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Adapting to change: Narratives of mathematics students in flexible learning modalities

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Abstract

This study focused on the impact of the Coronavirus Disease (COVID-19) pandemic on Mathematics education, emphasizing the lived experiences of Bachelor of Secondary Education (BSED) major in Mathematics students at Bataan Peninsula State University in the Philippines. With the adoption of flexible or blended learning strategies mandated by the Commission on Higher Education (CHED) and the Department of Education (DepEd), students can choose how, what, when, and where they learn, accommodating diverse learning styles and preferences through online classes and printed modular formats. This research employed a descriptive phenomenological approach, conducting in-depth individual interviews with eight (8) voluntary participants selected through homogeneous purposive sampling. The study aimed to explore the students' lived experiences during the Academic Year 2021–2022, providing contextualized insights into their experiences with flexible learning and identifying effective teaching practices of Mathematics teachers. Results from the study revealed that students value the integration of online videos and technologies in the teaching and learning process. This strategic use of technology supports learning by providing explicit explanations and repeated practice, aligning with the research findings. Moreover, students appreciate their teachers' consideration and support, which emphasizes the importance of the teacher-student relationship in a flexible learning environment. Teachers dedicating time to explain and elaborate on challenging topics emerged as an important factor contributing to students' positive experiences. These aspects enhance students' engagement in flexible learning modalities. The findings highlight the importance of incorporating supportive practices and effective use of technology in curricular improvements and strategic approaches for BSED Mathematics programs, especially in online and flexible learning contexts.

Keywords: Flexible learning strategies, Mathematics teaching, Online teaching and learning, Pandemic teaching.

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1. Introduction

The COVID-19 pandemic has forced drastic changes and transformations in educational systems worldwide, bringing about much-needed adjustments from institutions regarding such unique circumstances. There was an urgent need for changes in educational institutions from more traditional face-to-face lectures that had become so common to more adaptive and effective learning strategies suitable for the new situation. The World Health Organization describes this unusual and challenging situation as the 'new normal.' According to this, education also needs adaptability and resilience in a world like this. Thus, higher education institutions faced the difficult task of finding creative ways to help their students learn effectively amidst the widespread challenges presented by a global pandemic. Through a variety of modern and varied methodologies, including currently accessible self-paced learning opportunities, individuals are capable of integrating seamlessly into a learning system without the necessity of physical presence in a classroom. However, despite these developments, many issues still persist. These include insufficient access to reliable internet connectivity, a lack of adequate technological devices, and dependence on smartphones in excess. Additionally, a significant problem is the ignorance toward the basic principles of self-regulation. This presents specific challenges for students unfamiliar with concepts such as online and hybrid learning environments. These diverse challenges tend to be more pronounced in subjects like mathematics, where the introduction of active learning strategies becomes more feasible when students can work collaboratively in groups.

This flexible learning, which has evolved as the new norm adapted in the Philippines, has been implemented through the CHED and the DepEd. Under this innovative model of flexible learning, more freedom is given to students in determining the methods, time, and location to achieve their set educational goals. Flexible learning can take several forms, such as online courses, which are a form of distance learning; printed materials, serving as physical resources for module study; videotapes along with many storage mediums; and hybrid approaches, combining both online and offline activities to improve understanding and adaptability. Although this particular approach is designed to engage and support a variety of different learning styles, the application and integration of this approach into the delivery of mathematics instruction do give rise to a number of specific concerns and challenges. For example, inquiry-based pedagogical methods depend mainly on concurrent interactions in which teachers and students actively engage in the process of discovering and relating various mathematical concepts and ideas [1, 2]. In distance education, there is often a lack of opportunities for interactions among students, which prevents learners from benefiting from observing diverse strategies used by their peers and what has been referred to as productive struggle. In fact, it is this productive struggle that fosters and improves mathematical proficiency, which is an important component of comprehensive educational growth [3, 4]. Ultimately, in the distance learning context, societal views of mathematics more particularly, the negative attitudes that adults in a student's household have toward mathematics greatly act as barriers to the realization of the potential inherent in distance learning experiences [5].

Because an increasing number of students are embracing diverse flexible approaches to learning, it appears that there has been an inadequacy in the assessment of lived experiences of those participating in mathematics education under such changing learning contexts. This research study aims to bridge that enormous gap by digging deeper into the personal narratives and experiences of Bachelor of Secondary Education students majoring in Mathematics at Bataan Peninsula State University, and by doing so, provides a richer insight into their singular educational journeys. This study investigates the dynamics of flexible learning, focusing on how students perceive these adaptations that have been developed owing to the challenges from online and blended learning. In the process, it is hoped that the scrutiny of student perceptions will clarify issues and opportunities within mathematics education.

In addition, the paper critically explores diverse methods of teaching that students believe to be effective in improving their knowledge and involvement in the subject of mathematics. Mathematics is one of the disciplines that generally requires a combination of directed inquiry with substantial practice. This means that learning mathematics largely depends on teaching approaches. The strategies listed above must include a methodology that balances direct instruction and provides enough time for students to find questions and solve problems themselves. This means that the effective identification of pedagogies within an open learning framework will significantly enhance attainment, leading to notable improvements in instructional strategies and high-quality educational results.

The research investigation extends an extensive examination into the satisfaction of student learning, particularly in the context of flexible learning modalities that have gained recent popularity. In its effort to take a balanced and integrative approach towards the experiences of students, this research draws on a review of different satisfaction levels. This spans several dimensions, such as involvement in academics, depth of understanding, and the extent to which a degree has been achieved, all within a holistic framework where interdependence is considered. It is upon the understanding of these that effective flexible learning frameworks appropriate to the different needs and demands of mathematics learners may be built.

This research contributes significantly to the expanding body of literature focused on the concept of flexible learning, particularly in higher education environments, by having well-defined goals and depicting what takes place through the students involved in the process of mathematics education. This representation may help in developing strategic approaches aimed at overcoming the many challenges experienced in flexible learning environments. Simultaneously, it attempts to harness the potential of flexible learning to improve educational accessibility and student academic performance. To gather the necessary information for this study, detailed individual interviews were conducted with a set of participants to obtain deep and meaningful qualitative insights into their experiences and perspectives.

Even after the present pandemic, Chairman J. Prospero de Vera III believes that a flexible learning system that integrates many teaching methods will become the new standard in the school sector [6]. When it comes to flexibility, each course planner needs to identify aspects of the program or course that will be flexible. Flexibility is generally understood to mean offering options in a learning environment and helping a course better meet the individual needs of a student. The use

of internet technology to increase student independence and control access to course content and other resources is essential. These technologies significantly reduce the amount of formal face-to-face contact required and allow students to advance major course milestones at varying speeds. In this case, switching from traditional to online education would be the best choice. However, access to information technology equipment, as well as internet coverage and speed, is crucial in the learning of students at this time. Most flexible learning initiatives focus on characteristics of temporal and spatial flexibility in learning, which is now predominantly realized through the use of new technology [7].

Flexible learning is an offline approach option that does not require access to the internet. Printed modules or digital forms, such as video and audio recordings on storage devices, can be used for learning [6]. This modality adapts to the student's learning pace and needs. Parents and children can collaborate on the design, timetable, and steps for carrying out activities and tasks at their own pace and at a convenient time. Students in this approach usually use technology to access and study the learning materials and activities provided but do not always require internet usage.

Flexible learning has two important characteristics: student-centered learning and technology-based learning. Flexible learning must be student-centric in the sense that students take creativity and responsibility to understand the lesson. In a flexible learning mode, online learning can be described as a tool for making the teaching-learning process more student-centered, inventive, and adaptable. Offline learning is for students who do not have access to the internet or who choose to learn in this manner. Learning can be in the form of printed modules or digital formats such as video and audio stored on storage devices. This modality adapts to the pace of learning and the needs of students.

According to a study, online learning is a panacea in the COVID-19 crisis, forcing online education systems to be involved in pandemics around the world, but others are still offline. It said that all important and tough circumstances that may arise must be prioritized and plans made accordingly [8]. Many students have experienced psychological and emotional hardships at home/living environments and have been unable to interact successfully. The most effective methods for online homeschooling have yet to be developed [9]. This pandemic has also taught us that to survive a crisis, students must acquire particular skills such as problem-solving, critical thinking, and, most importantly, flexibility. To secure and prioritize the presence of these qualities in their students, educational institutions must embed resilience into their processes.

Online learning can be uninteresting for students at times. Because online learning takes so much time and flexibility, students never find the time to accomplish it. Online learning also has the serious problem of paying personal attention. The learning process will not reach its full potential unless students put what they've learned into practice. Online content can be theoretical at times, making it difficult for students to practice and learn successfully. There are major barriers to online learning that need to be considered. To make flexible learning approaches relevant, interesting, and meaningful, it is important to incorporate engaging learning presentations that will capture students' attention in particular subjects. Additionally, providing students with more engaging activities that utilize their past experiences and knowledge can enhance learning outcomes. Online learning is not just student-centered but also involves active learning for instructors by facilitating the learning process to help students stay motivated. Teachers need to set time limits and reminders to keep students alert. We should strive to humanize the learning process as much as possible. Students need to take personal responsibility to adapt easily to this learning environment [8].

Furthermore, in flexible learning, some students are dissatisfied with online classes since they are unable to directly ask the professor questions when they do not comprehend the topic. Students should be given individual attention so that they can readily adapt to this new learning environment. In contrast, students prefer traditional learning because they have a better understanding of the materials, it is easier to communicate with them, and they can focus, be active, and enjoy the session. Online learning, on the other hand, is ineffective due to some issues. Students and lecturers are unable to meet and inquire directly when they do not grasp the materials, making it difficult for students to divide their time between work and study. There is also less interaction between the lecturer and students, making it harder for them to comprehend the topics. According to research, more students favor traditional instruction over online instruction because students would understand better the materials being taught through the traditional teaching method [10]. In conclusion, the researcher discovered that traditional classes are more effective than online classes as a result of the investigation.

A study found that a flexible learning space improves student well-being because students feel more comfortable, can choose from a variety of equipment, and can move to more locations [11]. Flexible learning spaces contribute to student learning by changing the way students learn and promoting self-study. In flexible learning, students felt they were learning more than from textbooks and traditional methods. Students believed they had learned more in a flexible learning area than they had using textbooks and traditional methods, according to a study [7]. According to a study on “A Comparative Study on the Effectiveness of Online and Offline Learning in Higher Education,” the authors revealed the following findings: Many higher education students agree that online learning tools can help them improve their academic performance [12]. This is because the online learning tool helps them to perform tasks more efficiently, and they can play the recorded videos of the online learning tool for assistance at any time to improve academic performance. Online learning tools have helped students save time studying. However, if there was a traditional study class before COVID-19 or an online class after COVID-19, students should have at least 12 hours a week of online and offline classes at about the same time.

Moreover, according to a study, students reported positive aspects of using flexible learning spaces, but students had difficulties in terms of academic performance [13]. Another student emphasized the desire for a quiet room so that he could work independently on the components of the project and found a positive link between flexible learning spaces and the learning outcomes of students. Further research is needed to find out how flexible learning spaces affect the academic performance of students.

The above-mentioned related studies provided insights into the present investigation. This study bears similarities with the previous studies as they deal with the different ways in which school heads can become more effective in implementing flexible learning and how they can accept and adopt changes that are happening in the educational system. Throughout the studies, there is consistent evidence that online learning has brought challenges to some students. This served as a basis for identifying the various impacts and challenges faced by students in a flexible learning approach to their academic performance.

2. Research Methodology

The study employed a qualitative research methodology to explore the lived experiences of Bachelor of Secondary Education (BSEd) Mathematics students under flexible learning modalities. Due to a scarcity of literature focusing on this context within Philippine education, qualitative research was deemed the most appropriate approach to capture the nuances and complexities of the participants' perspectives. Specifically, the study utilized a descriptive phenomenological design, which offers a systematic procedure for discovering and analyzing participants' experiences while minimizing researcher biases. This approach facilitates mutual exploration of the phenomenon between the researcher and participants, aiming to reveal interconnected components that characterize the students' experiences under flexible learning.

The study was conducted at Bataan Peninsula State University-Dinalupihan Campus, where the Bachelor of Secondary Education major in Mathematics is offered. Participants were restricted to BSEd Mathematics students who enrolled during the Academic Year 2021–2022. Eight participants were chosen using homogeneous purposive sampling, a method designed to focus on individuals who share similar characteristics relevant to the study. This sampling approach is particularly advantageous for exploratory research, where the phenomenon can be viewed in detail within a defined subgroup. Using homogeneous sampling, the researcher was able to gather insights that reflect the shared experiences of students engaged in flexible learning modalities.

Participant selection was voluntary, and written consent was sought to guarantee ethical compliance and informed participation. The researcher collaborated with Mathematics faculty advisers to identify suitable participants who could provide rich, firsthand accounts of their experiences. The chosen sample size aligns with Creswell [14] recommendation of 5 to 25 participants for phenomenological studies, ensuring a depth of understanding without overextending the scope of the research.

In collecting data, the study conducted in-depth interviews as its primary data collection method. Semi-structured questionnaires guided these interviews, providing participants with the flexibility to voice their thoughts while allowing the researcher to probe for more profound insights. The online applications were used in conducting interviews because of the continued COVID-19 pandemic restrictions. Behavioral observation during the interview process was also used, acting as a supplementary tool that helped create contextual cues and non-verbal data that improved the qualitative findings.

The process of data analysis was conducted with rigorous phenomenological techniques to ensure that a comprehensive understanding of the participants' experiences was obtained. To begin with, the researcher involved herself in bracketing, a preparatory step characterized by the putting aside of preconceived notions about the phenomenon to avoid bias. This ensured that the analysis remained grounded in the participants' authentic perspectives. The process followed the six-step procedure given in phenomenological research, which includes the following: (1) reading and rereading of data for immersion into the narratives, (2) preliminary noting of important statements, (3) generating emerging themes from the data, (4) looking for the connection between themes, (5) moving on to the next case while maintaining continuity, and (6) identifying patterns across the cases.

Statements, sentences, and quotations that stood out as very relevant in illuminating the experience were given emphasis. Recurring patterns were then observed from the elements, which synthesized a comprehensive understanding of the phenomenon under study. This is in the discussion section, wherein the findings were placed into a broad context by establishing their relations with other scholarly literature written today for added pertinence and relevance in this field.

These methodological steps protect the rigor of the study, which aims to provide a comprehensive exploration of how flexible learning modalities impact the experiences, challenges, and strategies of BSEd Mathematics students.

3. Results and Discussion

3.1. Integration of Online Videos and Technologies for Teaching

In the context of online learning, the integration of online videos and digital technologies into teaching has become a cornerstone of modern educational strategies due to their multifaceted advantages. Research has shown that these tools are not only effective in capturing students' attention but also in creating a more immersive and dynamic learning experience [15]. Unlike traditional teaching methods, online videos provide a visual and auditory dimension that caters to diverse learning preferences.

The visual aids of instructional videos, animations, and interactive simulations have proven to be particularly effective in presenting abstract or complex mathematical concepts in ways that improve comprehension and retention. For example, mathematical theories and methods of solving problems can be animated step-by-step, showing students processes that otherwise seem abstract in a traditional classroom [16, 17]. Interactive simulations allow students to change variables and observe the outcomes in real time, which increases their understanding of mathematical relationships and principles [18].

In addition, these technologies allow for self-paced learning, which enables students to review content as many times as they want, thereby consolidating their understanding. This is particularly beneficial in mathematics, where mastery of basic concepts is essential for progressing to more advanced topics. Another way interactive technologies can support

formative assessment is through instant feedback, which helps students recognize and correct errors in their problem-solving approaches.

Thus, the integration of online videos and technologies in teaching mathematics not only supports achievement but also encourages active participation and independent learning, equipping students with the skills necessary for lifelong learning in an increasingly digital world. One participant said that:

> *"As a student, YouTube videos have been helpful for me, particularly when the videos simplify complex topics in a way that textbooks and lectures often do not. Because there is a variety of videos available, I can explore different explanations and perspectives about Mathematics, so I can choose the ones I need. Also, the flexibility to watch the videos again and again allows me to learn at my own pace, which is especially helpful for me during the pandemic (MS004)."*

For students, the accessibility of online videos represents a transformative shift in how learning materials are consumed and understood. Unlike traditional classroom settings with fixed schedules, online videos empower students to access educational content anytime and anywhere, offering unparalleled flexibility. This flexibility enables students to review and revisit the materials as often as they wish; this is particularly beneficial to those with other commitments, such as part-time jobs, caring for others, or engaging in extracurricular activities. Those with different learning styles or needs, such as slower processing of information or an appreciation for visual and audio inputs, find online videos an appropriate tool.

The ability to pause, rewind, and replay video content allows for the clarification of concepts as well as the filling in of gaps in understanding without any time pressures associated with live instruction [17]. This type of control over their experience improves their comprehension but also instills a sense of responsibility and independence in their educational journey. It is also convenient to access videos on multiple devices, ranging from smartphones and tablets to computers, so that learners can learn in virtually any environment, whether at home, in transit, or in a quiet library.

In addition to the academic benefits, the use of online videos helps develop soft skills. For example, students who learn to manage their study schedules and prioritize independent learning develop time management and self-discipline. The use of interactive video content often requires critical thinking, problem-solving, and adaptability all valuable competencies in academic and professional contexts.

In fact, educational institutions that integrate online videos into the learning process not only improve the accessibility and inclusivity of education but also prepare students for the demands of a technology-driven world, where self-directed learning and adaptability are key to success [19]. Another participant quoted that:

> *"Online videos are especially helpful for me as a student because I can access them easily anytime I need to. Whether it's late at night or during a busy day, I can always count on online videos to be there for me whenever I want to review a lesson or understand Math concepts better. This flexibility is important for me because it allows me to learn at my own pace and fit my studies into my schedule whenever it works best for me during the pandemic. So, having access to online videos helped me to learn Math better during the pandemic (MS008)."*

Moreover, incorporating online videos and digital technologies into classroom teaching enables educators to reach out to diverse learning styles effectively, while some students perform better when they are exposed to visual or auditory content. Therefore, multimedia presentations and instructional videos are the best for their understanding [20]. Meanwhile, other students might prefer to thrive in settings emphasizing hands-on or interactive activities that may be facilitated through online simulations, virtual experiments, or gamified learning tools [21]. Educators may diversify the types of media used for teaching to better cater to diverse preferences and needs in a learning environment that can be both inclusive and adaptive [22, 23].

In addition, videos in the online setting are best suited for personalized and self-directed learning. With the possibility of pausing, rewinding, and reviewing parts of video clips, students are allowed to control their own learning pace [24]. This is helpful, particularly for those who need a little more time to digest complex or difficult material. It also affords opportunities for students to review what has been learned and make it stick and better understood. Self-paced learning based on video resources helps cover the gaps in comprehension of students and allows students to be confident in the competence that they have built upon.

3.2. Teacher Support and Consideration in Online Learning

For students, the online learning environment sometimes brings about isolation, loneliness, or frustration because they are deprived of the direct contact with their peers and instructors. In fact, the absence of face-to-face communication with the instructor can make the student feel cut off from his learning community, thus negatively affecting motivation and engagement. In addition, online and digital tools pose challenges in terms of navigation, which add to the frustration of students, especially those who are not very tech-savvy or encounter technical issues.

Teachers' roles are essential in combating these challenges by creating a friendly and inclusive online learning environment. Teachers who are empathetic, considerate, and actively supportive help create a positive atmosphere in which students feel valued and respected [25]. Simple yet intentional actions, such as responding to students' questions promptly, giving constructive feedback, and acknowledging their efforts, can make a significant difference in students' sense of

belonging. Additionally, interactive activities like discussion forums, group projects, and live sessions can help students build connections with their peers, reducing feelings of isolation.

By developing a virtual classroom culture that is deeply rooted in emotional and social support, teachers motivate and inspire learners to participate actively and confidently. Thus, students who feel supported will effectively overcome challenges with their coursework, as they enjoy staying focused on their online lessons. Two participants said:

> *"My mathematics teacher is kind and helpful during our online classes. He goes above and beyond to communicate with me via messenger and assists me with any questions I have. Additionally, he takes the time to explain difficult concepts in a way that's easy to understand, which is incredibly valuable to me as a student. It's reassuring to know that he's there to support me every step of the way (MS002)."*

> *"I really appreciate the way my math teacher supports me as a learner, especially during the pandemic when it can feel isolating without my classmates. Having open communication with my teacher has been incredibly helpful in lessening my loneliness. Even though we're not physically in the same space, knowing that my teacher is there to help and support me makes a big difference. It's comforting to have someone I can reach out to whenever I have questions or need assistance with my studies (MS008)."*

Moreover, when teachers appear to care and be concerned about their students, there is a supportive learning environment is established that fosters trust and respect. This emotional connection among teachers and students can function as a catalyst for establishing motivation because students feel that the success of their efforts matters and that their challenges are taken seriously. A caring teacher acknowledges the uniqueness of each student, including his or her needs, strengths, and struggles. Such a teacher encourages and guides them according to their circumstances. Such personalized attention helps students feel seen and appreciated, thus reducing anxiety and encouraging them to take an active role in their learning journey.

When students feel that their teacher cares about their success, they will be more willing to participate in class activities, join discussions, and submit assignments with more effort and eagerness. This feeling of being supported gives students the confidence to overcome academic challenges, knowing that they have a teacher who believes in them. Additionally, a teacher's supportive attitude can help students develop resilience and a growth mindset, enabling them to view mistakes as opportunities for learning rather than setbacks. By cultivating such a positive and encouraging atmosphere, teachers can inspire students to strive for excellence, even in the face of difficulties.

Furthermore, the positive impact of teacher care extends beyond academic performance. When students feel supported by their teacher, they become more likely to connect better to the learning community at large. Such a connection enables cooperation, teamwork, and commitment among peers to learning. When students experience the rewards of an emotionally supportive environment, they become more likely to share in group activities, offer their ideas, and support their fellow learners in pursuit of knowledge. Therefore, a teacher's honest care not only encourages and motivates an individual, but it also sets the premise for a collaborative, inclusive, and dynamic learning experience. One student stated that:

> *"Because my math teacher takes the time to communicate with me through Facebook Messenger, I feel more motivated and engaged in learning math, even though it's a tough subject for me. Having that direct line of communication with my teacher makes me feel supported and valued as a learner. It's not just about getting through the subject; it's about really learning and understanding it deeply. Thanks to my teacher's help and accessibility, I'm approaching math with a new sense of confidence and determination (MS007)."*

Likewise, establishing a facilitative relationship with students should be the cornerstone in making them feel trusted and appreciated, especially when teaching using the internet since direct experiences are not present. By having a supportive relationship, that sense of security and connection is established, thus, promoting openness in communicating with the teacher. If the student realizes that his teacher is trusted and genuinely cares for them, then the student, too, becomes confident to voice any thoughts, questions, and concerns [26]. This trust is especially critical in an online environment where feelings of isolation and disconnection can easily arise. By showing empathy and understanding, teachers can create a virtual classroom that prioritizes connection and inclusivity.

The presence of a trusting relationship also facilitates effective communication and collaboration. Students who feel supported are more likely to seek help the moment they encounter problems: whether in coursework, technical issues, or personal problems. Responding to teachers with patience and encouragement can strengthen this bond, making students feel that no one is alone in their pursuit of education. Moreover, when students feel free to reach out, they are more likely to engage in discussions, ask meaningful questions, and contribute to group activities. This dynamic exchange of ideas not only enriches the learning experience for individual students but also enhances the collaborative atmosphere of the class.

Supportive teacher-student relationships contribute to the development of a resilient and engaged learning community. In an online context where students may have varied digital literacy and may hail from different backgrounds, building rapport can help fill those gaps and build mutual respect for one another. The educator who actively promotes trust and rapport encourages students to cooperate, share resources, and mutually contribute to achieving academic success. As students experience the benefit of a nurturing learning environment, they are more likely to stay committed to studies and approach challenges with confidence and determination. This forms a foundation for effective communication and meaningful collaboration, which are essential for success in online education.

"I love that my teacher allows students to confer while also visiting our breakout rooms. This feels like discussing inside the physical classroom, even though we are online and not together. We feel like our teacher is there with us, teaching us well (MS006)."

Thus, teachers who offer extra time to explain difficult concepts or provide personalized feedback demonstrate a commitment to meeting the individual needs of their students, which raises their interest and motivation in learning mathematics. This personalized support can be invaluable for students who require additional assistance or clarification [27].

3.3. Providing Extra Time for Students to Settle Down and Comprehend Difficult Concepts

It is, to a large extent, regarded as a difficult discipline for students due to its abstract nature and the type of logical reasoning it necessitates. Many mathematical ideas constitute a chain because one has to be familiar with them extremely well before moving on further to advanced material. For some students, it would be extremely overwhelming since they cannot sustain themselves at the pace dictated by the curriculum. For instance, mathematical concepts such as algebraic manipulation, calculus, or even geometric proofs require technical competence and conceptual understanding that cannot be learned in a single night. By giving students sufficient time to grapple with these concepts through practice and reflection, their abstract principles connect with their applications, thus building a powerful understanding of the subject matter.

It is in the process of giving the students enough time to understand complex mathematical concepts so that they can improve their understanding and develop their critical problem-solving skills. If rushed through challenging topics, a

Students may resort to rote memorization or other superficial learning strategies that could impede their ability to apply mathematical principles effectively. A well-paced approach, on the other hand, provides students with time to explore concepts in depth, ask questions, and learn from mistakes. Teachers can facilitate this process through various means, including interactive problem-solving, cooperative group work, and the use of visual aids or technology to make abstract ideas more concrete. When a student appreciates the time and effort required to excel in mathematics, they can be guided to become persistent, less anxious, and more confident. One student stated that:

"I really appreciate my math teacher because he gives us plenty of time to work through problems and lets us take a moment to let the ideas sink in before moving on. It makes a big difference in my understanding and confidence in the subject (MS003)."

Abstract ideas, especially in mathematics, are one of the causes of stress when learning. Students have to learn abstract ideas and solve complex problems within a very short time, which is stressful. Stress can be compounded in an online learning environment, especially when a student lacks direct interaction with teachers in real-time, experiences technological problems, or does not get immediate peer support. Online learning is sometimes accompanied by feelings of isolation, which further intensify anxiety levels, thereby making it harder for the student to be motivated and focused. In such an environment, students become discouraged and feel that they are lagging behind their classmates when they have problems understanding challenging content. These emotions can create a vicious cycle where stress worsens the learning process and problems with understanding amplify the stress levels.

More time for students to absorb and process difficult mathematical concepts greatly relieves these challenges. Being more flexible and accommodating allows students to interact with the material at their own pace, which helps reduce pressure from strict deadlines or keeping up with instruction. Teachers can assist in this way by creating online courses with time for reflection, additional learning materials such as recorded lectures or interactive tutorials, and the provision of one-on-one feedback. This approach makes students less anxious and enables them to work through the material effectively. Building confidence through this process will eventually empower students to tackle increasingly complex concepts in a positive and resilient manner, transforming their experience with mathematics from one of failure and frustration to one of growth and achievement, even within the online learning environment. Two students said:

"I'm really grateful for the time my math teacher gives us to grasp the concepts before moving on to the next lesson. It really helps lessen my stress and worries about the subject, knowing that I have enough time to fully understand each topic. Plus, having that extra time allows me to consult with my classmates to confirm if my understanding or solution to the problem is correct, which also adds confidence to me in learning math (MS004)."

"The additional time my math teacher gives us to understand concepts not only eases my stress but also allows me to collaborate with my classmates. This collaborative effort lessens the feeling of being alone during the pandemic, which is a challenge many students face. Learning a difficult subject can already be tough, and feeling isolated only adds to the difficulty of the situation. So having the time to process both the subject matter and the situation we're in is very important to me (MS005)."

In addition, more time allows students to think critically and solve problems at their own pace while attempting to understand abstract concepts [28]. When not forced to rush through tough subjects, students can analyze problems from various perspectives, try various approaches, and get to know mathematical ideas much better. This process promotes the development of advanced cognitive skills, including analysis, synthesis, and evaluation; such skills are very necessary both

for academic achievement and for practical application. Such skills ensure student success in mathematics and equip people to solve complex problems in a wide range of professional and personal contexts, making the time invested worthwhile [28].

Given that each student learns differently, teaching can be improved by giving students extra time to understand complex mathematical ideas and by providing teachers with the opportunity to give more individualized support [29]. Such an approach accounts for the different needs, abilities, and learning styles of individual students and therefore gives them the freedom to learn in a way that best suits them. Personalized approaches may include the provision of individualized feedback, additional resources, or one-to-one mentoring that can improve understanding. This is supported by research, which points out the risks associated with moving on from a difficult topic without enough time for reflection and practice, where it often leads to superficial understanding and limited retention of mathematical concepts [30].

However, spending enough time for students to appreciate and absorb the complexity of topics indeed holds the potential to further fortify their long-term capacity to memorize knowledge and use it in appropriate contexts [30]. For example, learners who understand the basics, such as the methods of algebra or logic in geometry, handle complex topics better and even help solve practical problems. The extra time for reflection and practice not only allows students to retain knowledge but also increases their confidence in their mathematical abilities. The long-term benefits associated with this approach underscore the importance of this method for both academic and personal growth [29, 30].

In addition, giving extra time enables students to engage in metacognitive activities such as self-reflection and self-regulation while evaluating their understanding and developing strategies to address the difficult parts [31]. Through metacognitive practice, students increase their knowledge of their learning strategies and can determine which are most helpful for them and make adjustments as needed. The development of self-awareness promotes a sense of responsibility and independence, in which students take charge of their learning experiences. Over time, it improves their math skills in preparation for the challenges and equips them with sufficient confidence and determination to help them understand the broader value of incorporating flexible pacing in their educational approaches [31].

3.4. Immediate Feedback and Assessment for Online Learning

Prompt feedback is one of the most important characteristics of effective mathematics teaching since it allows learners to respond and challenge problematic knowledge quickly. Any time learners receive prompt responses about their assignments, they can more precisely pinpoint specific errors or misconceptions before the situation escalates into large-scale problems. For instance, if a student is struggling with a particular approach to solving an algebra problem, that student may thrive when receiving immediate feedback focused on where they made the mistake and clear step-by-step correction of it. Such responses not only help in making sense of misconceptions but also solidify proper practices, which enables students to be better at mathematical principles. Prompt feedback allows students to engage actively in their educational process, thus boosting the students' confidence and pushing them to face more complex difficulties with an expectant attitude.

This technique is supported by research that emphasizes the potential of prompt intervention in breaking the cycle of misconceptions, which can hinder intellectual development. If misconceptions are not addressed, they have the potential to pile up; thus, it becomes progressively challenging for students to understand complex topics related to fundamental concepts. Immediate feedback enables students to remain focused on their set learning objectives because every step in their educational pathway provides them with a comprehensive understanding of the material they are studying. This further opens doors for students to ask or seek help in areas of concern. Thus, open communication is fostered between students and teachers. The challenges addressed promptly by educators help them to sustain their progress, keep up with the curriculum, and develop problem-solving abilities that are important for maintaining long-term success in math [32]. One student cited that:

> *"I really appreciate my math teacher's feedback, especially because it's provided immediately after each submission. This immediate comment not only helps me understand where I went wrong but also allows me to correct my mistakes right away. It's like having a personal guide to move forward through the challenging concepts, and more importantly, it boosts my confidence in taking the math subject (MS001)."*

> *"The immediate feedback provided by my math teacher is very valuable to me, especially during the pandemic when I often feel sad and alone. Knowing that I will receive feedback right after submitting my work lessens the time I spend overthinking my mistakes. It's encouraging to have my teacher's guidance and responses because it helps me stay focused and motivated in learning mathematics. Instead of dwelling on errors, I can quickly address them and move forward to the next topics."*

Additionally, giving immediate feedback provides students with a clear understanding of their learning progress and performance [33]. This enables students to identify areas of strength and areas for improvement, allowing for a more focused and efficient study approach. Another student mentioned that:

> *"Immediate feedback is very important for me, especially because I am the type of student who cannot juggle multiple tasks at once. I prefer to finish one thing before moving on to the next. So, it is very helpful when my math teacher gives comments right away. It lets me know how I am doing and helps me fix any mistakes before I move on. This way, I can stay focused and keep learning Math at my own pace (MS008)."*

Hence, providing immediate feedback encourages active engagement in the learning process [34]. Students are more likely to stay motivated and focused when they receive timely responses to their output, which can develop a personal sense of accountability and ownership of their knowledge and skills. One participant quoted:

> *"Learning during the pandemic hasn't been easy for me. There are times when I feel demotivated and isolated, especially with the challenges of online learning. However, the immediate feedback from my math teacher serves as a supply of encouragement during these tough times. It's like receiving a motivation pill that pushes me forward and supplies enough motivation to keep going. Knowing that my teacher is there to guide me and support me to learn math, gives me the strength to continue and try to learn as much as I can, despite the obstacles (MS 006)."*

As a consequence, immediate feedback functions not only as an instructional device to guide the learner but also strongly helps teachers develop the methodological approaches to teaching. While examining trends of what the student gets wrong or when there are dominant misconceptions, the teacher obtains rich information regarding areas that cause problems for a specific group of students for instructional adjustment [35]. For instance, if most students do not understand a particular mathematical topic, the teacher may revisit the topic, involve various explanations, or make use of different examples that will help them understand. It ensures that teaching strategies are aligned with the learners' needs, which facilitates a more effective and efficient learning environment. In addition, timely feedback allows teachers to intervene in specific ways, such as through customized practice exercises or focused group discussions targeted at the unique challenges individuals or groups are experiencing. Teachers can improve student understanding, increase self-efficacy, and ultimately help them progress toward proficiency and achievement in mathematics by actively using feedback to inform their instructional approaches.

4. Conclusion

The process of teaching mathematics has notably aligned itself with a number of Sustainable Development Goals (SDGs) established by the United Nations, underscoring the important and significant role that mathematics plays in advancing progress on a global scale. In particular, mathematics education has made meaningful contributions to Goal 4, which focuses on ensuring quality education for all; Goal 10, which aims to achieve reduced inequalities across different populations; and Goal 3, which emphasizes the importance of good health and well-being for individuals and communities alike. To achieve these objectives, educators have actively incorporated a variety of innovative practices as well as technological tools, all designed to improve learning outcomes while simultaneously promoting inclusivity among diverse groups of students.

The integration of internet videos and high technology in the study of Mathematics has contributed significantly to the advancement of Goal 4: Quality Education. This is achieved through enhancing student engagement, providing support for different learning styles, and creating opportunities for self-paced learning. The use of digital tools, including educational videos and interactive platforms, has empowered students by enabling them to explore mathematical concepts in ways that best suit their individual preferences and abilities. These innovative technologies have effectively removed various barriers that previously hindered accessibility. As a result, students, regardless of their location or socioeconomic status, have equal and fair access to quality learning resources.

The thought-provoking and strategic inclusion of technology in the teaching of Mathematics has also helped realize Goal 10: Reduced Inequalities. This was achieved through the creation of equal opportunities for all learners, regardless of their various needs and abilities. With the use of advanced tools in educational settings, solutions designed for individual learners have been developed. These include adaptive assessments that adjust to a student's learning level, alternative content formats that make information accessible in different ways, and interactive simulations that actively engage students in their learning processes. Educators have taken the initiative to transform rigid and unchanging traditional methods of teaching into dynamic and flexible approaches. They can now respond effectively to the challenges faced by a diverse range of students, ensuring that every learner receives the support and resources they need to succeed.

Besides the above advantages, teaching Mathematics has immensely contributed to Goal 3: Good Health and Well-Being through active promotion and improvement of positive mental health among students. Teachers have worked very hard to create supportive and nurturing environments where students are motivated not only to feel confident but also cared for in their pursuit of academics. With full realization of the unique challenges and difficulties some students face when they struggle with complex mathematical concepts, teachers have gone the extra mile to offer individualized guidance fitted to each student's needs, providing extra time for comprehension and giving immediate feedback. All these thoughtful strategies have really helped reduce anxiety levels among students and have successfully built confidence in solving mathematical problems. These strategies have enabled the students to learn Mathematics effectively and improved their holistic well-being.

Through these invaluable and concerted efforts, Mathematics education has been able to serve the purposes of imparting essential knowledge, but at the same time, empower students with vital tools, unwavering confidence, and strong support needed to achieve academic success and adapt to an ever-evolving global education. This comprehensive approach ensures that Mathematics education has contributed meaningfully to the societal goals of quality education, equitable access, and the well-being of people and communities.

Flexible learning will be highly recommended with the adoption of online videos and the usage of multiple technologies in teaching methodologies for Mathematics teachers, developing a learning experience that can provide both

an optimized and improved environment for students. The teacher can then provide lively learning opportunities that are devised to meet the diversity in the learning styles and preferences that their students present to them. Further, it will require teachers to make use of a wide range of instructional strategies to improve visual aids and incorporate interactive elements within lessons, to ensure that every student can better understand and grasp complex mathematical concepts.

More importantly, there is a complete need to nurture and build supportive relationships among teachers and students within the learning environment. Through the provision of traits like empathy, genuine care, and tailored support that address the needs of each learner, the teacher will be able to create a supportive and conducive environment in which the students can thrive. Students will be encouraged to freely share and address their issues regarding challenges they face in the subject of Mathematics because they are valued and empowered. Given that the subject of Mathematics is challenging and complicated, teachers should give students enough time to fully understand and grasp the mathematical concepts they are being taught while providing timely and constructive feedback coupled with appropriate assessment strategies to monitor students' academic progress effectively.

More importantly, it needs to be highly encouraged along with independent learning since this is important for refining and developing the confidence and skills of the students with respect to the subject matter, Mathematics. By asking them to reflect meaningfully on their acquired knowledge and also enabling them to assume full responsibility for their own learning path, teachers contribute to the accomplishment of critical problem-solving capabilities.

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