Revolutionizing Calculus Education on Flexible Learning: A Tale of Students in a State University

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ABSTRACT

With the new educational landscape, Bukidnon State University shifted its way of teaching and learning to a new form of modality, commonly called Flexible Learning. This qualitative study explored and described the different learning experiences ofstudents in Calculus with the emergent modality. The participants were the ten (10)BSED Mathematics students of Bukidnon State University. Thematic analysis was utilized to analyze the responses of the students. Results revealed two overarching meta-themes: (1) Struggling Experiences and (2) Coping Experiences. On the theme "Struggling Experiences", three subthemes emerged such as technology struggle, feedback struggle, and learning struggle. For the theme "Coping Experiences", four subthemes came out such as Flexible Coping, Teleinteractive Coping, e-Learning Coping, and Autodidactic Coping.This study recommends that students may empower themselves to be flexible and develop their own sense of responsibility for their learning while teachers are reaching out to them to foster effective feedbacking.

KEYWORDS: *New educational landscape; calculus; learning experiences; flexible learning; face-to-face class, thematic analysis, struggling experiences, coping experiences*

INTRODUCTION

The COVID-19 pandemic has presented a formidable challenge to educational systems worldwide, precipitating the widespread closure of schools. Consequently, not only has the immediate and in-person influence of educators been effectively curtailed, but also the physical presence of students within the traditional school environment has been entirely precluded (Pang-an, et al, 2022). In response to this unprecedented crisis, various alternative pedagogical modalities have emerged as urgent and necessary measures to ensure the uninterrupted provision of education(Aranzo, et al., 2023).One such modality is Flexible Learning, which can be defined as a system of instructional delivery that endows students with a high degree of autonomy, enabling them to exercise comprehensive control over the timing, location, and manner in which they engage with educational content.

Flexible learning environments encompass a holistic approach, considering space usage, student grouping, and time allocation. When resources permit, dedicated breakout rooms encourage collaborative learning (Luzano, 2020). This flexibility extends to student control over the pace, location, and educational approach, such as accelerated or part-time programs (Luzano&Ubalde, 2023). Learning options range from traditional classrooms to online, commuter, and work-study settings. The concept of "mode" emphasizes technology's role, including blended, online, and tech-enhanced methods. This adaptable approach caters to individual preferences and aligns with the

evolving educational landscape (Casanova, et al., 2023).The interpretation of effective performance is context-dependent, influenced by the environment. Research underscores the pivotal role of learning conditions in shaping student achievements, encompassing factors such as seating, lighting, noise levels, and even the choice of colors (Romorosa, et al., 2023). Students immersed in conducive learning environments exhibit heightened motivation, dedication, and overall cognitive prowess. Conversely, learners in suboptimal settings, characterized by discomfort, excessive noise, or distracting elements, encounter substantial obstacles in knowledge assimilation and sustaining engagement (Luzano, 2020).

The COVID-19 pandemic precipitated a transformation in learning environments, leading to considerable uncertainty regarding their impact on students' academic attainment and performance (Luzano, 2023). A specific article we have examined foretells that, at the outset of the 2020 school year, students would likely exhibit approximately 70% of the typical reading proficiency gains seen in conventional years, drawing from historical learning trends and previous research on the influence of out-of-school periods on learning outcomes. In the realm of mathematics, expectations were even more modest, with students projected to return with less than half of the customary learning progress typically observed in preceding years.

In light of these considerations, it is imperativeto undertake a study that investigates the varied learning experiences of students in a novel calculus learning environment. This research endeavor is motivated by the anticipation that its outcomes will accrue substantial benefits to both teachers and students in mathematics.

FRAMEWORK

This study is anchoredon Cognitive Learning Theory of Bandura which states that internal and external factors affect an individual's mental processes to complement learning. Learning then, is an active cognitive process in the mind that is affected by the environment and ways of acquiring knowledge. This theory emphasizes the importance of cognitive processes, social interactions, and the role of self-efficacy in learning and behavior. It provides a framework for understanding how individuals acquire new knowledge and skills through observation, self-regulation, and the dynamic interplay between personal, behavioral, and environmental factors. This theory further supports on how students were affected and adapted to the new learning phenomenon brought by the pandemic, shifting from learning at school into flexible learning.

METHODS

Research Design

This research employed a qualitative case studyto investigate and describe the significant experiences of BSE Mathematics in Calculus towards Flexible Learning. Case study research is a method that delves into a particular instance, which could be an individual, a circumstance, an institution, or a phenomenon, with the aim of acquiring insights that can be applied to a broader set of instances (Creswell, 2003). Qualitative case studies generally entail the examination of one to twelve occurrences, with the purpose of utilizing a distinct context to enrich a more extensive inquiry (Gerring, 2006).

Research Participants

The participants of the study were the ten (10) BSE Mathematics students who took Calculus on a Flexible Modality.The study employed a purposive sampling technique as to the gathering of responses from the student participants (Etikan&Alkassim, 2016. Recruitment of the participants was voluntary with the informed consent as proof of their voluntary participation.

Research Locale

The research was carried out at Bukidnon State University (BukSU). Due to the prevalent outbreak of the Coronavirus Disease in the vicinity of the institution, face-to-face classes were temporarily halted as an urgent measure to contain the virus's spread. Consequently, students transitioned to alternative learning modalities, including the use of PDF modules distributed via email and Facebook Group Chat, e-modules via Google Classroom and Google Meet, as well as printed modules with support through SMS and phone calls.

Data Collection and Analysis

In this research, the investigator assumed the role of the principal data-gathering tool. The study employed a method of data source triangulation, which involved collecting information through interviews and document analysis. The researchers created an Interview Guide and applied it during both in-person and virtual interviews.

The Interview Guide consists of a series of engaging, exploratory, and exit questions meticulously crafted to delve into and portray the noteworthy experiences of tertiary mathematics instructors in the Philippines.

The collected data underwent a comprehensive analysis aimed at revealing underlying patterns and extracting significance from the case study. Thematic analysis played a central role in guiding the scrutiny of participants' narratives, identifying implications, and formulating models. The data analysis process in this study consisted of five distinct stages.

In the first stage, known as Immersion Tasks (Stage 1), the data were organized into textual form, and an iterative reading of the texts took place, followed by initial interpretations to facilitate subsequent coding.The Understanding Tasks (Stage 2) constituted the second stage, focusing on identifying primary constructs and encoding the collected data.Moving on to the third stage, Abstraction (Stage 3), the emphasis was placed on identifying secondary constructs and organizing them into sub-themes.In the fourth stage, Synthesis and Theme Development (Stage 4), the sub-themes were clustered into broader themes, and further elaboration of these concepts occurred.The fifth and final stage, Illumination and Illustration of Phenomena (Stage 5), involved linking the study's findings to existing literature, synthesizing the observed phenomenon, and ultimately constructing a model (Ajjawi and Higgs, 2007).

RESULTS AND DISCUSSION

Results revealed two overarching meta-themes: *(1) Struggling Experiences and (2) Coping Experiences.* On the theme *"Struggling Experiences"*, three subthemes emerged such as *technology struggle, feedback struggle*, and *learning struggle*. For the theme "Coping Experiences", four

subthemes came out such as *Flexible Coping, Teleinteractive Coping, e-Learning Coping, and Autodidactic Coping*.

Struggling Experiences

Technology Struggle

In the realm of learning Calculus through a Flexible Learning Modality, a pervasive theme emerges as the majority of students grapple with technology struggles. The primary issue that plagues their educational journey is the reliability of internet access and connectivity, transforming what should be a seamless learning experience into a formidable obstacle. Students' own testimoniesvividly illustrate the profound impact of these technological hiccups, underscoring the pressing need for improved digital infrastructure and support in the educational landscape.

"As a student in the digital age, I've encountered numerous challenges when it comes to technology. While it's true that technology has transformed the way we learn, communicate, and work, it has also brought along its own set of obstacles. One of the most common issues I've experienced is the constant battle with software and hardware glitches. It seems that just when I'm about to complete an important assignment, my computer decides to freeze or crash, leaving me frustrated and stressed." [SP2]

Feedback Struggle

Based on the data gathered, students experienced to have a limited feedback on their learning. Students are forced to look towards alternative methods for providing feedback. Providing student feedback in an online setting is still a relatively unsearched topic area, and it might take a while for any specific strategies to become fully research-based and proven to be effective. "I find it hard to assess my learning because the feedback is limited" and "It was so very challenging for me to know if I got the correct or wrong answers." are the responses of the students who experienced to have limited feedback in learning calculus.

"In the shift to flexible learning, I've faced my fair share of challenges, particularly concerning feedback from teachers. Adapting to this new format can be tough, especially when it comes to promptly understanding and applying their feedback. The lack of in-person interactions makes seeking clarification and real-time discussions with teachers a rarity, leading to moments of frustration and confusion as I work to decode their comments and integrate their suggestions." [SP4]

Learning Struggle

Amidst the exploration of learning struggles, the data vividly underscores the challenges faced by the students in their journey to master Calculus within a Flexible Learning modality. This departure from traditional methods has brought forth a host of difficulties, with students expressing their struggle to adapt.These accounts emphasize the formidable learning challenges encountered, and they underline the need for innovative approaches to make the educational journey more accessible and engaging in the realm of flexible learning as mentioned:

"Although you are determined to learn calculus, there are lots of barriers that will hinder your learning growth. Time is limited, including interaction, therefore I can really tell that learning calculus during flexible learning wasn't easy." [SP 5]

"I have realized that this learning modality makes students feel unmotivated, and they become more concerned with submission than retention." [SP 3]

"Learning online comes with its challenges: the absence of in-person interaction and the need to adapt to a non-traditional classroom structure have been major adjustments. Maintaining motivation and a consistent routine has been tough when work and leisure boundaries blur. Technical issues, like unreliable internet and software glitches, have often left me frustrated. Additionally, the limited chances for immediate clarification or in-depth discussions with instructors have hindered my grasp of complex subjects. Nevertheless, these hurdles have taught me self-discipline and adaptability, and they highlight the need for institutions to enhance digital support, ultimately making the learning experience more accessible and fulfilling." [SP 7]

Coping Experiences

Flexible Coping

This is a vital skill in our rapidly changing world, requiring individuals to adapt and respond to various challenges with resilience and versatility. In education, this approach is indispensable, particularly in the era of diverse learning modalities. Students must seamlessly transition between in-person and online learning, embrace evolving technology, and manage information overload while sustaining their well-being.As the educational landscape continues to evolve, flexible coping skills enable students to thrive, providing them with the tools to tackle uncertainty and change, ultimately enhancing their academic and personal growth in an ever-shifting environment. Data showed about the experiences of students in the flexible learning modality:

"Adapting to flexible learning has required a significant degree of flexible coping, especially in the face of a constantly changing educational landscape. Shifting between online and in-person classes, learning to navigate various digital tools and platforms, and managing the influx of information can be challenging. However, it's also been a valuable opportunity to develop resilience and adaptability. Learning to juggle different learning modalities and stay motivated while dealing with external stressors has been a transformative experience. The ability to pivot, adjust, and remain focused on my educational goals, even when faced with uncertainty, has become a crucial part of my academic journey in the flexible learning era." [SP8]

Teleinteractive Coping

This is a concept that emerges in response to the ever-evolving digital landscape, particularly in an era where remote communication and online interaction have become integral aspects of our personal and professional lives. This coping mechanism centers around the ability to navigate and adapt to the challenges presented by a teleinteractive world, where technology-mediated interactions, such as video conferences, instant messaging, and virtual collaboration, have become the norm.

"Adapting to the demands of teleinteractive coping during flexible learning has been both a learning curve and a transformative experience. Navigating the online classroom, communicating effectively through various digital platforms, and collaborating with peers virtually have become essential skills. It's not just about managing the technical aspects but also about preserving a sense of engagement and motivation in a remote learning environment. Setting boundaries between personal and academic time, managing screen fatigue, and seeking help through online channels

have been pivotal to maintaining my well-being. While it's been a challenge, this era of teleinteractive learning has also provided me with valuable skills that I believe will be increasingly relevant in our digital-centric world, where effective teleinteractive coping is more crucial than ever." [SP4]

e-Learning Coping

This is an essential concept that comes into play in the rapidly evolving landscape of digital education. With the rise of online learning platforms, virtual classrooms, and remote education, students must adapt and develop strategies to navigate the unique challenges and opportunities that e-learning presents. This coping mechanism involves the ability to effectively manage the demands and stresses of digital education while maintaining productivity, well-being, and academic success.

"Coping with e-learning in the context of flexible learning has been both a challenge and an opportunity for personal growth. Managing my time effectively and staying disciplined in a self-paced environment has required significant adjustments. Adapting to various online platforms and learning tools has been a learning curve, and occasional technical hiccups have tested my patience. Staying motivated and engaged without the physical presence of peers and instructors has been another hurdle, but it's also pushed me to become more proactive in seeking out resources and building connections virtually. Alongside these challenges, I've had to prioritize stress management, recognizing the importance of self-care and reaching out for support when needed. E-learning coping has expanded my skill set, not only for academic success but also for thriving in the digital age, where flexibility and adaptability are invaluable attributes." [SP 6]

Autodidactic Coping

This is a critical concept in the context of flexible learning, where self-directed learning plays a central role. Autodidactic coping involves students taking charge of their own education, navigating the challenges and opportunities of flexible learning, and developing strategies to succeed independently. In this environment, where students often have a higher degree of control over their learning, the ability to self-manage and adapt is paramount.

"Adapting to flexible learning has truly put my independent learning skills to the test. With the freedom to structure my own study routine and navigate a variety of digital resources, I've had to develop discipline and time management to keep myself on track. Staying motivated and self-directed in the absence of in-person interactions can be challenging, but it has encouraged me to take the initiative in seeking out additional materials and connecting with my peers and instructors virtually. The ability to evaluate online sources critically and set clear learning goals has also become second nature. While autodidactic coping in flexible learning can be demanding, it's a skill set that empowers me to take control of my education and make the most of the opportunities presented by the digital era, ultimately leading to personal and academic growth." [SP8]

Emergent Model

- ✓ *Technology Struggle*
- ✓ *Feedback Struggle*
- ✓ *Learning Struggle*

- ✓ *Flexible Coping*
- ✓ *Teleinteractive Coping*
- ✓ *e-Learning Coping*
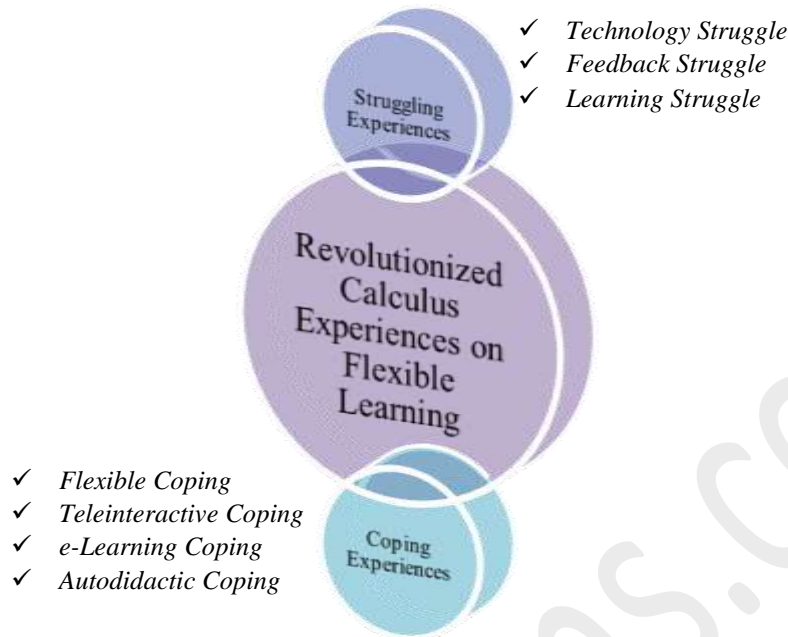- ✓ *Autodidactic Coping*

Figure 1. Emergent Model of Revolutionized Calculus Experiences on Flexible Learning

CONCLUSION AND RECOMMENDATION

In conclusion, the study's findings have illuminated two overarching meta-themes, namely "Struggling Experiences" and "Coping Experiences." Within the theme of "Struggling Experiences," three specific subthemes were identified, encompassing challenges related to technology, feedback, and the learning process itself. Conversely, the theme of "Coping Experiences" unveiled four distinct subthemes, which reflect various adaptive strategies employed by individuals to navigate these challenges: Flexible Coping, Teleinteractive Coping, e-Learning Coping, and Autodidactic Coping.

Based on these results, it is recommended that educational institutions and policymakers recognize the significance of addressing the specific struggles encountered by learners and educators in technology-driven learning environments. Moreover, fostering and supporting coping mechanisms, such as the flexible and interactive approaches identified, should be a priority to enhance the overall quality of education in similar contexts. Additionally, further research is encouraged to explore the effectiveness of these coping strategies and their potential for broader application in education.

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