

Students' Perception of their Math Anxiety when Shifted to Online Learning

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Abstract

Schools suddenly shifted from face-to-face to online classes because of the COVID-19 pandemic. The abrupt change may increase students' math anxiety. The paper aims to study junior high school students' perception of math anxiety when they shifted to online learning; 120 high school students were surveyed. The survey tool is a 4-point Likert scale consisting of 15-item statements. Descriptive statistics, ANOVA, and T-test were used for data analysis. Results show that students agreed that their math anxiety levels increased during online learning. There is a statistically significant difference in math anxiety levels between genders and among grade levels. Most students prefer face-to-face classes because they feel their math anxiety level increased during online classes. Teachers should implement different learning strategies to help students learn more effectively and decrease anxiety.

Keywords: Face-to-face learning, Math anxiety, Online learning

Background

One of the United Nations' Sustainable Development Goals is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (United Nations, 2015). In the Philippines, AmBisyon Natin 2040 envisions Filipino students equipped with foundational literacies, competencies, and character qualities; one of the foundational literacies is numeracy (National Economic and Development Authority, 2016). Regardless of whether students and teachers were prepared, most educational institutions worldwide have resorted to a sudden shift from traditional face-to-face classes to online teaching and learning between March and April 2020 due to the pandemic caused by COVID-19 (UNESCO IESALC, 2020). The face-to-face method of conducting classes was suspended; to continue education during the pandemic, the Department of Education implemented online and modular distance learning to deliver instruction (Sarmiento et al., 2021).

Even before the pandemic, Franklin et al. (2015) predicted the prevalence of online classes in the future. The advent of COVID-19 gave rise to a drastic change in the educational system; from traditional face-to-face classes, educational institutions were forced to shift to online classes.

Online and Traditional face-to-face learning

There are two modalities of learning: online and traditional face-to-face learning. Online and traditional face-to-face classes have similarities and differences. Both modalities require students to attend classes, study the lessons, and accomplish learning activities. Teachers still design the curriculum and assessment to ensure instructional quality. The two modalities differ from each other since it can be observed that traditional face-to-face classes are teacher-centered, while online classes tend to be more learner-centered.

Studies have shown contradicting results regarding online and traditional face-to-face classes. Ganesh et al. (2015) found that students rated traditional classes better than online classes in the following dimensions: overall evaluation, perceived competence, perceived communication, and perceived challenge.

The study by Bergstrand and Savage (2013) found that students feel they have learned less in online classes. Students' grades in online classes were slightly lower than their face-to-face counterparts (Fischer et al., 2020). On the contrary, other studies did not find a significant difference between students' academic performance in online and traditional face-to-face classes (Ni, 2013; Edwards et al., 2017; Nemetz et al., 2017).

Baum and McPherson (2019) mentioned that students with poor academic foundations struggle most in online classes. Prior online learning experience and sense of preparedness predicted students' anxiety in online classes (Abdous, 2019). Low technology readiness resulted in low self-efficacy in interaction with other students (Warden et al., 2022).

The study by Gherhes et al. (2021) has shown that students prefer face-to-face learning over e-learning. It was also interesting to note from the study that those who have only experienced e-learning favored face-to-face learning more than students who have experienced both face-to-face learning and e-learning. According to Dios & Charlo (2021), students would rather have face-to-face learning than e-learning due to the social interaction fostered in the classroom, which allows them to raise questions quickly, work on tangible learning materials, and learn collaboratively. In addition, the study by Joshi and Bodkha (2021) showed that students found online lectures to be monotonous, resulting in less satisfaction than face-to-face lectures. Moreover, they have noted that attending face-to-face lectures helped them to be more attentive and motivated, thus giving them a higher degree of satisfaction.

Muthukrishnan et al. (2021) found that students see e-learning as beneficial since it allows them to record lectures, access online learning materials, and learn at their own pace and preferred environment. However, this was also considered disadvantageous since the lack of social interactions and other technical issues contributed to students' compromised discipline in their studies. In the study by Tan et al. (2021), undesirable learning experiences were caused by insufficient communication and interaction. Harefa & Sihombing (2022) also saw limited social interaction negatively affecting students in the e-learning modality. With this, they suggest that teachers take thoughtful and creative steps to target the teaching objectives.

Math anxiety

Research on math anxiety has been around for decades. Extant literature shows how it affects math performance and the daily lives of individuals with math anxiety. Math anxiety affects students worldwide. It is characterized by apprehension, worry, aversion, and frustration from performing math tasks (Luttenberger et al., 2018). According to Westfall et al. (2021), math anxiety significantly hinders people from pursuing mathematics proficiency. Moreover, Mutlu (2019) states that having high math anxiety harms the mathematical performance of those who have it. Individuals with math anxiety find it challenging to handle math- or number-related information and tasks in everyday life and school. Math anxiety interferes with processing knowledge and activities relating to math or numbers. (Commodari & La Rosa, 2021). According to Aarnos & Perkkila (2012), "Mathematics anxiety refers to individual's negative affect when engaging in numerical and mathematical tasks" (p. 1495). Furthermore, Luttenberger et al. (2018) mentioned in their study that those with math anxiety are affected in the emotional, cognitive, and physiological aspects, resulting in fewer accomplishments.

Different factors cause math anxiety (Rozgonjuk, 2020). Math anxiety may be influenced by the environment, culture, educational system, parents' and teachers' attitudes toward math, their students, and children (Luttenberger et al., 2018). According to Luttenberger et al. (2018), "compared to men, women have higher prevalence rates across all anxiety-disorder categories" (p. 312). Several theories explain why girls tend to have higher math anxiety levels than boys. Some discuss genetic-biological differences and social-environmental factors (Levy et al., 2021).

Math anxiety has been known to impact individuals' mathematical abilities negatively. Pizzie and Kraemer (2017) found that when exposed to mathematics, highly math-anxious individuals lead to a reaction related to threat avoidance. Mathematically anxious students exhibited lower numerical intelligence and exposed mathematical deficits (Schillinger et al., 2018). Similarly, students with high levels of math anxiety were associated with poor academic performance (Núñez-Peña & Bono, 2019). The 2015 study by Wang et al. showed a modest negative association between math anxiety and performance in respondents with low levels of intrinsic motivation. Associations between Mathematics and anxiety were stronger than those between Mathematics and calmness (Schmitz et al., 2019). The study by John et al. (2020) discovered that individuals with consistent positive experiences with math report lower math anxiety, while others with consistent negative experiences tend to avoid math in the future.

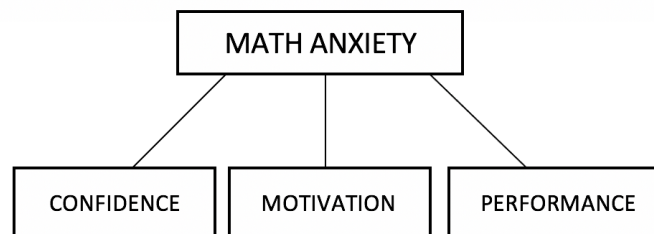
Research Method

The current study is based on Attentional Control Theory (Derakshan & Eysenck, 2009) and Control-Value Theory (Pekrun, 2006). On the one hand, Derakshan and Eysenck (2009) state that anxiety at the heart of attention control theory is projected to affect performance. On the other hand, Pekrun (2006) states that "the control-value theory implies that students' emotions can be positively influenced by fostering their perceptions of competence and control over academic activities and outcomes, and by shaping their appraisals of the values of these activities and outcomes" (p. 334).

In this research, the factors of math anxiety are based on the definitions given by Ashcraft (2002) and Maloney et al. (2011). Ashcraft (2002) explains that math anxiety is related to decreased motivation and self-confidence in mathematics, while Maloney et al. (2011) state that Math anxiety has negatively impacted mathematics performance. It was found that mathematics anxiety has consistently inhibited an individual's mathematics performance and attitudes toward the subject, including interest and confidence in mathematics (Novak & Tassell, 2017). The three clusters below contribute to math anxiety: confidence, motivation, and performance.

Figure 1

Math anxiety and its relationships with confidence, motivation, and performance



Confidence

People who are not confident or think they are not good at math are more likely to have anxiety (Dowker et al., 2016). Students who are highly confident in their mathematical abilities are less anxious about it.

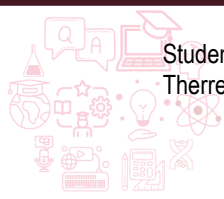
Motivation

The findings of Meece et al. (1990) reveal that affective and motivational factors shape students' pursuit of mathematics; this means that motivation is a factor in math anxiety. Hembree (1990) states that higher math anxiety was related to less enjoyment and less motivation in math. If students are motivated, then they have less anxiety. The results of the study by Mamolo (2022) showed that "students in the online mode of instruction got a significant decrease in their motivation and self-efficacy while maintaining High Anxiety" (p. 7). Student motivation is a factor in which self-efficacy affects performance (Skaalvik et al., 2015).

Performance

The study of Ramirez et al. (2016) concludes that math anxiety can negatively affect students' academic performance. Higher math anxiety is associated with lower math performance (Foley et al., 2017). The research aims to determine whether there is an increase in junior high school students' perceived math anxiety when classes are shifted online. The study's results will enlighten teachers about students' perceptions regarding online learning. It will help plan, prepare, and modify learning plans to cater to students' learning needs and address math anxiety.

Few studies investigated how students' perception of math anxiety increased during the shift from traditional face-to-face classes to online classes. Most of the available research articles about math anxiety discuss Math anxiety and its relationship with motivation and achievement (Ramirez et al., 2016; Justicia-Galiano et al., 2017; Pantoja et al., 2020; Barroso et al., 2021), the role of parents and teachers (Novak et al., 2017; Szczygiel, 2020; Silver et al., 2021; Becker et al., 2022), and gender difference (Xie et al., 2019; Van Mier et al., 2019; Wang et al., 2021; Levy et al., 2021).



Current study

The research aims to determine students' perceptions of their math anxiety when transitioning from traditional face-to-face to online classes. The sudden shift to online classes may have increased the anxiety levels perceived by the students, which is why the researchers found this topic relevant to investigate.

This research study aims to address the following research questions:

1. Is there an increase in students' perceived math anxiety level when they shifted to online class learning?
2. Is there a significant difference in student's perception of their math anxiety level increase towards online learning across grade levels?
3. Is there a significant gender difference in perceived math anxiety during online learning?

Methodology

A survey tool was used to determine student's perceptions of their anxiety increase. The survey consists of 15-item statements, and the respondents must choose their level of agreement.

Procedure

The survey was conducted online through Google Forms. The link for the Google form was sent through the adviser for each section.

Instrument

The survey tool consists of 15 items divided into three clusters: confidence, motivation, and performance. The clusters were based on the definitions of Math anxiety from the studies of Ashcraft (2002) and Maloney et al. (2011). Each participant was asked to rate each item based on their agreement using a 4-point Likert scale. The descriptive ratings of the 4-point Likert scale were as follows: 1 - Strongly Disagree, 2 - Disagree, 3 - Agree, and 4 - Strongly Agree. The survey tool has a Cronbach alpha of 0.886.

Participants

The survey respondents were junior high school students from grades 7 to 10. A total of 120 junior high school students participated in the study. There were 46 males and 74 females. The participants were students from a private high school in Manila.

The figures below show the demographic information of the participants.

Figure 1
Gender

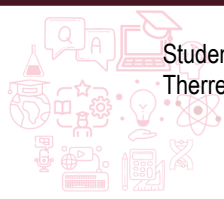
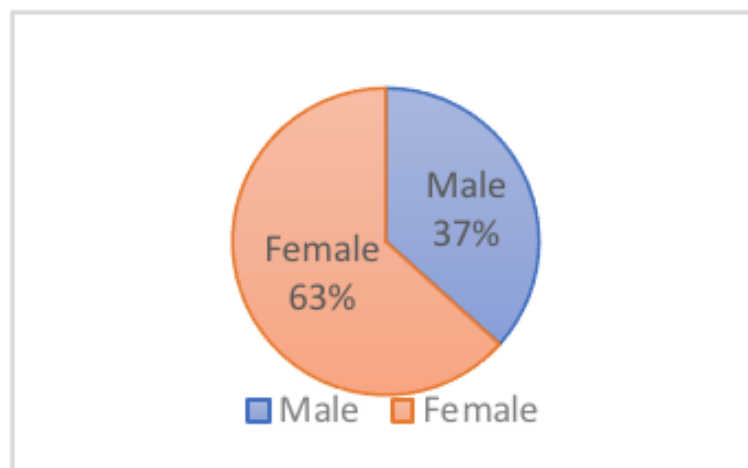


Figure 2
Grade level

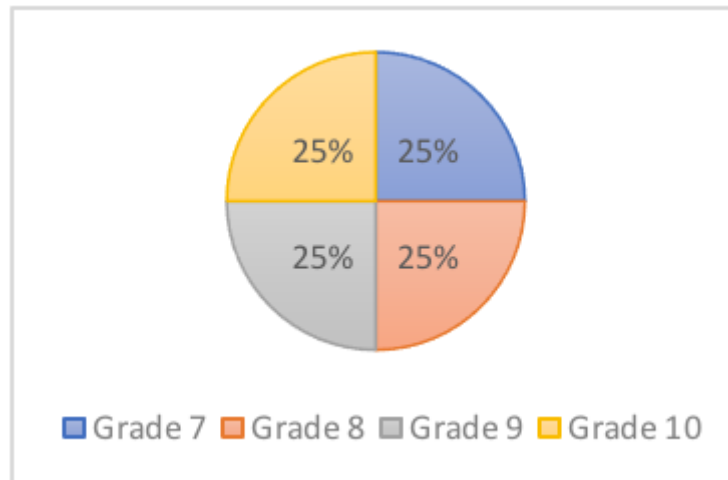
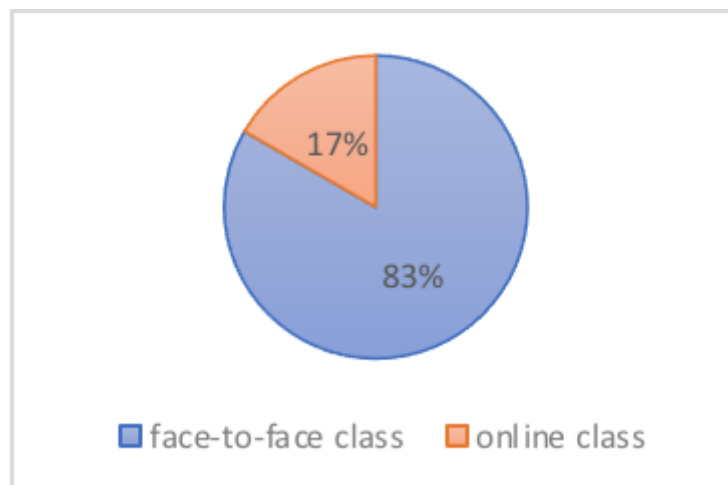


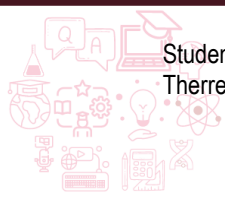
Figure 3
Learning preference



100 out of 120 respondents (83%) preferred face-to-face classes over online classes. It shows that most students would choose face-to-face classes over online classes if given an option.

Statistical Techniques

The research utilized both descriptive statistics and inferential statistics. For descriptive statistics, the Measures of Central Tendency and Variation were used to measure students' agreement regarding their perceived math anxiety level (mean and standard deviation). Suitable scales were generated to describe students' agreement. These scales describe the data gathered: 0.01 - 0.10, absolutely no agreement; 1.01 - 2.00 without agreement; 2.01 - 3.00, approaching agreement; 3.01 - 4.00 totally in agreement. For inferential statistics, One-way ANOVA was used to determine the significant difference in student's perception of their Math anxiety level across grade levels. In contrast, an independent sample t-test was used to examine gender differences. All analyses were performed in SPSS, and the level of confidence is at $\alpha = 0.05$.



Results and Discussion

Students' perception

Table 1
Mean and Standard deviation of Students' perception

Factors	M	SD
Confidence	2.897	0.881
Motivation	3.208	0.764
Performance	2.635	0.877
Overall Perception	2.913	0.840

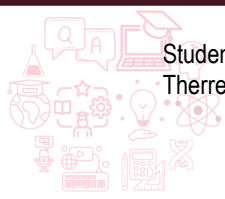
Table 1 shows the mean and standard deviation of each factor affected by math anxiety and students' overall perception.

Confidence. The mean of 2.897 shows that students agree that their confidence in mathematics decreased during online classes. Due to adjustments brought about by the sudden shift in the educational system, students might be less confident with their math ability.

Motivation. The mean of 3.208 shows that students agree that their motivation in mathematics declined during online classes. The lack of physical interaction and engagement with peers and teachers may cause decreased motivation.

Performance. The mean of 2.635 shows that students agree that their performance in mathematics was negatively affected by the shift to online classes. Fischer et al. (2020) stated that students' inability to self-direct their learning experiences may cause performance gaps between online and face-to-face coursework.

Among the three factors affected by math anxiety, motivation garnered the highest mean score of 3.208, meaning that motivation was the most affected. The overall perception of 2.913 means that students agree that there was an increase in their perceived math anxiety level when schools shifted from traditional face-to-face classes to online classes. Because of familiarity and conventionality, students may be more inclined to face-to-face classes than online classes. The sudden shift of learning may have brought significant adjustments to students regarding academic and social interaction, resulting in increased perceived math anxiety levels.



Grade levels

Table 2

One-way analysis of variance of mean scores of students by Grade level

Source	df	SS	MS	F	p
Between groups	3	4.513	1.504	4.393	0.006
Within groups	116	39.725	0.342		
Total	119	44.239			

Table 2 shows data analysis by One-Way ANOVA, which was conducted to compare the mean scores on students' perception of Math anxiety across different grade levels. Analysis of variance showed a statistically significant difference at the $p < 0.05$ level in mean scores for the four grade levels: $F(3, 116) = 4.393$, $p = 0.006$. Since the level of confidence chosen is **0.05** and the One-way ANOVA generated p-value is 0.006, it means there is a statistically significant difference between the grade levels.

Gender Difference

Table 3

*Independent t-test
Gender difference*

Gender	n	Mean	SD	SE	t	p
Male	44	2.7500	0.63557	0.09582	-2.031	0.44
Female	76	2.9816	0.58116	0.06672		

Table 3 shows the computed p-value of 0.44, which is greater than 0.05; we can conclude from this that insufficient evidence shows a statistically significant difference between the genders. The results are contrary to the finding of Else-Quest et al. (2010), which states that girls had significantly higher math anxiety than boys despite the minimal gender differences in math performance.

Conclusion

Based on the findings, most students preferred face-to-face classes over online ones. It was also found that there was an increase in the perceived math anxiety level of students when they shifted to online learning. According to Bower (2019), a lack of confidence in using technology or a lack of sense of cognitive and social interaction may affect students' learning; this is a possible reason why most students prefer face-to-face classes. Due to the sudden shift in the teaching and learning modality, students were surprised and unprepared to participate in online classes. We expect that, through time, learners will be able to adapt to the new learning environment with the guidance and help of their teachers. The findings also show a statistically significant difference in the perception of math anxiety level increase across the four grade levels, probably due to the different Math topics and learning encounters experienced in each grade level. Lessons and activities in Mathematics also vary in ease; some are easily transferred to the online setup, while others are not. Lastly, the findings of this research paper also show that female students' perception of their math anxiety level increase did not differ significantly from their male counterparts, which is contrary to the study of Hill et al. (2016). The study by Hill et al. (2016) indicated that girls had higher math anxiety scores than boys in primary and secondary students, but there was no gender difference in math performance.

In conclusion, there was an increase in the math anxiety level of students when they shifted to online learning based on their perceptions. Moreover, there is a statistically significant difference in the perception of math anxiety level increase across the four grade levels. Furthermore, no significant gender difference exists in their perception of math anxiety level increase.

Limitations and Recommendations

The current study is limited to students' perspective of their math anxiety level increase. This research does not measure students' exact math anxiety levels nor its relation to performance and achievement. It only focuses on students' attitudes toward the increase in their math anxiety level when they shifted to online classes. Other researchers may focus on factors contributing to increasing math anxiety for further studies. They may also measure the specific amount of math anxiety level increase felt by the students during online classes. They can also conduct a comparative study regarding the math anxiety levels of students in online and traditional face-to-face learning.

Educational Implications

Finding that students perceived their math anxiety levels increased, teachers should innovate different learning strategies to help students learn better and lessen their anxiety. In line with this, teachers should help students increase their self-efficacy. The study of Rozgonjuk et al. (2020) states that math self-efficacy has a significant impact on math anxiety, and improving students' self-efficacy can help lessen anxiety. The teacher is essential in alleviating students' math anxiety.

The study by Johnson & vanderSandt (2011) discussed how the teacher could influence students' anxiety. If teachers have math anxiety, they may pass it to their students, negatively affecting their math achievement. It is a must that teachers should have low math anxiety levels or be utterly devoid of it.

Gamification in teaching and learning is recommended to increase students' motivation and engagement online. Castillo et al. (2020) state that gamification strategies in education can bring higher student motivation and engagement. Through gamification, students will enjoy and have fun while learning. Teachers can provide online collaborative activities that will stimulate interaction among the students.

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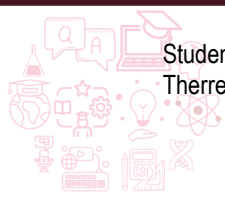


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