International Journal of Learning, Teaching and Educational Research
Vol. 21, No. 6, pp. 18-33, June 2022
https://doi.org/10.26803/ijlter.21.6.2
Received Mar 3, 2022; Revised May 29, 2022; Accepted Jun 22, 2022

Mindset and Levels of Conceptual Understanding in the Problem-Solving of Preservice Mathematics Teachers in an Online Learning Environment

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Abstract. Mindset plays a vital role in tackling the barriers to improving the preservice mathematics teachers' (PMTs) conceptual understanding of problem-solving. As the COVID-19 pandemic has continued to pose a challenge, online learning has been adopted. This led this study to determining the PMTs' mindset and level of conceptual understanding in problem-solving in an online learning environment utilising Google Classroom and the Khan Academy. A quantitative research design was employed specifically utilising a descriptive, comparative, and correlational design. Forty-five PMTs were chosen through simple random sampling and willingly took part in this study. The data was gathered using validated and reliable questionnaires and problem-solving tests. The data gathered was analysed using descriptive statistics, analysis of variance, and simple linear regression. The results revealed that the college admission test, specifically numerical proficiency, influences a strong mindset and a higher level of conceptual understanding in problem-solving. Additionally, this study shows that mindset predicts the levels of conceptual understanding in problem-

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solving in an online environment where PMTs with a growth mindset have the potential to solve math problems. The use of Google Classroom and the Khan Academy to aid online instruction is useful in the preparation of PMTs as future mathematics teachers and problem-solvers. Further studies may be conducted to validate these reports and to address the limitations of this study.

Keywords: conceptual understanding; growth mindset; mathematics education; online learning; preservice teachers

1. Introduction

Future math teachers must be equipped with the right mindset and a full understanding of problem-solving. Mindset and conceptual understanding have a crucial role in the preparation of preservice mathematics teachers (PMTs). The academic mindset is critical in deeper learning (Farrington, 2013) where understanding the mindset of preservice teachers improves their morale as future educators (Yazon et al., 2021). Sadly, preservice teachers have a mindset that they cannot do mathematics (Cutler, 2020). Considering that a positive mindset is a gateway to mathematical achievement (Sun, 2018) and problem-solving performance (Pentang et al., 2021), an exploration of this matter is necessary to guide the teacher educators in empowering the PMTs. Poor conceptual understanding may also be a product of a negative mindset. Ibañez and Pentang (2021) have reported this among preservice teachers in the Philippines. Discovering ways to develop a strong mindset and conceptual understanding among PMTs was disrupted by the occurrence of the novel coronavirus disease in 2019 (COVID-19). Nevertheless, it opened up opportunities for teacher education institutions (TEIs) to explore alternative teaching and learning modalities.

TEIs in the locality suspended face-to-face classes and limited academic exchanges to mitigate the public health effects of COVID-19 (Tan et al., 2021). Institutions adopted a purely online modality while some blended it with self-learning modules to aid the instructions which may have affected the mindset and level of conceptual understanding among PMTs. Although online learning has been configured under a wide variety of different formats over half a century, one could say that COVID-19 has made educational institutions aware of the new normal way of academic exchange. Given the challenges due to the pandemic's impact, experts in educational institutions have been forced to adopt remote teaching strategies maximising online resources as a teaching-learning tool. As online classrooms promote a healthy mindset and encourage learning motivation (Bacsal et al., 2022; De Souza et al., 2021), TEIs have begun to adopt online technology methods for disseminating the teaching-learning processes such as Google Classroom and the Khan Academy.

On the other hand, educators who wish to improve their learning outcomes must consider approaches to establish a growth mindset (Dimitriadis, 2015). A person with a strong mindset shows grit, hard work, and perseverance. Embedded in each of these beliefs, or mindsets, are networks of beliefs and assumptions that shape how people approach learning (Tabrizi, 2020). In contrast, those who believe that intelligence is fixed tend to focus on judgment. They are more concerned with proving that they are intelligent or concealing that they are not, which means that they avoid circumstances in which they might fail or have to work hard (Dweck, 2016). The faculty and staff require more than just technological knowledge; they must also be fully prepared to apply instructional approaches that improve the students' online experiences (DeBrock et al., 2020; De Souza et al., 2021). Thus, there is a need for teachers, including those in the preservice, to assess their beliefs about intelligence. Their mindset will drive how they teach and facilitate learning in the mathematics classroom.

Studies about mindset have not yet been fully explored, especially in the field of mathematics education. It is noticeable that growth mindset research emerged recently, less than ten years ago. Likewise, the conceptual understanding of problem-solving in an online environment has not yet been examined. It will be interesting to find out whether mindset has a connection with the level of conceptual understanding in an online setup. Moreover, the research will likely be compelling if the study is done in a group of preservice teachers who are taking mathematics majors. Considering that these future teachers will probably teach mathematics in the K-12 program in a few years (Bacsal et al., 2022; Domingo et al., 2021; Ibañez & Pentang, 2021; Pentang et al., 2021), it would bring in great benefits to the students, parents, and administrators if their mindset and levels of conceptual understanding are found to be related.

As an academic institution that trains and prepares preservice teachers, Central Luzon State University (CLSU) has been dramatically affected by the pandemic due to the lockdown and school closures that started in March 2020. Online resources are needed to address the unprecedented pandemic issues in the teaching-learning process (Manca & Meluzzi, 2020; Pentang, 2021b). Given the uncertainty of how long the pandemic lasts, online learning plays a vital role in the continuity of teaching and learning (Bacsal et al., 2022). Google Classroom and the Khan Academy was used to facilitate continuous learning despite the ongoing closure and lockdown in schools, colleges, and universities. These scenarios have compelling reasons to study the mindset and levels of conceptual understanding in problem-solving in an online learning environment using readily free available tools like Google Classroom and the Khan Academy in a mathematics classroom at CLSU, specific to PMTs, who are deemed to be able to recuperate the status of Philippine mathematics education.

Research Questions

1. What is the PMTs' mindset when problem-solving in terms of growth and a fixed mindset?
2. What is the PMTs' levels of conceptual understanding when problem-solving regarding best, partial, complete/incomplete, functional, and no understanding?
3. Is there a significant difference in the PMTs' mindset when problem-solving when grouped according to socio-demographic characteristics?

4. Is there a significant difference in the PMTs' levels of conceptual understanding of problem-solving when grouped according to socio-demographic characteristics?
5. Do the PMTs' mindsets significantly predict their conceptual understanding of problem-solving?

2. Conceptual Framework

The inequalities in the Filipino students' mathematical literacy can be attributed to their unawareness of a growth mindset and lack of conceptual understanding, both of which are linked to their teachers' means of imparting knowledge and skills in mathematics. With the unprecedented move to online learning brought about by the pandemic, mathematics educators have been obligated to employ online learning management systems such as Google Classroom with the Khan Academy to train and prepare future maths teachers who are deemed able to address the mathematics illiteracy among young Filipinos. It is an opportunity to assess the growth mindset and conceptual understanding of problem-solving of the preservice mathematics teachers (PMTs). The Khan Academy existed prior to the pandemic but was not commonly used in formal mathematics instruction.

The PMTs' mindsets can be influenced by what they believe about their academic ability. Intelligence may be strengthened by a growth mindset (Dweck, 2016). A person with a growth mindset knows that intelligence may be attained through hard work and the assistance of others (Romero, 2015). Knowing a student's mindset will assist a teacher in developing techniques to promote learning (Tabrizi, 2020). Growth mindset techniques enable the students to engage in risk-taking activities (Hennessey, 2019). Thus, it is vital to consider the right mindset when pursuing academic success in mathematics, especially in relation to problem-solving. The PMTs' mindset may be found to be helpful in problem-solving activities with the aid of the Khan Academy.

PMT's conceptual understanding of problem-solving also has implications for mathematics education. Conceptual understanding denotes a comprehensive and functional knowledge of mathematical notions (National Research Council, 2001). Conceptual understanding is critical to solving a problem and understanding why the algorithms and approaches used work. Conceptual understanding, in which learners grasp ideas in a transferable manner, enables them to apply what they learn in class across domains (Moser & Chen, 2016). Problem-solving and deep conceptual understanding is demonstrated when a student decides how to solve a problem (Ibañez & Pentang, 2021; Pentang et al., 2021). The PMTs should be able to monitor their process and judge whether the procedure is the right method to answer the question or if a new way is needed (Pentang, 2021a; Schoenfeld, 1989). Through the Khan Academy, it is deemed that the PMTs' conceptual understanding will be estimated.

The socio-demographic characteristics such as sex, number of siblings, birth order, family monthly income, father's and mother's educational attainment, and CAT Numerical Proficiency, are essential factors to consider when determining the PMTs' mindset and level of conceptual understanding. Considering that both mindset and conceptual understanding are essential in mathematics education, this study resolves the gap in the literature where no exploration has established the influence of socio-demographic characteristics in relation to the PMTs mindset and conceptual understanding of problem-solving as well as to establish whether mindset is a predictor of the PMT's conceptual understanding. The study also conceptualised the vital role of online learning in problem-solving through the use of Google Classroom and the Khan Academy (Figure 1).

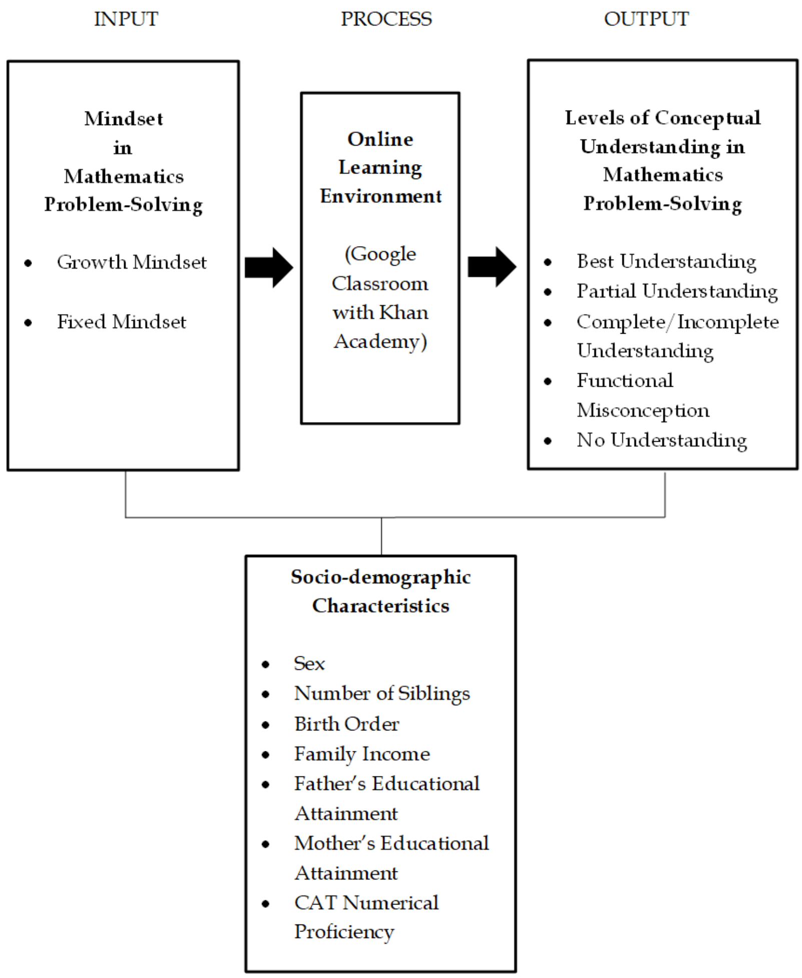

Figure 1: Conceptual Framework of the Study

3. Methodology

3.1. Research Design

This study employed a quantitative research design combining descriptive, comparative, and regression methods to address the research questions and conceptual framework of the study (Magulod et al., 2021). The descriptive analysis addressed the first two research questions which described the participants' mindset and their level of conceptual understanding of problem-solving in an online learning environment. Additionally, the comparative analysis answered the third and fourth research questions which distinguished between the socio-demographic characteristic differences in the participants' mindset and level of conceptual understanding, respectively. Moreover, the regression analysis answered the fifth question which showed whether the PMT's mindset predicts their conceptual understanding of problem-solving.

3.2. Participants and Sampling Procedure

The participants of the study were preservice mathematics teachers (third-year Bachelor of Secondary Education major in Mathematics students) from Central Luzon State University. The study targeted respondents who had taken mathematics college courses and who were currently enrolled in Problem-solving, Mathematical Investigation, and Modelling in their first semester of the school year 2020-2021. The simple random sampling employed drew 45 participants (Table 1).

Table 1: Participants' socio-demographic characteristics (n = 45)

Socio-Demographic Characteristics		Frequency	Percentage
Sex	Male	14	31.11
	Female	31	68.89
Number of Siblings	0 - 2	10	22.22
	3 - 5	31	68.89
	6 and above	4	8.89
Birth Order	Last-born (Youngest)	12	26.67
	Middle-born	21	46.67
	First-born (Eldest)	12	26.67
Family Monthly Income	Less than ₱11,690	34	75.56
	Between ₱11,690 to ₱23,380	9	20.00
	Between ₱23,381 to ₱46,761	2	4.44
Father's Educational Attainment	Did not finish Elementary	7	15.56
	Elementary Graduate	7	15.56
	High School Graduate	26	57.78
	College Graduate	5	11.11
Mother's Educational Attainment	Elementary Undergraduate	2	4.44
	Elementary Graduate	6	13.33
	High School Graduate	30	66.67
	College Graduate	7	15.56
CAT Numerical Proficiency	Below Average	8	17.78
	Average	24	53.33
	Above Average	13	28.89

3.3. Research Instrument

The instrument utilised in this study was a survey questionnaire (for Part I and Part II) and a problem-solving test (for Part III). Part I determined the socio-demographic characteristics of the participants. Part II focused on the participants' mindset following the example of Dweck (2016). It consisted of two subscales: Entity Self Beliefs (items number 1 to 4) and Incremental Self Beliefs (items number 5 to 8). The entity or fixed mindset items were reverse coded so then the students who answered strongly disagree for these items showed agreement with the growth mindset. Higher scores for this subscale showed agreement with the incremental or growth mindset items. Part III was aimed at the participants' levels of conceptual understanding of problem-solving in terms of their best understanding, partial understanding, incomplete understanding, functional misconception, and no understanding. The levels were determined based on Jensen and Finley's (1995) theory. The problems provided focused on the following topics: expressions in multiple variables, systems of equations, graph labels and scales, quadratics, and exponential graphs. These problems were among the difficult items included in the work of Bacsal et al. (2022), Domingo et al. (2021), Ibañez and Pentang (2021), and Pentang et al. (2021) in their studies on mathematics problems concerning elementary preservice teachers in the same institution. The research instrument was pilot tested which demonstrated a high internal consistency (Cronbach's alpha = 0.891).

3.4. Data Gathering Procedures

The researchers secured approval and consent from the institution and the participants, respectively. Upon approval, the course professor assisted the researchers in gathering the data. At the start of the class, the participants familiarised themselves with the course expectations of the online learning environment. The participants completed an online survey about their socio-demographic characteristics and mindset towards problem-solving. In the following meetings in the first week, the course professor facilitated discussions on mathematical investigation, developing critical thinking and problem-solving skills, as well as math problem-solving techniques and strategies. Examples of how to solve different mathematics problems were presented which served as a review of the PMTs' prior knowledge regarding their mathematics courses.

The researchers oriented the participants of the Khan Academy online resource in the first meeting of the second week of class. Given how the participants have prior knowledge of the mathematics concepts from previous years, the Khan Academy platform offered them an opportunity to practice mathematical skills repeatedly to master the concepts. It also allowed them to track their progress as it provided instant feedback. Thus, the participants could fill in the gaps in their understanding by watching the related videos and getting hints or moving ahead.

During the two weeks of the class meetings, the students independently practiced their problem-solving skills. The PMTs continued to do the practice exercises and watch videos, if necessary. In the next two weeks of the classes, the students answered the problem-solving questions in Google Classroom through Google Forms. Each problem set had four multiple-choice questions. The students wrote the solutions and explanations to their chosen answers in the multiple-choice area for each item question. After a month of online learning, the researchers gathered the data on the number of times each participant tried to answer the given five sets of problems to achieve mastery learning using the Khan Academy.

3.5. Data Analysis

Descriptive statistics such as the mean and standard deviation were utilised to determine the PMTs' mindset regarding the presence of a growth mindset or absence of a growth mindset, equivalently a fixed mindset, whereas frequency count and percentage were used to describe the PMTs' level of conceptual understanding of problem-solving in an online environment. Besides this, a series of Analysis of Variance tests were employed to distinguish between the significant differences in the PMTs' (a) mindset and (b) conceptual understanding in problem-solving when grouped according to their socio-demographic characteristics. Follow-up post hoc analysis was conducted using the Scheffe test. Furthermore, simple linear regression was utilised to find out whether the PMTs' mindset was able to predict their level of conceptual understanding of problem-solving in an online environment.

4. Results and Discussion

4.1. PMTs' Mindset

The study found alarming results where the PMTs recorded a weak growth mindset (Mean = 3.98, SD = 0.16). The PMTs have limited their perspective regarding their intelligence and ability to do problem-solving. Still, the Khan Academy online intervention showed that the PMTs performed the exercises several times to reach the mastery level. As Table 2 reflects, the PMTs have a strong growth mindset regarding the time and effort needed to improve themselves. This demonstrates the PMTs' readiness to maximise their resources, learn from their mistakes, and accept challenges, as they consider failure as a chance to learn (Boaler, 2022; Dweck, 2016). Also, the PMTs seemed determined and persevering when it came to accomplishing whatever they set their minds to. Hence, the PMTs showed that they are most likely to demonstrate the characteristics of people with a growth mindset, such as hard work, perseverance, seeking help from others, and learning from feedback (Boaler, 2022; Dweck, 2016; Wilkins, 2014).

There is still a need to cultivate a growth mindset among the PMTs. The PMTs' growth mindset will be vital when addressing the poor status of mathematics education in the Philippines. Several online resources relevant to mathematics instructions may be adopted to fully prepare prospective math teachers. With "the teacher's crucial role in facilitating and monitoring the student's development" (Agayon et al., 2022), this weak growth mindset may be replicated in the PMTs' students. Thus, the institution may provide ample training and activities to strengthen the PMTs' growth mindset. In line with De Souza et al. (2021) and Pentang (2021b), the course professors concerned may further utilise several online teaching-learning tools and integrate available technology to communicate effective instructions.

Table 2: PMTs' mindset

Parameters	Mean	SD	Description
*1. I don't think I can do much to increase my intelligence.	3.84	1.26	WGM
*2. I can learn new things but I can't change my basic intelligence.	3.76	1.28	WGM
*3. My intelligence is something about me that I can't change very much.	3.98	1.29	WGM
*4. To be honest, I don't think I can change how intelligent I am.	3.93	1.25	WGM
5. With enough time and effort, I think I could significantly improve my intelligence level.	5.24	0.98	SGM
6. I believe I can always substantially improve my intelligence.	4.89	0.71	AGM

7. Regardless of my current intelligence level, I think I can change it quite a bit.	4.80	0.50	AGM
8. I believe I can change my basic intelligence level considerably over time.	4.87	0.69	AGM
Pooled Mean	**3.98**	**0.16**	**WGM**

Note: 5.16–6.00 = Strong Growth Mindset (SGM) *Reversely Coded
4.33–5.15 = Average Growth Mindset (AGM)
3.50–4.32 = Weak Growth Mindset (WGM)
2.67–3.49 = Weak Fixed Mindset (WFM)
1.84–2.66 = Average Fixed Mindset (AFM)
1.00–1.83 = Strong Fixed Mindset (SFM)

4.2. PMTs' Level of Conceptual Understanding

Most (40 out of 45) PMTs recorded their best conceptual understanding in problem-solving (Table 3). This shows that the PMTs have prior knowledge of the concepts and mastered the skills needed in problem-solving, which opposes the work of Ibañez and Pentang (2021) and Pentang et al. (2021) who revealed that the majority of the preservice teachers have functional misconceptions and an incomplete understanding of problem-solving. This result approves the effective use of Google Classroom with the Khan Academy as employed by the PMTs' professors where the institution they belong to has led to the standard of being one of the best universities in Asia. The PMTs have shown their ability to impart knowledge and skills in mathematical problem-solving to their future students.

Meanwhile, five PMTs had an incomplete to partial understanding, which can be attributed to a lack of contextual comprehension of the mathematical topics (Domingo et al., 2021; Pentang, 2021a; Pentang et al., 2021). This unwanted result may infer that the PMTs are not yet ready for the challenge to empower young Filipinos in their mathematics courses. Since partial understanding hampers the students' understanding of the subsequent mathematical knowledge (Shockey & Pindiprolu, 2015), there is a need for an intervention to facilitate the preparation of the PMTs as math teachers. Other online-based platforms and resources may be utilised in the teaching-learning process to improve the PMTs' conceptual understanding as well as to effectively strengthen their growth mindset in mathematics.

Table 3: PMTs' level of conceptual understanding

Levels	Frequency (n = 45)	Percentage
Best Understanding	40	88.89
Partial Understanding	4	8.89
Incomplete Understanding	1	2.22
Functional Misconception	0	0
No Understanding	0	0

4.3. Mindset in Problem-Solving When Grouped According to Socio-Demographic Characteristics

ANOVA found there to be a significant difference in the PMTs' mindset in terms of the CAT numerical proficiency of the PMTs, $F_{(2,42)} = 1.002$, $p < 0.05$ (Table 4). PMTs with an above-average CAT numerical proficiency (Mean = 4.430, SD =

0.139) tended to have a stronger growth mindset in relation to problem-solving compared to the PMTs with an average (Mean = 3.973, SD = 0.155) and below-average (Mean = 3.937, SD = 0.197) CAT numerical proficiency. This means that numerical proficiency can influence mindset in relation to problem-solving. Overall, the study results suggested that there is no statistical evidence to say that there is a significant difference between the PMTs' mindsets when grouped according to their socio-demographic characteristics except for their CAT Numerical Proficiency.

The results can be related to the work of Boaler (2022) and Bower (2017) where people who have a growth mindset directly impact how they face academic challenges, including college examinations. However, this finding contradicts Li and Bates (2020) where admission test scores throughout the transition from high school to college were not found to be connected to a growth mindset. When establishing the PMTs' mindset, it would be beneficial to focus more on their academic profile, such as college admission test scores. The PMTs' high school background may be included, and a stringent retention policy in the mathematics teacher education program may be implemented.

Table 4: Socio-demographic characteristic differences in relation to the PMTs' mindset towards problem-solving

Socio-Demographic Characteristics	Mean	SD	df	*F*	*p*
Sex					
Male	3.946	0.137	1,43	-1.044	0.302
Female	4.000	0.168			
Number of Siblings					
0 - 2	4.000	0.150	2,42	0.496	0.613
3 - 5	3.989	0.162			
6 and above	3.916	0.176			
Birth Order					
Youngest	3.923	0.148	2,42	1.297	0.284
Middle	4.015	0.153			
Eldest	3.983	0.178			
Monthly Family Income					
Less than ₱11,690	3.890	0.152	2,42	0.409	0.667
Between ₱11,690 to ₱23,380	3.972	0.186			
Between ₱23,381 to ₱46,761	4.083	0.235			
Father's Educational Attainment					
Did not finish Elementary	4.023	0.133	3,41	0.537	0.219
Elementary Graduate	3.964	0.249			
High School Graduate	4.003	0.127			
College Graduate	3.850	0.170			
Mother's Educational Attainment					
Did not finish Elementary	4.000	0.235	3,41	0.058	0.981
Elementary Graduate	4.000	0.166			
High School Graduate	3.983	0.165			
College Graduate	3.964	0.143			
CAT Numerical Proficiency					
Below Average	3.609_b	0.197	2,42	1.002	0.037

Average	3.903_b	0.155			
Above Average	4.430_a	0.137			

Note: Means with the same subscript do not differ using Scheffe post hoc analysis.

4.4. Socio-Demographic Differences in the PMTs' Conceptual Understanding of Problem-Solving

ANOVA found there to be a significant difference in the PMTs' conceptual understanding of problem-solving when grouped according to CAT Numerical Proficiency, $F_{(2,42)} = 3.464$, $p < 0.05$ (Table 5). The post hoc analysis using Scheffe showed that PMTs with an above-average CAT Numerical Proficiency (Mean = 3.792, SD = 0.238) tended to have higher conceptual understanding of problem-solving compared to the PMTs with an average (Mean = 3.644, SD = 0.423) and below-average (Mean = 3.306, SD = 0.545) CAT numerical proficiency. This suggests that there is no significant difference between the PMTs' conceptual understanding of problem-solving in an online environment when grouped according to the socio-demographic characteristics, except according to their CAT Numerical Proficiency.

College admissions tests have a long track record of bringing value to higher education institutions by giving a predictive value of student success in entry-level college courses. This conforms to the work of Allen and Bond (2001), Mengash (2020), Montalbo et al. (2018), and Tesema (2014) but opposes Laus (2021). The college admission test is indeed a good measure for admitting potential preservice teachers. However, the institution may opt to accept those with a higher numerical proficiency to ensure that the PMTs are ready not only in their college preparation but also for the board exam and their anticipated teaching career. A strict admission policy may be implemented considering other backgrounds such as their high school grade point average and national achievement test results.

Table 5: Socio-demographic characteristic differences in relation to the PMTs' conceptual understanding of problem-solving

Socio-Demographic Characteristics	Mean	SD	df	F	p
Sex					
Male	3.739	0.208	1,43	1.490	0.229
Female	3.571	0.494			
Number of Siblings					
0 - 2	3.783	0.130	2,42	0.989	0.380
3 - 5	3.565	0.503			
6 and above	3.700	0.127			
Birth Order					
Youngest	3.691	0.270	2,42	2.115	0.133
Middle	3.478	0.554			
Eldest	3.800	0.126			
Monthly Family Income					
Less than ₱11,690	3.576	0.475	2,42	0.862	0.429
Between ₱11,690 to ₱23,380	3.750	0.208			
Between ₱23,381 to ₱46,761	3.850	0.212			

Father's Educational Attainment					
Did not finish Elementary	3.521	0.655	3,41	0.237	0.870
Elementary Graduate	3.707	0.302			
High School Graduate	3.617	0.439			
College Graduate	3.680	0.148			
Mother's Educational Attainment					
Did not finish Elementary	3.875	0.354	3,41	0.258	0.855
Elementary Graduate	3.575	0.194			
High School Graduate	3.610	0.472			
College Graduate	3.650	0.475			
CAT Numerical Proficiency					
Below Average	3.306_b	0.545	2,42	3.464	0.041
Average	3.444_b	0.423			
Above Average	3.792_a	0.238			

Note: Means with the same subscript do not differ using the Scheffe post hoc analysis.

4.5. Mindset as a Predictor of the PMTs' Conceptual Understanding of Problem-solving

A simple linear regression analysis was performed to determine whether the PMTs' mindset predicts their conceptual understanding of problem-solving in an online learning environment. Table 6 shows that the model is significant, R^2 = 0.515, Adjusted R^2 = 0.407, $F_{(1,43)} = 4.781$, $p < 0.05$, indicating that PMTs who have a growth mindset tend to have higher conceptual understanding of problem-solving. The coefficient of determination (R^2) means that about 51.5% of the variance in the PMTs' levels of conceptual understanding in problem-solving in an online learning environment is explained or accounted for by their mindset.

Similar to Hennessey (2019), the results show that a growth mindset is associated with better educational outcomes. The study also agrees that an individual with a growth mindset is inspired by mastery goals, finds inspiration in others' success, and learns from feedback (Wilkins, 2014). This inspiration and reflection is cultivated in an online learning environment. Thus, the growth mindset must be instilled among PMTs while they are in their formative years in the teacher education program. This measure will be helpful as part of encouraging a full understanding of problem-solving.

The results further prove that people who have a growth mindset accomplish much (Boaler, 2022) as the PMTs pursue becoming excellent math teachers. However, this study is contrary to the research conducted at the same institution concerning elementary preservice teachers. Although the preservice teachers try to develop a positive disposition, they find it hard to learn mathematics (Ibañez & Pentang, 2021). Even preservice teachers who have a growth mindset toward mathematics do not show a full conceptual understanding when solving problems (Pentang et al., 2021). The study still needs validation due to the limited sample size.

Table 6: Simple linear regression analysis of the PMTs' conceptual understanding in problem-solving as the criterion with mindset as the predictor

Model	Unstandardised Coefficients		Standardised Coefficients	t-value	p-value
	B	Std. Error	Beta		
Constant	2.365	1.729		-1.983	0.055
Mindset	0.273	0.420	0.558	4.490	0.049

Note: $R^2 = 0.515$, Adjusted $R^2 = 0.407$, $F_{(1,43)} = 4.781$, $p < 0.05$

5. Conclusion and Recommendations

The PMTs have to develop a strong growth mindset which is necessary for them as future teachers. The PMTs' preparedness to teach mathematics to young Filipinos cannot be assured with a fixed mindset. To foster a growth mindset among the PMTs, this may be integrated into the Psychology Course that the preservice teachers are taking. The PMTs with a growth mindset are more likely to know that academic success is no accident – it is related to learning, studying, hard work, perseverance, sacrifice, and love of what you are doing or learning to do. Additionally, the inclusion of growth mindset activities in the Mathematics Education Courses would be beneficial to the PMTs. This may result in more awareness that intelligence can be developed. This may lead to a stronger growth mindset among the PMTs who will shape the younger generation's minds in the upcoming K-12 program.

The PMTs attained the expected level of conceptual understanding in problem-solving. The PMTs showed a mastery of skills in mathematical problem-solving due to their strong academic background combined with the online intervention via the Khan Academy activities. Nevertheless, it is noteworthy that there are still a handful of them who have gaps in their conceptual understanding of problem-solving. It is good to advocate the use of an open-source platform like the Khan Academy to enhance the PMTs' conceptual understanding. They are likely to be motivated to have mastery skills through independent learning. It is also a useful intervention for those who exhibit a partial or incomplete understanding of the mathematics concepts.

Since the PMTs with a higher CAT Numerical Proficiency tend to have a stronger growth mindset and higher conceptual understanding of problem-solving, it is proposed that the college admission test is used in the admission of potential PMT applicants. Besides this, mindset predicts the level of conceptual understanding in problem-solving in an online environment. With the use of online resources through Google Classroom and the Khan Academy, it is profitable to develop and implement online mathematics lessons that incorporate a growth mindset and conceptual understanding.

The continuous use of online resources (e.g., lesson videos and practice exercises) via the Khan Academy even in the post-pandemic time is highly recommended even after limited face-to-face classes are implemented. Online resources are beneficial for the PMTs' growth mindset and conceptual understanding of mathematical problem-solving. This may also help the PMTs to prepare for the board examinations and their future teaching career. With the limitations posed by the current study, further research on online learning may be looked to, considering a larger sample size and the adoption of similar variables and methods to validate this report. Other online learning tools such as maths applications and software as well as academic and non-academic factors that possibly influence the mindset and conceptual understanding may also be considered.

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