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Senior high school students' Mathematics anxiety through learning modalities and digital tools utilization

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Abstract

Aim: This study examined how learning modalities and digital tools utilization relate to mathematics anxiety among Grade 12 learners at Liceo de Cagayan University–Main Campus during the Academic Year 2025–2026, with the goal of identifying instructional conditions that may influence students' emotional experiences in mathematics learning.

Methodology: A predictive-correlational research design was employed. Using proportionate stratified random sampling, 338 Grade 12 students participated in the study. An expert-validated and pilot-tested survey questionnaire measured students' perceptions of face-to-face, synchronous, asynchronous, and blended learning; utilization of educational applications, online resources, and learning management systems; and five dimensions of mathematics anxiety. Data were analyzed using descriptive statistics, Pearson product–moment correlation, and multiple regression analysis at a .05 level of significance.

Results: Face-to-face learning was perceived most favorably, while synchronous, asynchronous, and blended learning were rated moderately effective. Digital tools were utilized at a moderate level, with learning management systems used most frequently. Mathematics anxiety was also found to be moderate, with higher levels reported in test-related contexts. No significant relationship was found between mathematics anxiety and learning modalities. However, mathematics anxiety showed a weak positive relationship with digital tools utilization. Multiple regression analysis further revealed that higher digital tool utilization significantly predicted increased mathematics anxiety, whereas a stronger preference for face-to-face learning significantly predicted lower anxiety levels.

Conclusion: The findings suggest that strong face-to-face instruction may help reduce mathematics anxiety, while frequent or poorly structured use of digital tools may contribute to increased anxiety. The results highlight the importance of designing mathematics instruction that preserves the strengths of in-person learning while ensuring that digital tools are integrated in a purposeful, structured, and pedagogically sound manner to support positive learning outcomes.

Keywords: *digital tools, mathematics anxiety, learning modalities, learning management systems, senior high school*

INTRODUCTION

Mathematics anxiety is a widespread educational concern that affects students' academic performance, motivation, and emotional well-being. As mathematics plays a central role in developing critical thinking, problem-solving, and logical reasoning skills, it remains a foundational subject in preparing learners for Science, Technology, Engineering, and Mathematics (STEM)-related fields. However, many students experience fear, tension, and nervousness when engaging in mathematical tasks, which can interfere with learning, weaken participation, reduce self-confidence, and discourage the pursuit of mathematics-related careers.

This concern has become more pronounced in the context of changing educational delivery systems, particularly following the COVID-19 pandemic. The transition to synchronous, asynchronous, and blended learning modalities required students to adapt to new and unfamiliar learning environments (Adnan & Anwar, 2020). Although these modalities offered flexibility and continuity of instruction, they also introduced new academic and psychological challenges. Synchronous learning often required immediate participation and response, which may heighten pressure and anxiety (Hodges et al., 2020). In contrast, asynchronous learning may have reduced opportunities for interaction and timely feedback, contributing to feelings of isolation and decreased motivation (Akpen et al., 2024). Blended learning combined the features of face-to-face and online instruction, but also demanded that students manage the complexities of both formats (Sarkar & Sharma, 2020).

Alongside these changes in learning modalities, the use of digital tools has become increasingly significant in mathematics education. Digital platforms, applications, and online resources can potentially enhance engagement, support independent learning,

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and improve access to instructional materials. However, their effectiveness depends not only on the availability of these tools, but also on students' level of digital literacy, access to devices, and the quality of internet connectivity. When these conditions are inadequate, or when digital tools are overused or ineffectively implemented, students may experience cognitive overload, stress, and disengagement instead of meaningful learning support. This suggests that digital tools may function as either a protective or a risk factor in mathematics learning. In a recent study based on PISA 2022 data, digital learning resource accessibility was significantly related to math-learning anxiety among high school students, while teacher support and sense of school belonging moderated those relationships (Wang et al., 2025). Similarly, studies have shown that digital interventions may help alleviate anxiety in some contexts (Riboldi et al., 2022), whereas excessive or unstructured use of digital devices may be associated with lower academic performance and a reduced sense of belonging (Lee, 2024).

Despite the growing body of literature on learning modalities and digital technology, limited studies have examined how these factors jointly influence mathematics anxiety, particularly among senior high school students. Much of the existing research has focused either on the benefits of digital tools in general learning environments or on anxiety in broader educational and psychological contexts. There remains a need to better understand how students' experiences with different learning modalities and their utilization of digital tools relate to their mathematics anxiety, especially within the Philippine setting, where disparities in internet access, device availability, and digital readiness remain evident.

In the local context, these issues are especially relevant among senior high school students who continue to experience varied instructional approaches and technology-mediated learning. Differences in access to digital resources, familiarity with online platforms, and adaptability to learning environments may shape how students respond emotionally and academically to mathematics. Examining these relationships is important in identifying the factors that may either intensify or reduce mathematics anxiety.

Hence, this study investigated the mathematics anxiety of senior high school students in relation to learning modalities and digital tools utilization. Specifically, it sought to determine how students' learning experiences and use of digital tools are associated with their level of mathematics anxiety. The findings of the study may contribute to the development of more responsive instructional practices and intervention strategies that promote students' confidence, engagement, and success in mathematics. In doing so, the study also supports broader educational goals of inclusive and equitable quality education, consistent with Sustainable Development Goal 4.

Review of Related Literature and Studies

This section reviews recent literature on mathematics anxiety in relation to learning modalities and digital tools utilization. It focuses on how instructional environments and technology-based learning experiences influence students' emotional responses to mathematics, then identifies the research gap addressed by the study.

Learning Modalities

Learning modalities shape how mathematics is taught and experienced. Because mathematics often requires interaction, feedback, and guided practice, the mode of delivery may affect both learning and anxiety.

Face-to-face learning remains important because it allows direct interaction, immediate feedback, and collaborative problem-solving. These features have been linked to lower mathematics anxiety and stronger feelings of competence and support (Balt et al., 2022; Pizzie & Kraemer, 2023).

Synchronous learning supports real-time communication through online platforms. It can reduce isolation and improve confidence by allowing students to ask questions and receive immediate clarification (Lowenthal et al., 2022). However, its effectiveness depends on connectivity, device access, and students' readiness to participate online.

Asynchronous learning offers flexibility and self-paced study, which may benefit students who need more time to process mathematical ideas (Hodges et al., 2020; Huang & Liu, 2024). Still, reduced interaction and delayed feedback may increase disengagement and anxiety, particularly among learners with weaker self-regulation (Fabriz et al., 2021).

Blended learning combines classroom instruction with online components. It may improve engagement, independence, and problem-solving when both components are well integrated (Ding, 2024; Nida et al., 2020). However, poor implementation and technological demands may also create additional stress (Rasheed et al., 2020).

Overall, the literature suggests that modalities that provide interaction, timely feedback, and structured support are more likely to reduce mathematics anxiety.

Digital Tools in Mathematics Education

Digital tools have become central to mathematics education because they offer interactive, flexible, and personalized learning experiences. Educational applications, online resources, and learning management systems may improve understanding and reduce anxiety when they are accessible and well designed (Ersozlu, 2024; Sammallahti et al., 2023).

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Educational applications such as GeoGebra, Desmos, and Kahoot! help students visualize concepts, strengthen engagement, and build confidence (Chechan et al., 2023; Wang & Tahir, 2020). Online resources such as video tutorials and interactive e-books allow students to revisit difficult lessons at their own pace and may reduce performance-related stress (Joshi et al., 2023). Learning management systems such as Moodle and Google Classroom provide structure for content delivery, communication, and feedback, and have been linked to better engagement and reduced anxiety when effectively used (Adnan & Anwar, 2020; Hadi et al., 2021).

In general, digital tools can support mathematics learning when they are integrated purposefully. However, access issues, digital literacy, and poor instructional design may reduce their benefits and become additional sources of stress (Odekeye et al., 2020).

Mathematics Anxiety

Mathematics anxiety is a persistent barrier to students' achievement, confidence, and participation in mathematics. It is commonly associated with fear, tension, and worry during mathematical tasks. Recent studies show that digital and interactive interventions may help reduce anxiety by making mathematics more accessible and engaging (Mamolo & Sugano, 2023; Ersozlu, 2024). Mathematics anxiety is multidimensional and includes test anxiety, learning anxiety, numerical anxiety, performance anxiety, and evaluation anxiety. Test anxiety is linked to stress during assessments and lower performance (Yarkwah et al., 2024). Learning and numerical anxiety occur during concept learning and number-related tasks, while performance and evaluation anxiety arise when students feel judged or pressured in mathematics situations (Mammarella et al., 2021; Wang, 2023; Mitchell & George, 2022). Across these dimensions, structured feedback, cognitive support, and emotional regulation have been shown to reduce anxiety and improve outcomes (Sammallahti et al., 2023).

Relationship Between Learning Modalities and Mathematics Anxiety

Learning modalities influence how students engage with mathematics and may shape their anxiety levels. Research suggests that anxiety tends to decrease when the learning modality matches students' needs and provides clear structure, support, and timely feedback. Ivan and Maat (2024) found that students with independent and participative learning styles reported lower mathematics anxiety, whereas avoidant and dependent learners were more prone to higher anxiety. Similarly, Khoo et al. (2024) showed that misalignment between instructional approach and learner preference may intensify anxiety, especially in mathematics.

Other studies highlight the importance of immediacy and scaffolding across modalities. Ng et al. (2022) observed that even when digital or asynchronous environments are engaging, anxiety remains higher when students do not receive enough support or feedback. Overall, the literature indicates that learning modalities influence mathematics anxiety not simply by format, but by the quality of interaction, guidance, and instructional support they provide.

Relationship Between Digital Tools Utilization and Mathematics Anxiety

Digital tools can either reduce or heighten mathematics anxiety depending on how they are designed and used. Supportive and user-friendly tools may lessen anxiety by providing feedback, visual support, and adaptive guidance that strengthen confidence and perceived control (Rafiq et al., 2024). In contrast, tools that are complex, poorly integrated, or difficult to use may increase frustration and stress, especially among students with low digital literacy (Peceño-Capilla et al., 2022; Argao et al., 2023).

Research also shows that digital environments promoting engagement, collaboration, and positive emotional experiences may reduce anxiety. Higher levels of flow and self-efficacy have been associated with lower mathematics anxiety, while collaborative platforms may lessen performance and evaluation anxiety by increasing peer support (Schmitt-Cerna et al., 2024). Thus, the value of digital tools depends on their accessibility, purpose, and quality of implementation.

Predictors of Mathematics Anxiety

Mathematics anxiety is shaped by multiple interacting factors rather than a single cause. Prior studies show that fewer adaptive coping strategies, lower achievement, and certain demographic characteristics are associated with higher anxiety (Luu-Thi et al., 2021). Cognitive factors such as reduced attention and weaker spatial abilities have also been linked to poorer mathematics performance and greater anxiety (Geary et al., 2021).

Technology- and learning-related factors also appear important. Supriadi et al. (2024) found that learning anxiety, reasoning, and problem-solving ability influence students' motivation and emotional engagement in mathematics. Ersozlu (2024) similarly noted that well-designed digital environments may reduce anxiety, whereas confusing or poorly structured platforms may intensify it. In the Philippine context, perceived usefulness of technology, online learning readiness, and expectations toward online learning have also been associated with mathematics anxiety and performance (Dodongan, 2022; Gorospe, 2022). More recent evidence suggests that the quality and manner of digital tool use may predict lower anxiety more strongly than frequency of use alone, with teacher support and school belonging acting as important protective factors (Wang et al., 2025).

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Taken together, these studies suggest that learning modalities, digital tools, and contextual support may serve as meaningful predictors of mathematics anxiety. This supports the need to examine how these variables jointly shape senior high school students' emotional experiences in mathematics.

Synthesis of the Literature and Research Gap

The literature shows that both learning modalities and digital tools influence students' experiences in mathematics. Face-to-face and well-supported blended or synchronous settings tend to provide stronger interaction, feedback, and guidance, while digital tools can reduce anxiety when they are accessible, purposeful, and aligned with instruction. At the same time, weak support, technological barriers, and poorly designed learning environments may intensify anxiety.

Although many studies have examined learning modalities, digital tools, and mathematics anxiety, these factors are often studied separately. Limited research has investigated how learning modalities and digital tools utilization jointly relate to mathematics anxiety among senior high school students. This gap justifies the present study, which examines the relationship of these variables and identifies which among them significantly predict mathematics anxiety.

Theoretical Framework

This study is anchored in three complementary theories: Cognitive Load Theory (CLT), Social Learning Theory (SLT), and the Technology Acceptance Model (TAM). These theories explain how learning modalities and digital tools may shape students' mathematics anxiety.

Cognitive Load Theory explains that learning becomes difficult when tasks impose excessive mental demands on learners (Sweller, 1988). In mathematics, abstract concepts and multi-step procedures may increase cognitive load, especially when instructional materials or digital tools are poorly designed. Conversely, tools and learning environments that reduce unnecessary mental effort and provide structured guidance may improve understanding and lessen anxiety (Sweller, 2020).

Social Learning Theory emphasizes the role of observation, interaction, and feedback in learning (Bandura, 1977). In mathematics education, students may develop greater confidence when they can observe problem-solving processes, interact with teachers and peers, and receive timely support. Learning modalities that promote collaboration and social presence may therefore reduce feelings of isolation and anxiety, while limited interaction may increase uncertainty and disengagement.

The Technology Acceptance Model explains that students are more likely to engage with digital tools when they perceive them as useful and easy to use (Davis, 1989). In mathematics learning, digital tools that are accessible, relevant, and user-friendly may support confidence and participation. In contrast, tools that are difficult to navigate or poorly aligned with learning needs may increase frustration and anxiety (Setälä et al., 2025).

Taken together, these theories suggest that mathematics anxiety is influenced not only by the difficulty of mathematical content but also by instructional conditions, social interaction, and students' experiences with digital tools. These theoretical perspectives guided the present study in examining how learning modalities and digital tools utilization relate to mathematics anxiety among senior high school students.

Conceptual Framework

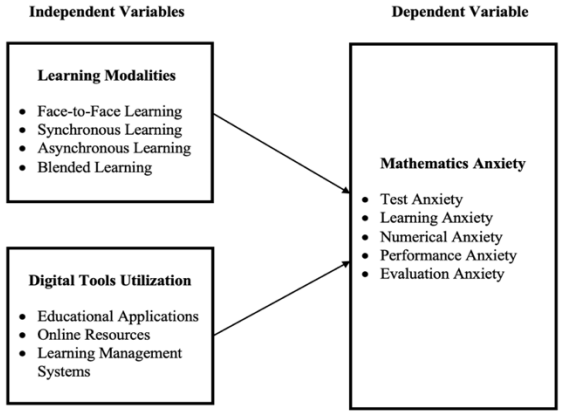

Figure 1. Schematic Diagram Illustrating the Senior High School Students' Mathematics Anxiety through Learning Modalities and Digital Tools Utilization

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The study was anchored on the assumption that learning modalities and digital tools utilization influence mathematics anxiety among senior high school students. Learning modalities were examined in terms of face-to-face, synchronous, asynchronous, and blended learning, while digital tools utilization included educational applications, online resources, and learning management systems. Mathematics anxiety was treated as the dependent variable and was assessed across five dimensions: test anxiety, learning anxiety, numerical anxiety, performance anxiety, and evaluation anxiety. The framework assumes that students' experiences with learning modalities and their use of digital tools may significantly relate to and predict their level of mathematics anxiety.

Statement of the Problem

Mathematics anxiety remains a persistent educational challenge that affects students' academic performance, confidence, and participation in mathematics learning. In recent years, changes in instructional delivery systems and the increasing integration of digital technologies in education have transformed the learning experiences of students. Learning modalities such as face-to-face, synchronous, asynchronous, and blended learning, together with the growing use of digital tools, have created new opportunities for mathematics instruction but may also introduce additional sources of academic stress and anxiety for learners.

Among senior high school students, mathematics anxiety may be influenced by how mathematics is taught and how digital tools are integrated into instruction. While digital platforms, applications, and online resources can support interactive and flexible learning, poorly structured or excessive use of these technologies may contribute to cognitive overload and emotional pressure. At the same time, different learning modalities may provide varying levels of instructional support, interaction, and feedback that can either alleviate or intensify students' anxiety toward mathematics.

Despite the increasing integration of digital technologies and alternative learning modalities in mathematics education, limited research has examined how these instructional conditions collectively influence mathematics anxiety among senior high school students. Understanding these relationships is important in developing instructional practices and technology integration strategies that support students' emotional well-being and academic success in mathematics.

Hence, this study examined the mathematics anxiety of senior high school students in relation to learning modalities and digital tools utilization. Specifically, the study investigated students' perceptions of learning modalities, their level of digital tools utilization in mathematics learning, the level of mathematics anxiety they experience, and the relationships among these variables.

Research Objectives

General Objective

To examine the mathematics anxiety of senior high school students in relation to learning modalities and digital tools utilization.

Specific Objectives

1. To determine the level of senior high school students' perceptions of learning modalities in terms of:
    - face-to-face learning
    - synchronous learning
    - asynchronous learning
    - blended learning
2. To determine the level of digital tools utilization in the mathematics learning experiences of senior high school students in terms of:
    - educational applications
    - online resources
    - learning management systems
3. To determine the level of mathematics anxiety among senior high school students in terms of:
    - test anxiety
    - learning anxiety
    - numerical anxiety
    - performance anxiety
    - evaluation anxiety
4. To examine the significant relationship between mathematics anxiety and:
    - learning modalities
    - digital tools utilization
5. To identify which variables—learning modalities, digital tools utilization, or their combinations—significantly predict mathematics anxiety among senior high school students.

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Research Questions

1. What is the level of perception of senior high school students on the various learning modalities in terms of:
    - face-to-face learning
    - synchronous learning
    - asynchronous learning
    - blended learning?
2. What is the level of digital tools utilization in the mathematics learning experience of senior high school students in terms of:
    - educational applications
    - online resources
    - learning management systems?
3. What is the level of mathematics anxiety among senior high school students in terms of:
    - test anxiety
    - learning anxiety
    - numerical anxiety
    - performance anxiety
    - evaluation anxiety?
4. Is there a significant relationship between mathematics anxiety and:
    - learning modalities?
    - digital tools utilization?
5. Which among the variables—learning modalities, digital tools utilization, or their combinations—significantly predict mathematics anxiety among senior high school students?

Hypotheses

H_{o1}: There is no significant relationship between the students' levels of mathematics anxiety and the learning modalities and digital tools utilization.

H_{o2}: None of the variables—learning modalities, digital tools utilization, or their combinations—significantly predict mathematics anxiety among senior high school students.

Methodology

Research Design

This study used a quantitative predictive-correlational design. This non-experimental design was appropriate because it examined the relationships among learning modalities, digital tools utilization, and mathematics anxiety without manipulating the variables (Creswell & Creswell, 2022; Gray, 2022).

The design was applied by collecting survey data from Grade 12 students and analyzing whether learning modalities and digital tools utilization were significantly associated with, and predictive of, mathematics anxiety. In this study, learning modalities and digital tools utilization served as the predictor variables, while mathematics anxiety was the outcome variable. This made the design appropriate for identifying significant relationships and predictors of students' mathematics anxiety (Babbie, 2020).

Population and Sampling

The participants of the study were 338 Grade 12 students enrolled at Liceo de Cagayan University–Main Campus during the School Year 2025–2026. They were drawn from a total population of 2,786 students across six academic strands: ABM (408), HUMSS (470), STEM (1,545), AD (53), HE (123), and ICT (187). Grade 12 students were selected because they were actively engaged in mathematics-related subjects and were therefore considered appropriate for examining the relationship of learning modalities and digital tools utilization with mathematics anxiety.

The sample size was determined using the Raosoft sample size calculator at a 95% confidence level and 5% margin of error, which yielded a minimum sample of 338 students. To ensure fair representation of each strand, the study used proportionate stratified random sampling. Based on this procedure, the final sample included 49 students from ABM, 57 from HUMSS, 188 from STEM, 6 from AD, 15 from HE, and 23 from ICT. This sampling technique was appropriate because it ensured proportional subgroup representation and reduced sampling bias, allowing the findings to reflect the characteristics of the overall Grade 12 population.

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Research Instruments

Data were gathered using an adapted survey questionnaire composed of three sections: learning modalities, digital tools utilization, and mathematics anxiety. The instrument was modified from established measures to fit the context of senior high school mathematics education, and all sections used a 5-point Likert scale.

The learning modalities section measured students' perceptions of face-to-face, synchronous, asynchronous, and blended learning. Items were adapted from the Community of Inquiry Survey, the Web-Based Learning Environment Instrument, and the Blended Learning Scale (Arbaugh et al., 2008, as cited in Carroll et al., 2024; Chang & Fisher, 2003, as cited in Ahmad et al., 2021; Thendral & Ganesan, 2022).

The digital tools utilization section measured students' use of educational applications, online resources, and learning management systems. Items were adapted from the Web-Based Learning Environment Instrument, the Blended Learning Scale, and related studies on digital learning tools (Chang & Fisher, 2003, as cited in Ahmad et al., 2021; Thendral & Ganesan, 2022; Ababa et al., 2021; Asyari, 2024).

The mathematics anxiety section measured test anxiety, learning anxiety, numerical anxiety, performance anxiety, and evaluation anxiety. Items were adapted from the Abbreviated Math Anxiety Scale, the Shortened Math Anxiety Rating Scale, and the Mathematics Anxiety Scale for Children (Hopko et al., 2003, as cited in Ikeda et al., 2025; Alexander & Martray, 1989, as cited in Maldonado Moscoso et al., 2021; Chiu & Henry, 1990, as cited in Primi et al., 2020).

Content Validation

The survey questionnaire was first subjected to content validation to ensure that the items were clear, relevant, and aligned with the objectives of the study. Four experts in the areas of educational research, educational technology, psychometrics, and mathematics reviewed the instrument. Their comments and suggestions were used to refine items that appeared ambiguous or misaligned with the constructs being measured.

Based on the validators' feedback, minor wording revisions were made to improve clarity and appropriateness. All indicators were retained, as they were found to be relevant and representative of the variables under investigation. These revisions helped establish the content validity of the instrument for measuring learning modalities, digital tools utilization, and mathematics anxiety among senior high school students.

Reliability Testing

After content validation, the instrument was pilot-tested with 30 students from one HUMSS section and one STEM section who had similar characteristics to the target participants but were not included in the main study. The pilot data were analyzed to determine the internal consistency of the questionnaire using Cronbach's alpha. A coefficient of 0.70 or higher was considered acceptable for reliability.

The pilot test results showed excellent reliability across all subscales. For learning modalities, Cronbach's alpha coefficients were 0.964 for face-to-face learning, 0.914 for synchronous learning, 0.943 for asynchronous learning, and 0.969 for blended learning. For digital tools utilization, the coefficients were 0.910 for educational applications, 0.910 for online resources, and 0.973 for learning management systems. For mathematics anxiety, the coefficients were 0.950 for test anxiety, 0.958 for learning anxiety, 0.963 for numerical anxiety, 0.950 for performance anxiety, and 0.966 for evaluation anxiety. All item-total correlations met the acceptable criterion, and no item was removed. These results indicated that the instrument was reliable for use in the main study.

Data Collection Procedure

Prior to data collection, approval to conduct the study was secured from the appropriate university and school authorities. The research protocol was also submitted for ethics review, and all procedures followed institutional ethical standards for voluntary participation, confidentiality, and informed consent. For participants below legal age, parental consent and student assent were obtained before inclusion in the study.

After approval, the final survey questionnaire was administered through Google Forms. The instrument was distributed only to eligible Grade 12 students who had prior exposure to digital tools in mathematics instruction during Grade 11. Eligibility was confirmed in consultation with mathematics teachers, while students without such exposure were excluded from the study. Participation was voluntary, and respondents were informed that they could withdraw at any time without penalty.

To support accurate recall, participants were first asked to reflect on their Grade 11 mathematics learning experiences before answering the survey. Completion of the questionnaire required approximately 10 to 15 minutes. No personally identifying information was collected, and all responses were treated confidentially and used solely for academic purposes. This procedure helped ensure that the data were gathered systematically, ethically, and in a manner consistent with the objectives of the study.

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Treatment of Data

The data were analyzed using both descriptive and inferential statistics. Prior to analysis, the dataset was screened for completeness and checked for the assumptions required for parametric testing. Mean and standard deviation were used to determine the level of students' perceptions of learning modalities, digital tools utilization, and mathematics anxiety. Pearson product-moment correlation was applied to examine the relationships among mathematics anxiety, learning modalities, and digital tools utilization. Multiple regression analysis was then used to identify which variables significantly predicted mathematics anxiety. All analyses were conducted at a .05 level of significance.

Ethical Considerations

This study observed ethical standards for research involving human participants. Prior to data collection, permission was secured from the appropriate school authorities, and the study underwent ethics review. Participation was voluntary, and respondents were informed of the purpose of the study, their right to withdraw at any time, and the confidential handling of their responses. For minors, parental consent and student assent were obtained. No personally identifiable information was collected, and all data were used solely for academic purposes, stored securely, and reported only in summarized form.

RESULTS and DISCUSSION

This section presents the results of the study through the analysis and interpretation of the data gathered. The findings are organized according to the research questions. Tables and narrative discussion are used to provide a clear understanding of the level of students' perceptions of learning modalities and the level of digital tools utilization in mathematics learning.

1. Level of perception of senior high school students on the various learning modalities

Table 1 shows that the overall mean for learning modalities was 3.32 (SD = 0.559), interpreted as moderately effective. This indicates that students generally viewed the available learning modalities as helpful in mathematics, although not to the same degree. The low standard deviation suggests that students' perceptions were relatively consistent across modalities.

Table 1. Summary of Results of Mean and Standard Deviation for the Level of Perception of Senior High School Students on the various Learning Modalities

Sub-constructs	Mean	SD	Description	Interpretation
Face-to-face learning	4.03	.791	Agree	Effective
Synchronous learning	2.96	.788	Moderately Agree	Moderately Effective
Asynchronous learning	3.02	.877	Moderately Agree	Moderately Effective
Blended learning	3.27	.811	Moderately Agree	Moderately Effective
Overall Mean	**3.32**	**.559**	**Moderately Agree**	**Moderately Effective**

Among the four modalities, face-to-face learning obtained the highest mean (M = 4.03, SD = 0.791), indicating that it was perceived as the most effective. This suggests that students still value direct teacher guidance, immediate clarification, and classroom interaction in learning mathematics. This finding supports the study of Balt et al. (2022), who emphasized the role of teacher presence and emotional support in reducing mathematics anxiety, and Mitchell and George (2022), who found lower anxiety levels in traditional mathematics classes.

Blended learning ranked second (M = 3.27, SD = 0.811), showing that students moderately valued the combination of face-to-face instruction and online support. This suggests that while students appreciate the flexibility of blended learning, they still depend on the structure and immediacy of in-person teaching. This is consistent with Sari and Priatna (2020) and Ding (2024), who noted that blended learning can enhance engagement and autonomy when properly structured.

By contrast, synchronous learning (M = 2.96, SD = 0.788) and asynchronous learning (M = 3.02, SD = 0.877) received the lowest ratings, although both remained in the moderately effective range. These findings suggest that students accept online learning modalities, but view them as less effective than face-to-face learning. This may be due to distractions, connectivity issues, and the greater self-regulation required in online settings. Similar concerns were reported by Lowenthal et al. (2022), Hodges et al. (2020), and Fabriz et al. (2021), who found that online learning can be beneficial but may weaken engagement and support when feedback and interaction are limited.

Overall, the findings indicate that students perceived learning modalities in mathematics as moderately effective, with face-to-face learning emerging as the most preferred modality. For educational practice, this suggests that alternative modalities may be strengthened by incorporating clearer guidance, timely feedback, and stronger teacher presence to better support students' learning and confidence in mathematics.

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2. Level of digital tools utilization in the mathematics learning experience of senior high school students

Table 2 shows that the overall mean for digital tools utilization was 3.33 (SD = 0.689), interpreted as moderate utilization. This indicates that students sometimes used digital tools in learning mathematics. The low standard deviation suggests a fairly consistent pattern of digital engagement among respondents.

Table 2. Summary of Results of Mean and Standard Deviation for the Level of Digital Tools Utilization in the Mathematics Learning Experience of Senior High School Students

Sub-constructs	Mean	SD	Description	Interpretation
Educational applications	3.24	.826	Sometimes	Moderate Utilization
Online resources	3.30	.815	Sometimes	Moderate Utilization
Learning management systems	3.45	.849	Sometimes	Moderate Utilization
Overall Mean	**3.33**	**.689**	**Sometimes**	**Moderate Utilization**

Among the three sub-constructs, learning management systems obtained the highest mean (M = 3.45, SD = 0.849), indicating that students relied more on platforms such as Google Classroom, Moodle, Quipper, or EduQuest for accessing materials, submitting tasks, and reviewing lessons. This suggests that students are more likely to use digital tools that are directly integrated into school routines and teacher-managed instruction. This finding is consistent with Adnan and Anwar (2020), Shaame (2020), and Goh and Yang (2021), who emphasized that LMS platforms are most effective when they are meaningfully integrated into instruction and support engagement and organization.

Online resources ranked second (M = 3.30, SD = 0.815), indicating moderate utilization. This suggests that students used video tutorials, websites, and similar resources to supplement mathematics learning, mainly for review and reinforcement. This supports McKain (2019) and Joshi et al. (2023), who found that online resources promote flexible and self-paced learning while helping students revisit difficult content.

Educational applications obtained the lowest mean (M = 3.24, SD = 0.826), although they were still moderately utilized. This indicates that tools such as GeoGebra, Desmos, Kahoot!, or Photomath were used less often than LMS platforms and online resources. This suggests that students may view these applications as supplementary rather than essential tools. This interpretation agrees with Chechan et al. (2023), and Wang and Tahir (2020), who noted that educational applications are most beneficial when they are purposefully integrated into classroom activities.

Overall, the findings indicate that students demonstrated moderate utilization of digital tools in mathematics, with the strongest reliance on learning management systems. For educational practice, this suggests that digital tools are more meaningful to students when they are structured, teacher-guided, and directly connected to mathematics learning tasks.

3. Level of mathematics anxiety among senior high school students

Table 3 shows that the overall mean for mathematics anxiety was 3.38 (SD = 0.961), interpreted as moderate. This indicates that students sometimes experienced mathematics anxiety. The finding suggests that anxiety was present in mathematics learning, although it was not equally strong across all situations.

Table 3. Summary of Results of Mean and Standard Deviation for the Level of Mathematics Anxiety

Sub-constructs	Mean	SD	Description	Interpretation
Test anxiety	3.64	1.05	Often	High
Learning anxiety	3.19	1.03	Sometimes	Moderate
Numerical anxiety	3.20	1.07	Sometimes	Moderate
Performance anxiety	3.44	1.14	Sometimes	Moderate
Evaluation anxiety	3.44	1.06	Sometimes	Moderate
Overall Mean	**3.38**	**.961**	**Sometimes**	**Moderate**

Among the five sub-constructs, test anxiety obtained the highest mean (M = 3.64, SD = 1.05), indicating that it was the most prominent form of anxiety experienced by students. This suggests that examinations and time-pressured assessments were the strongest sources of stress in mathematics. The finding supports Yarkwah et al. (2024), who reported that fear of failure, weak concept mastery, and exam pressure significantly contribute to test anxiety. It also agrees with Sammallahti et al. (2023), who emphasized the value of cognitive and emotional support in reducing mathematics anxiety in testing situations.

In contrast, learning anxiety (M = 3.19, SD = 1.03) and numerical anxiety (M = 3.20, SD = 1.07) obtained the lowest means, although both remained at a moderate level. This indicates that students only sometimes experienced anxiety while learning new concepts or dealing with numbers and calculations. These results suggest that routine mathematics tasks were generally less

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anxiety-provoking than formal assessments. This is consistent with Wang (2023), who found that stronger mathematics self-concept is associated with lower learning anxiety, and Rose et al. (2023), who highlighted that numerical anxiety varies according to students' attentional control and emotional responses to numerical tasks.

Performance anxiety and evaluation anxiety both obtained a mean of 3.44, with standard deviations of 1.14 and 1.06, respectively, and were interpreted as moderate. This suggests that students sometimes felt anxious when asked to demonstrate mathematical ability publicly or when they felt judged based on their performance. Such situations may include recitations, board work, class participation, and graded performance tasks. This finding supports Pizzie and Kraemer (2023), who noted that socially evaluative mathematics situations can heighten anxiety, and Aydın and Özgeldi (2024), who linked evaluative anxiety with academic performance and self-regulation.

Overall, the findings indicate that students experienced a moderate level of mathematics anxiety, with test anxiety emerging as the most prominent dimension. For educational practice, this suggests the need for supportive classroom strategies, clearer assessment procedures, and anxiety-reducing interventions that can help students manage stressful mathematics situations more effectively.

4. Significant relationship between mathematics anxiety, learning modalities, and digital tools utilization

Table 4 presents the Pearson r results for the relationship between students' mathematics anxiety, learning modalities, and digital tools utilization. As shown, learning modalities were not significantly related to mathematics anxiety. Face-to-face learning ($r = -.050$, $p = .362$), synchronous learning ($r = -.006$, $p = .917$), asynchronous learning ($r = .029$, $p = .590$), blended learning ($r = .081$, $p = .138$), and overall learning modalities ($r = .021$, $p = .698$) all yielded non-significant results. By contrast, digital tools utilization showed significant positive relationships with mathematics anxiety, particularly for educational applications ($r = .271$, $p < .001$), online resources ($r = .250$, $p < .001$), learning management systems ($r = .210$, $p < .001$), and overall digital tools utilization ($r = .293$, $p < .001$). These relationships were weak in magnitude but statistically significant.

Table 4. Results of Pearson r Correlation for the Significant Relationship between the Students' Levels of Mathematics Anxiety, Learning Modalities, and Digital Tools Utilization

Constructs	N	R	P-value	Interpretation
Face-to-face learning	338	-.050	.362	Not Significant
Synchronous learning	338	-.006	.917	Not Significant
Asynchronous learning	338	.029	.590	Not Significant
Blended learning	338	.081	.138	Not Significant
Overall Learning Modalities	338	**.021**	**.698**	**Not Significant**
Educational applications	338	.271	.000	Significant
Online resources	338	.250	.000	Significant
Learning management systems	338	.210	.000	Significant
Overall Digital Tools Utilization	338	**.293**	**.000**	**Significant**

Legend:(p=.05 or p<.05 is significant and p>.05 is not significant)

Correlation Coefficient Range	Level of Correlation/Effect Size (**Cohen, 1992**)
0.50 and Above	Strong Correlation/Large Relationship
0.30 to 0.49	Moderate Correlation/Medium Relationship
0.10 to 0.29	Weak/Small Relationship

The findings suggest that mathematics anxiety was not determined by the learning modality itself, but rather by the kind of support students experienced within that modality. This supports the view that teacher guidance, clarity of instruction, and timely feedback may matter more than whether learning is face-to-face, synchronous, asynchronous, or blended. This interpretation is consistent with Rasheed et al. (2020) and Fabriz et al. (2021), who emphasized that student anxiety is shaped more by instructional design, interaction, and support than by mode of delivery alone. In educational practice, this means that improving the quality of support within any modality may be more effective than focusing only on format.

On the other hand, the positive correlations between digital tools utilization and mathematics anxiety indicate that greater use of digital tools may also be associated with higher anxiety. Although the relationships were weak, the pattern suggests that digital learning may become stressful when students must manage multiple platforms, unclear expectations, or technical demands. This supports Adedoyin and Soykan (2020), who linked online learning demands with cognitive overload and academic stress, and Lowenthal et al. (2022), who noted that complex digital environments may increase learner discomfort when not well structured.

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Overall, the results imply that mathematics anxiety is influenced less by modality and more by the quality of instructional support and digital structure surrounding the learning experience. For educational practice, this highlights the importance of streamlining digital platforms, clarifying online workflows, and ensuring consistent feedback to make technology use more supportive and less anxiety-inducing.

5. Predictors of Mathematics Anxiety among Senior High School Students

Table 5 presents the results of the multiple regression analysis used to determine which variables significantly predicted mathematics anxiety. The model was statistically significant, $F(7, 330) = 6.95$, $p < .001$, with $R = .359$ and $R^2 = .129$. This indicates that the predictors collectively explained 12.9% of the variance in mathematics anxiety, suggesting that other factors not included in the study may also contribute to students' anxiety.

Table 5. Results of Multiple Regression Analysis Predicting Mathematics Anxiety among Senior High School Students from Learning Modalities and Digital Tools Utilization

Predictors	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Interpretation
	B	Std. Error	Beta			
(Constant)	2.86	.343		8.37	.000	Significant
Face-to-face learning	-.223	.068	-.183	-3.25	.001	Significant
Synchronous learning	-.151	.083	-.124	-1.82	.069	Not Significant
Asynchronous learning	-.062	.069	-.057	-.89	.372	Not Significant
Blended learning	.077	.078	.065	.990	.323	Not Significant
Online resources	-.055	.145	-.047	-.379	.705	Not Significant
Learning management systems	-.056	.114	-.050	-.494	.622	Not Significant
Overall Digital Tools Utilization	.653	.239	.469	2.73	.007	Significant
R=.359 R^2=.129 F(7, 330)=6.95 P=.000						

Model Summary: $R = 0.359$; $R^2 = 0.129$; $F(7, 330) = 6.95$; $p = 0.000$

Among the predictors, face-to-face learning had a significant negative effect on mathematics anxiety ($B = -0.223$, $\beta = -0.183$, $p = 0.001$), indicating that stronger preference for face-to-face learning was associated with lower anxiety. This suggests that direct teacher support, immediate clarification, and classroom interaction may help reduce students' stress in mathematics. This finding is consistent with Balt et al., (2022) and Pizzie and Kraemer (2023), who emphasized the value of teacher presence and supportive learning environments in reducing mathematics anxiety.

In contrast, overall digital tools utilization had a significant positive effect ($B = 0.653$, $\beta = 0.469$, $p = 0.007$), indicating that greater digital tool use predicted higher mathematics anxiety. This suggests that technology may become stressful when its use is excessive, fragmented, or insufficiently supported. This interpretation supports Adedoyin and Soykan (2020) and Lowenthal et al. (2022), who found that complex and poorly integrated digital environments may increase academic stress and discomfort.

The remaining predictors, such as synchronous learning, asynchronous learning, blended learning, online resources, and learning management systems, were not significant. This indicates that they did not uniquely predict mathematics anxiety when the other variables were considered. As noted by Fabriz et al. (2021), instructional support and students' sense of competence may matter more than the modality itself.

Overall, the findings indicate that face-to-face learning predicted lower mathematics anxiety, whereas greater digital tools utilization predicted higher mathematics anxiety. For educational practice, this suggests the need to preserve the strengths of face-to-face instruction while ensuring that digital tools are integrated in a clear, manageable, and supportive way.

Conclusions

This study concludes that mathematics anxiety among Grade 12 students is influenced less by the learning modality itself than by the quality of the learning conditions within that modality. Face-to-face learning emerged as the most favorable and appears to function as an anxiety-buffering context, likely because it provides immediate feedback, direct clarification, and stronger teacher-student interaction. In contrast, greater digital tools utilization was associated with higher mathematics anxiety, suggesting that technology use may also introduce additional cognitive and organizational demands when not implemented coherently.

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The findings further indicate that learning modalities alone do not determine students' emotional experiences in mathematics. Rather, such experiences are shaped by the presence of clear instruction, timely feedback, predictable routines, and supportive learning environments. Synchronous, asynchronous, and blended learning may still support mathematics learning when these conditions are present, but may contribute to anxiety when they are absent.

The results also show that mathematics anxiety was generally moderate, with test-related situations emerging as the strongest source of anxiety. This suggests that assessment contexts remain particularly stressful for students and that the design of assessment and feedback practices plays a critical role in shaping their emotional responses to mathematics.

Overall, the study highlights that digital tools are not inherently anxiety-inducing; instead, anxiety may increase when technology use is excessive, fragmented, or poorly structured. Thus, a more coherent and purposeful integration of digital tools, alongside the strengths of face-to-face instruction, may help reduce mathematics anxiety and improve students' learning experiences. In sum, when instruction emphasizes clarity, timely support, and organized use of technology, students are more likely to feel competent, supported, and in control in mathematics learning.

Recommendations

Based on the findings of the study, the following recommendations are offered:

1. School administrators may streamline the use of digital platforms and establish clear school-wide routines for communication, deadlines, and feedback in order to reduce confusion and cognitive overload among students.
2. Mathematics teachers may strengthen face-to-face instruction through clear explanations, guided practice, immediate feedback, and supportive interaction, while ensuring that digital tools are used in a manageable and purposeful way.
3. Teachers and curriculum planners may consider reducing test-related anxiety by incorporating formative assessments, practice tests, transparent rubrics, and feedback-focused instructional strategies prior to major examinations.
4. Guidance counselors may provide targeted support programs for students experiencing mathematics anxiety, including screening, coping-skills sessions, and interventions focused on managing test anxiety.
5. Parents may support students by encouraging consistent study routines, helping them focus on teacher-recommended digital tools, and promoting positive study habits and help-seeking behaviors.
6. Students may practice effective time management, review lessons regularly, use digital tools selectively, and apply self-regulation strategies when preparing for mathematics assessments.
7. Future researchers may further examine additional factors related to mathematics anxiety, such as self-efficacy, digital literacy, prior achievement, and classroom climate, and may explore these variables using experimental or longitudinal research designs.

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