DOI: 10.56773/bj.v2i2.34
E-ISSN: 2809-8528

Brillo Journal
Volume 2, Issue 2, June 2023, pp. 122-135

MATHEMATICS RESILIENCY IN THE NEW NORMAL: A THEORY DEVELOPMENT

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Abstract

This paper aimed to generate a theory that answers the question, "How do students cope with the challenges in learning mathematics in the normal? This study made used of the deductive axiomatic approach in theory generation following the steps prescribed by Padua (2012). Four axioms were formulated: (1) Students employ time management in studying math; (2) Students uses compensation strategies in overcoming challenges; (3) Students' resourcefulness leads them to learn mathematics; and (4) Students asked help from teachers and peers in understanding mathematical concepts. Two propositions were derived from these axioms: students' cope with the challenges in learning mathematics by (1) direct coping strategies support students' resiliency in learning mathematics and (2) Indirect coping strategies indirectly provide support for coping strategies through planning, socializing with others and increasing empathy. From these propositions, the Students' Mathematics Resiliency Based Theory is formulated: The Students' Mathematics Resiliency Theory states that resiliency in learning mathematics is affected by both direct and indirect coping strategies. Direct coping strategies include compensation strategies, while indirect strategies include social, time management, and resourcefulness.

Keywords: Coping mechanism, Deductive theory development, Resiliency.

Abstrak

Makalah ini bertujuan untuk menghasilkan suatu teori yang menjawab pertanyaan, "Bagaimana siswa mengatasi tantangan dalam pembelajaran matematika secara normal?" Studi ini menerapkan pendekatan aksiomatik deduktif dalam menghasilkan teori dan mengikuti langkah-langkah yang ditentukan oleh Padua (2012). Empat aksioma dirumuskan: (1) Siswa menggunakan manajemen waktu dalam mempelajari matematika; (2) Siswa menggunakan strategi kompensasi dalam mengatasi tantangan; (3) Keterampilan siswa membawa mereka untuk belajar matematika; dan (4) Siswa meminta bantuan dari guru dan teman sebaya dalam memahami konsep matematika. Dua proposisi diperoleh dari aksioma-aksioma ini: siswa mengatasi tantangan dalam pembelajaran matematika melalui (1) strategi penanganan langsung yang mendukung resiliensi siswa dalam mempelajari matematika, dan (2) strategi penanganan tidak langsung yang secara tidak langsung memberikan dukungan bagi strategi penanganan melalui perencanaan, bersosialisasi dengan orang lain, dan meningkatkan empati. Dari proposisi-proposisi ini, dirumuskanlah Teori Resiliensi Matematika Siswa: Teori Resiliensi Matematika Siswa menyatakan bahwa resiliensi dalam mempelajari matematika dipengaruhi oleh strategi penanganan langsung dan tidak langsung. Strategi penanganan langsung meliputi strategi kompensasi, sedangkan strategi tidak langsung meliputi aspek sosial, manajemen waktu, dan kemampuan dalam menggunakan sumber daya.

***Kata kunci**: Ketangguhan, Mekanisme penanganan, Pengembangan teori deduktif.*

How to Cite: Callaman, R. A. (2023). Mathematics Resiliency in the New Normal: A Theory Development. *Brillo Journal*, *2*(2), 122-135.

INTRODUCTION

This present time of the global pandemic of COVID 19 poses more stressful and adverse

psychological problems among our students. As students are confronted with these challenges in their day-to-day living, these affect their way of thinking and the way they deal with others and manage situations. Thus, these impel students to cope and be able to manage challenges.

In the teaching and learning process that practically happens daily, resilience is the most important factors in dealing with challenges (Masten, 2014). It encompasses the ability of a system, given such condition of its being dynamic, to adapt disturbances successfully, which by principle threaten the functionality, viability, and development of the said system (Lehmann & Joseph, 2015). Resilience observed to have positive effects on reducing depression among college students (Zamirinejad et al., 2014; Wu et al., 2020) and on alleviating mental health problems among children and adolescents (Smith et al., 2018; Dray et al., 2017; Wu et al., 2020). However, most existing studies about resilience and coping styles among university students are done separately, but only a few investigated its relationship (Wu et al., 2020). Further, the majority of these few studies examined the relationship between resilience and coping among adults and patients (Chen, Das, & Ivanov, 2019; Chen, Song, & Wei, 2017) and the relationship between resilience and coping among undergraduate students (Chen, 2016; Wu et al., 2020). But, the nature of the relationship between resilience and coping styles of students has not been established. In addition, inconsistent findings are reported in the literature.

Examining the coping mechanisms in this challenging time is imperative and prompted the researchers to explore the coping mechanisms of the students and to develop theory about the phenomena. It is through this study that the positive coping mechanisms of students employed would bring into the picture as encouraged by The World Health Organization, to employ positive coping strategies in addressing various stressful and mental health concerns (Wu et al., 2020). The theory developed on this study form part of the existing literature that guides teachers and students in designing the teaching-learning activities in the new normal.

That instance, resilience is frequently defined as the capacity to recover from or overcome some kind of adversity and so enjoy favorable results in spite of an adverse occurrence or circumstance. Hence, adversity and successful outcomes are important components of resilience (Pai & Vella, 2018). That is, resilience is commonly described as the ability to bounce back or overcome some form of adversity and thus experience

positive outcomes despite an adverse event or situation. Debate continues as to whether resilience is best conceptualized as a state or trait phenomenon (Stainton et. al., 2019) when resilience is considered as a personal characteristic (Ayed, Toner, and Priebe, 2019).

Resilience in arithmetic, according to Dilla, Hidayat, and Rohaeti (2018) is a crucial mathematical soft talent. Students with resilience, which is a positive character trait in mathematics instruction incorporates assurance in its achievement through working hard and remaining persistent while faced with challenges. With this type of resilience, students are capable of overcoming difficulties in learning mathematics that stem from low self-confidence, nervousness, and a lack of interest in the subject which impact on learners' intellectual capacity.

In the study conducted by the researchers Williams and Bryan (2014), and Hernandez-Martinez and Williams (2013), there are four classifications of mathematics resiliency: growing mindset, valuing of mathematics in a personal way, minding the fact that there are struggle in learning mathematics, considering ways to be able to get support in learning mathematics. In the same manner, Kooken et al. (2016) explored how such construct work with people who has already mathematical resilience. In addition, Simbulas (2018) revealed that mathematical resilience of the students is significantly correlated to mathematics achievement. It was concluded that among the three dimensions of mathematical resilience only struggle best influenced mathematics achievement.

Meanwhile, in the study conducted by Kiel and Callaman (2021) about assessing the mathematics resiliency of BSEd-Math students, it was reported that the students face the following challenges: (1) technology-related problems; (2) Input processing-related challenges; (3) limited student-teacher interactions; (4) psycho-emotional challenges; and (5) overlap between school and household tasks. Moreover, the college students' time management, study strategies, resourcefulness, the presence of more knowledgeable others and social strategies were found to be their coping mechanisms in this time of pandemic. It was also found out that students developed time management and self-discipline, cultivate self-reliance, and prepared contingency plans to cope with their challenges in the new normal setup of education (Agum et al., 2021).

In addition, Gueta and Janer (2021) claimed that time management, motivation, seeking assistance from neighbors and teachers and interactive communication between

students-teachers and students-students were the coping strategies of elementary students in distance learning challenges.

However, Castroverde and Acala (2021) opined that teacher should use various ways to cope with the challenges encountered in modular distance learning modality such as time management, innovating teaching strategies, being adapting, being flexible, providing alternative plans, being optimistic, patient, and equipping oneself with the necessary skills for the new normal ways of education.

Combining all these studies, and principles on resiliency, there has been a gap on the development of theory on how to wrap all the factors to describe the holistic view that contributes the students' mathematics resiliency in the new normal. Hence, this is the goal of the study.

This paper is aimed to answer the question" How do students cope with the challenges in learning mathematics in the new normal?" and formulate a theory describing the phenomenon.

RESEARCH METHODS

The paper utilized the process of deduction in theory development. The deductive approach starts with a few axioms—simple true statements about how the world works. The understanding of the phenomenon can be deduced from the nature of the axioms Nisbet, Miner, and Yale (2018). Specifically, the deduction process was done through the deductive axiomatic approach so to generate the theory on students' mathematics resiliency in the new normal.

The primitive assumptions are called axioms, and the consequences of these axioms are the propositions. These propositions are put to test through using appropriate methodology with specific data. When these propositions are accepted, then the generated theory must be accepted (Zalaghi & Khazaei, 2016). The steps that the paper followed are reflective of the deductive axiomatic approach in generating the theory (adapted from Padua, 2012), as illustrated in Figure 1.

The first step was choosing the phenomenon of interest. The first step for theory generation using the deductive axiomatic approach was to select the phenomenon of interest. This stage is crucial since it will serve as the focal point for the theory development, which may include a variety of underlying ideas (Grageda, Diokno, &

Abadiano, 2023). The phenomenon may originate in either the practical world of affairs, a theoretical discipline, or a personal experience or insight (Van de Ven, 2016).

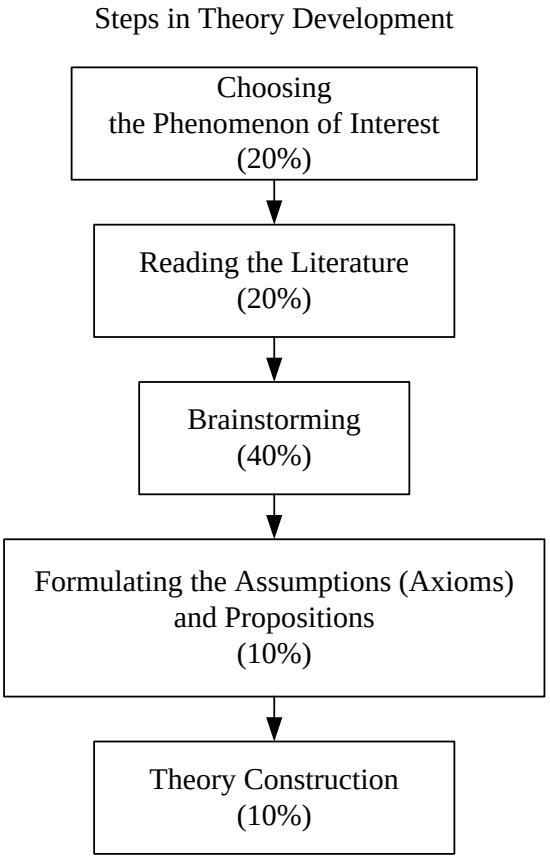

Figure 1. Deductive Axiomatic Approach in Theory Development

The second step was reading the literature. After selecting the phenomenon of interest, a researcher should consider reading the many examined resources as a crucial next step (Selden, Widdowson, & Brooker, 2016). Furthermore, reviews summarize the literature that has been published on a subject and describe the state of the art. Hence, borrowing from systematic review procedures that are meant to minimize bias in the selection of articles for review and utilizing a successful bibliographic research strategy can both enhance the quality of a narrative review (Ferrari, 2015). Among these, broadening of the knowledge base is the most vital in theory generation as this strengthens the formulation of the axioms and propositions concerning the phenomenon.

The third step was brainstorming. After reviewing the existing literature, the researcher investigated many aspects of the phenomenon through developing and analyzing the facts, and gaining multiple perspectives about it (Mickenberg, 2017). Brainstorming is essential for convergently aligning facts and related articles to

demonstrate the significance of the phenomenon (Seeber et al., 2017). These helped the researcher to formulate axioms appropriate to the phenomenon, as well as to make propositions coherent with the axioms. This stage supports the coherence and cohesion of data to be used in the theory development process (Henningsen & Henningsen, 2018).

The fourth step was formulating the axioms and propositions. The outcomes of the brainstorming were gathered, assessed and synthesized to formulate axioms and propositions. The formulation of axioms and propositions is an important step in theory development. Propositions are statements that come from the axioms, whereas axioms are basic theorems and primitive assumptions that regulate them (Novikov, 2011). These axioms and propositions are the essential in theory development.

The fifth step was theory construction. The alignment of all premises to identify and conclude a theory is the last step in theory building using a deductive axiomatic approach (Stergiou & Airey, 2018). The methodology for theory construction presented by Borsboom et al. (2021) outlines a realistic process for making explanatory theories. The systemic structure of Theory Construction Methodology (TCM) makes clear that developing theories requires talent; involves both focused practice and teaching.

RESULTS AND DISCUSSION

Phenomenon

The phenomenon in this research study is the coping mechanism of students in learning mathematics in the new normal. Student's mathematics resiliency accounts for the increasing number of students who survived schooling. Further, these students hurdle adversity and find effective coping strategies in this time of pandemic. These circumstances led the researcher in formulating its research problem "How do students cope with challenges in learning mathematics in the new normal? Thus, this paper develops the "Students Mathematics Resiliency Based Theory".

Axioms

Literature review and brainstorming led the researcher to formulate statements, which are regarded to be recognized, putative, and self-evidently factual. These statements or axioms are as follows: (1) Students employ time management in studying math; (2) Students uses compensation strategies in overcoming challenges; (3) Students'

resourcefulness leads them to learn mathematics; and (4) Students asked help from teachers and peers in understanding mathematical concepts.

AXIOM 1: *Students employ time management in studying math.*

Time management has been also acknowledged as being crucial in the education field. In fact, in the study conducted by Kiel and Callaman (2021) about assessing mathematics resiliency, time management found to be one of the coping mechanisms of students. In a research project conducted by Bettinger et al. (2018), data enable them to look into the amount of time spent on each algebraic problem. On the one hand, it is conceivable that pupils who are more tenacious are able to maintain greater concentration and work harder, and as a result, are able to work through the challenges more quickly. On the other hand, given the complexity of the problems, more tenacious students might have persisted longer before giving up on a problem. Instead of making a guess at random and moving on to the next question, they might have chosen to explore several strategies. As a result, they are unable to state with certainty how the study's intervention affects time utilization. Furthermore, it was discovered that there are no significant treatment effects on either the entire sample or the pertinent subsamples when looking at time spent on the first 10, 20 or 32 min. Indeed, different styles of time management work for different people. Taking all of the above into consideration, it is clear that the tools supporting students in their time management activities will have to be very flexible to meet the needs and expectations of such a diversified population (Mamman, 2013; Xu, 2013). Consequently, according to Trueman and Hartley (1996) they will have to inter alia account for different levels of time management, permit the gradual development and refinements of schedules and allow for modifications (also in main goals and priorities). Furthermore, arguably the main barriers for people to engage in time management activities are a lack of self-discipline or motivation and time-consumption (Grey, Al Saihati, & McClean, 2013). Planning, scheduling, prioritizing, monitoring, or evaluating all takes time and patience.

Learning mathematics in the new normal context requires time management among learners. Because of the circumstances, students are challenged on how to give prioritization in the overlapping activities in both school and personal lives. Hence, it can be assumed that students employ time management in studying math.

AXIOM 2: *Students use compensation strategies in overcoming challenges*.

Compensation strategies are those that are used by learners to compensate for their weaknesses in learning. These strategies are used to help learners use techniques for comprehension and production regardless of the limited knowledge learners have with learning math. Making up for an inadequate repertoire of mathematics concepts is the purpose of compensation strategies (Oxford, 1990). For example, when given a complex Mathematics task, students tend to be practical and responsible by watching YouTube tutorial videos about the topic. Others would look for some alternative ways to help them overcome the challenges. Hence, it can be assumed that learners use compensation strategies to make up for their deficiencies.

AXIOM 3: *Students' resourcefulness leads them to learn mathematics*.

Students overcome challenges in learning mathematics in the new normal by finding ways to be connected virtually during the online synchronous sessions and looking for available options in submitting their learning tasks (Kiel & Callaman, 2021). Resourcefulness is the ability to find quick and clever ways to overcome difficulties. The level of learned resourcefulness was associated with classroom and stress training. Individuals' self-leadership levels showed a positive relationship with their learned resourcefulness level (Avcı & Kaya, 2021).

The limited resources and the seemingly lack of readiness of the system in the new normal education has made it difficult for students to learn mathematics. For instance, in a study conducted by Russo et al. (2020), majority of students repeatedly stated that enabling prompts gave them more authority as learners and allowed them to take ownership of and succeed in their mathematics study. Students thought that prompts had the ability to deepen their comprehension and to help them approach mathematical activities with more confidence. They particularly valued being able to access prompts when they were stuck on a subject. In general, students did not equate using enabling prompts with being "bad" at arithmetic and acknowledged that even accomplished mathematicians occasionally needed a suggestion. Hence, the innate tendency of learners to adapt to the demands of time and making use of available resources to cope with the demands of education have made them succeed in learning. This, it is assumed that students' resourcefulness leads them to learn mathematics.

AXIOM 4: *Students asked help from teachers and peers in understanding mathematical concepts.*

Social strategies refer to learner's communication with people who also are into learning mathematics. According to Oxford (1990), these strategies include asking question, cooperating with others, and empathizing with others. Among the three, asking question is the most helpful and comes closest to understanding the meaning. It is also helps in conversation by generating response from the partner and shows interest and involvement. Cooperating with others eliminates competition and, in its place, brings group spirit. Empathy means to put oneself in someone else's situation to understand that person's point of view. Learners can social strategies to develop cultural understanding and become aware of thoughts and feeling of others.

Communication plays a big role in learning mathematics (Castroverde & Acala, 2021). Moreover, Kiel and Callaman (2021) emphasized that students learned mathematics lesson by asking help from their classmates who fully understand the concepts and friends who were knowledgeable about the lesson. Another illustration is guided discovery learning, which is still student-centered and uses the teacher as a guide. However, the amount of guidance provided by the teacher must be kept to a minimum since too much direction can resemble direct learning, which negates the advantages of learning. Through creative learning, it encourages students' capacity for innovation, investigation, problem-solving, and independent thought. Students can integrate and build their own knowledge while engaging in guided exploration learning, according to Shieh and Yu (2016). Furthermore, students are learning the processes of the scientific method for issue solving in groups, commencing with stimulation, problem formulation/identification, data collection, data processing, verification, and drawing conclusions (Yerizon, Putra, & Subhan, 2018).

Social strategies are very important for a successful learning. Learning does not need to mean competing with one another but forging a relationship that promotes support system and positive enablers in learning. Hence, it is assumed that students asked held from teachers and peers in understanding mathematics concepts.

Propositions

The formulation of the four axioms further lead to the formulation of two proposition. These propositions are as follows: (1) direct coping strategies support students' resiliency

in learning mathematics and (2) Indirect coping strategies indirectly provide support for coping strategies through planning, socializing with others and increasing empathy.

PROPOSITION 1: *Direct coping strategies support students' resiliency in learning mathematics.*

According to Oxford's (1990) definition which directly involve the target concepts are called direct strategies. These strategies include compensation strategies (Axiom 2). All of these direct strategies involve mental processing of concepts.

PROPOSITION 2: *Indirect coping strategies indirectly provide support for coping strategies through planning, socializing with others and increasing empathy.*

Indirect strategies include social strategies (Axiom 4) and they provide indirect support for language learning through focusing, planning (Axiom 1), evaluating, seeking opportunities, controlling anxiety, increasing cooperation and empathy, and other means (Axiom 3) (Oxford, 1990). This proposition was supported by the study of Gueta and Janer (2021) who claimed that time management, motivation, seeking assistance from neighbors and teachers and interactive communication between students-teachers and students-students were the coping strategies of elementary students in distance learning challenges. This was also affirmed in the study of Agum et al. (2021) that students developed time management and self-discipline, cultivate self-reliance, and prepared contingency plans to cope with their challenges in the new normal setup of education.

Theory

The Students' Mathematics Resiliency Theory states that resiliency in learning mathematics is affected by both direct and indirect coping strategies. Direct coping strategies include compensation strategies, while indirect strategies include social, time management, and resourcefulness. It is presented in Figure 2.

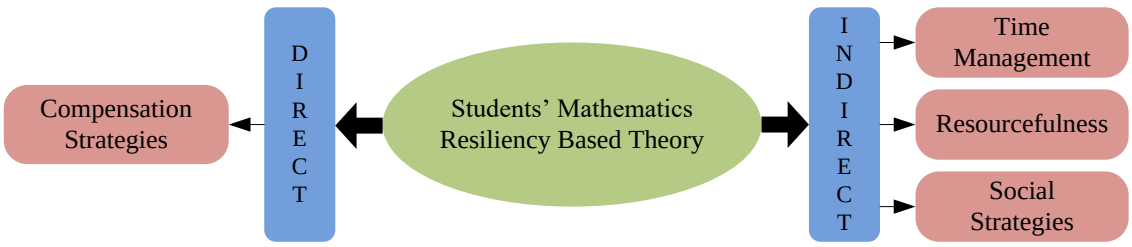

Figure 2. Students' Mathematics Resiliency Based Theory

Future direction

As part of the theory development process, a validation of the generated theory on Students' Mathematics Resiliency Based Theory must be conducted. Survey questionnaires can be administered in all propositions. In-depth interview and Focus group discussion can be carried out to students. The participants of the theory validation will be the college students in across Region XI. This will be done through stratified random sampling and purposive sampling technique. Ethical considerations in the conduct of the study will be dealt seriously.

Data gathering is done through audiotaped interviews and questionnaires. The obtained data will be analyzed through appropriate tools. Results and conclusion for each proposition will be presented and discussed as separate chapters.

CONCLUSION

Resilience in learning mathematics can be influenced by both direct and indirect coping strategies. Direct coping strategies, such as compensation strategies, involve finding ways to overcome difficulties in mathematical tasks directly. Whereas, indirect coping strategies, such as social, time management, and resourcefulness strategies, involve using external resources to overcome challenges.

Overall, even though the new normal poses difficulties for children learning mathematics, they are adapting and discovering fresh approaches to succeed in their studies.

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