching mathematics (Sung et al., 2016). The teachers are responsible of the application that is use inside the classroom, teacher must use based on student interest, functionality and features that suitable on student needs (Luzano, 2020). The interest of a user and the functionality of an item (e.g., an App) from a set of user-item ratings, and they recommend an item to a user if the item's functionality well matches the user's interest (Liu et al., 2015). Research also conclude that it has strong relationship between in interest and academic achievement (Renninger et al., 2014).

Moreover, good user interface matter so that the application is easy to use and understand. Good user interface creates a good communication between the user and application (Stone et al., 2005). A well-crafted user interface (UI) encompasses several crucial aspects for a positive user experience. Firstly, it emphasizes usability and efficiency, prioritizing easy navigation and intuitive task completion to save users time and reduce frustration, thereby enhancing satisfaction (Shneiderman, 2005). Secondly, a visually appealing and

interactive UI fosters engagement and retention, capturing user attention and promoting repeat usage, contributing to greater loyalty (Hassenzahl, 2008).

The preferences of respondents vary significantly across dimensions such as the user interface, specific interests, and the overall functionality of an application. This variation underscores the importance of selecting applications that align with each respondent's unique tastes and requirements. By doing so, users can fully utilize the application, finding it easier to navigate and understand its contents (Luzano, 2023). This tailored approach not only enhances user engagement but also significantly improves the learning experience. It ensures that the application is not just a tool, but a customized resource that adapts to individual learning styles and preferences, thereby fostering a more effective and enjoyable learning process.

Theme 4: Accessibility and Inclusivity of Math Applications

Other important that is hidden in plain sight was accessibility of math application. Student mention the diverse learning style on learning, utility for teacher and collaboration. The accessibility and inclusivity of math applications cater to individuals with diverse abilities, learning styles, and cultural backgrounds (Smith, 2020). There has been a growing recognition of the importance of making mathematics more accessible and inclusive to ensure equal educational opportunities for all students.

Various strategies have been developed to enhance the accessibility of math applications (Johnson, 2019, Aranzo, et al, 2023). For instance, the use of assistive technologies such as screen readers, magnifiers, and speech-to-text software can support individuals with visual impairments or reading difficulties. Moreover, inclusive design principles play a crucial role in creating math applications that are accessible to all users (Brown, 2019). Designers considered factors such as color contrast, font size, and layout to ensure readability for individuals with visual impairments. Providing multiple means of representation, expression, and engagement can accommodate diverse learners' needs and preferences.

Ensuring the accessibility and inclusivity of math applications has a significant impact on learners' educational experiences (Garcia, 2021). Moreover, an inclusive approach fosters a positive learning environment that celebrates diversity and promotes collaboration among students. Furthermore, math application transcends geographical barriers, democratizing education for students in remote areas or those facing socioeconomic challenges. With minimal internet access, learners can unlock a treasure trove of educational resources, bridging the gap between traditional classroom instruction and individualized support. This fosters a more inclusive and equitable learning environment, where every student has the potential to unlock their full academic potential.

Summary of Findings

This analysis captured and formulated four (4) themes describing second year students' experiences with utilizing Symbolab and Photomath. Instinctively, the items include learning support in mathematics, ethical use of mathematics applications, user-friendly mathematics application features, accessibility and inclusivity of mathematics applications. These themes describe the various experiences of utilizing the said application. These distinct experiences of the students suggest that some views or perspectives. Each students perceive a different view and experience at the end of the day, so they choose to apply different insights about the application and their experience itself.

Students utilizing Symbolab or Photomath navigate a journey of mathematical exploration. They initially tap the apps as learning aids, seeking solutions, validating works, and grasping new concepts. Next,

they compare and integrate, evaluating each app's ease of use, accuracy, and features to determine their preferred learning companion. Within the chosen app, functionality takes center stage as students utilize camera scanning, step-by-step guidance, and alternative solution exploration (Pang-an, et al, 2022). Beyond problem-solving, the apps foster education in terms of accessibility and inclusivity through its features like customized buttons. Ultimately, Symbolab and Photomath applications empower students as valuable learning tools, but responsible use is paramount to ensure that conceptual understanding thrives alongside problem-solving proficiency.

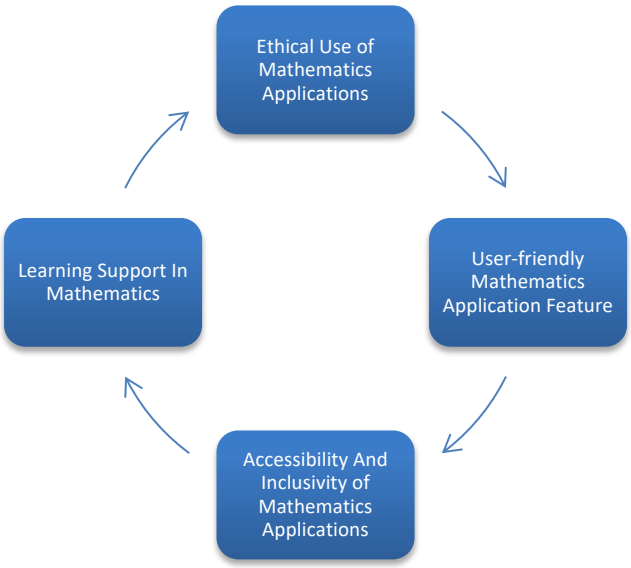

Figure 1. Model of Students' Experiences in Utilizing Symbolab and Photomath Applications

Several studies reported various experiences encountered by the student on utilizing similar and exact application. Theoretically, an individual has a variety of thoughts about the application and their experience itself. Their thought and experience are dependent on specific contexts. In this research, case analysis explored the experience of student in the 12 cases of second year student under the program of secondary education major in mathematics. However, the students' distinct experience may differ slightly across age groups, genders, and cultures. Students' distinct experience might vary to some extent between computer application, website-based application and even the operating system of the phone. This present study suggests that student experience on utilization of math application should be explored in different aspects that may lead to Filipino students' generalizability.

CONCLUSION AND RECOMMENDATIONS

Math learning apps such as Symbolab and Photomath offer personalized support, flexible learning, and engaging interfaces, promoting deeper understanding and interest. However, ethical issues like privacy and overreliance necessitate responsible use. User preferences for features and inclusivity vary, demanding apps to cater to diverse needs and bridge the gap between traditional and individual learning. Through responsible development and focus on accessibility, these apps can cultivate a love of learning and unlock true mathematical potential for all.

Based on the findings and conclusions of the study, the following are the recommendations: (a) Application Developers prioritize maintaining and enhancing the quality of these applications to continually uplift students' educational journeys in calculus; (b) Teachers are encouraged to incorporate Symbolab and Photomath into their instructional repertoire as supplementary materials. These applications can serve as valuable resources to augment traditional teaching methods, providing additional support and fostering a deeper understanding of calculus-related subjects among students; (c) Students are urged to actively utilize these applications to enrich their learning experiences in calculus and related subjects. By integrating Symbolab and Photomath into their study routines, students can benefit from the advanced features these applications offer, thereby enhancing their comprehension and problem-solving skills in calculus, (d) and future researchers are recommended to conduct similar studies. Such endeavors can uncover new and essential insights, contributing to the growing body of literature on the use of Symbolab and Photomath applications as effective formative assessment tools in mathematics education. This continuous research effort would further enrich our understanding and application of these technological resources in educational settings.

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