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Academic Boredom in Technology-Based Mathematics Learning: A Phenomenological Study from a Didactical Mathematics Perspective

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ABSTRACT

Recent studies have shown that academic boredom negatively affects students' engagement, motivation, and achievement; however, little is known about how students experience boredom in technology-based mathematics learning from a didactical perspective. This study aimed to explore students' lived experiences of academic boredom, identify contributing factors, and interpret these experiences through a mathematics didactical lens. A qualitative design employing Interpretative Phenomenological Analysis (IPA) was used. Thirty-five students aged 13–15 years with experience in technology-supported mathematics learning were purposively selected to capture diverse experiences while maintaining in-depth individual and cross-case analysis. Data were collected through semi-structured interviews, classroom observations, reflective notes, and supporting documents. The findings revealed five interconnected themes: emotional exhaustion, passive engagement, monotonous learning experiences, didactical factors that fuel boredom, and students' expectations for meaningful learning. Academic boredom emerged not only from individual emotional responses but also from repetitive instructional practices, limited interaction, weak didactical engagement, and ineffective use of educational technology. The study extends current understanding of academic boredom by demonstrating that boredom in technology-based mathematics learning is both an emotional and a didactical phenomenon shaped by instructional design and classroom interactions. These findings provide implications for developing more interactive, emotionally responsive, and meaningful mathematics learning environments.

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1. INTRODUCTION

Recent studies have increasingly emphasized the importance of academic emotions in learning processes, particularly within digital learning environments [1]. Existing research has demonstrated that academic boredom is associated with lower motivation, reduced engagement, weaker self-regulation, and lower academic achievement [2]. Within mathematics education, previous studies have primarily focused on cognitive outcomes such as problem-solving ability, conceptual understanding, cognitive load, and academic performance, while emotional experiences have received considerably less attention [3]. Research on technology-based mathematics learning has also largely concentrated on effectiveness, usability, and learning outcomes rather than students' subjective emotional experiences during the learning process [4]. Consequently, although the relationship between educational technology and learning achievement has been widely investigated, relatively little is known about how students experience academic boredom while learning mathematics through technology-mediated environments.

The theoretical foundation of this study integrates four complementary perspectives. First, Control-Value Theory explains that academic boredom emerges when students perceive limited control over learning activities and assign low value to learning tasks [5]. Students are more likely to experience boredom when learning activities are perceived as repetitive, irrelevant, excessively difficult, or insufficiently challenging. Second, Didactical Situation Theory proposed by Brousseau emphasizes that learning occurs through interactions among students, teachers, and mathematical situations designed within instructional environments [6]. Third, Didactical Design Research highlights the importance of anticipating students' cognitive and affective responses when designing learning experiences [7]. Fourth, the academic boredom literature suggests that boredom is not merely an individual emotional state but is strongly influenced by instructional design, classroom interaction, and learning environments [8]. Collectively, these perspectives suggest that students' boredom in technology-based mathematics learning may emerge from the interaction between emotional appraisals, instructional design, and mathematical learning situations.

Based on these theoretical perspectives, this study proposes a conceptual relationship in which technology-based learning environments influence students' perceived control and value of learning activities, while didactical situations and instructional designs shape students' cognitive and emotional experiences. When these elements fail to provide meaningful engagement, appropriate challenge, and opportunities for active participation, academic boredom may emerge. Conversely, well-designed didactical environments may support positive emotional engagement and meaningful mathematical learning experiences. Figure 1 presents the conceptual framework guiding this study.

Although previous studies have investigated academic boredom in educational settings, in digital learning experiences, and in mathematics learning processes, several important gaps remain. First, existing studies rarely examine academic boredom specifically within technology-based mathematics learning environments. Second, limited research has explored boredom from a didactic perspective that considers interactions among students,

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teachers, learning tasks, and instructional design. Third, most previous studies have relied on quantitative survey approaches, providing limited insight into how students personally experience, interpret, and respond to boredom during mathematics learning. As a result, the subjective meaning of boredom in technology-supported mathematics classrooms remains insufficiently understood.

A phenomenological approach is therefore necessary because it enables a deeper exploration of students' lived experiences and interpretations of boredom beyond what quantitative measures alone can capture [9]. Mathematics was selected as the focus of this study because it is widely recognized as a cognitively demanding subject that frequently evokes negative academic emotions, including boredom, frustration, and anxiety [10]. Technology-based learning was chosen because digital technologies are increasingly integrated into mathematics instruction, yet their influence on students' emotional experiences remains unclear and potentially contradictory. While technology may increase engagement and interactivity, it may also create passive participation, cognitive overload, and digital fatigue when poorly implemented.

The novelty of this study lies in integrating academic boredom theory, technology-based mathematics learning, and didactical perspectives within a phenomenological framework. Unlike previous studies that predominantly examined cognitive outcomes or measured boredom through quantitative indicators, this research investigates how students experience, interpret, and construct meanings related to academic boredom during technology-supported mathematics learning. The findings are expected to contribute to the development of emotionally responsive mathematics instruction, provide insights for improving didactical design in digital learning environments, and expand the literature on academic emotions in mathematics education.

Based on the background and research gaps identified above, this study addresses the following research questions: (1) How do students experience academic boredom when learning mathematics with technology? (2) What factors contribute to students' boredom during technology-based mathematics learning? Furthermore, (3) How do students interpret technology-based mathematics learning from a mathematics didactical perspective? Therefore, the purpose of this study is to investigate students' lived experiences of academic boredom in technology-based mathematics learning, identify factors contributing to boredom, and analyze these experiences through a didactical lens in mathematics education.

2. METHOD

This study employed a qualitative research design using an Interpretative Phenomenological Analysis (IPA) approach to explore students' lived experiences of academic boredom in technology-based mathematics learning. A qualitative approach was selected because the study aimed to understand how students perceive, interpret, and construct meaning from their emotional experiences during technology-supported mathematics learning activities. Qualitative inquiry is particularly appropriate for examining affective and experiential dimensions of learning that cannot be adequately represented through numerical measures alone [11]. The phenomenological perspective allows

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researchers to focus on the essence of participants' experiences and the meanings attached to those experiences within authentic educational contexts [12].

The study adopted an interpretative phenomenological approach because the objective was not merely to describe boredom experiences but also to interpret how students construct meaning from those experiences within mathematics learning situations. Interpretative phenomenology acknowledges that participants actively interpret their experiences, while researchers engage in a second level of interpretation to understand those meanings within broader educational contexts [13]. This approach is particularly relevant for investigating academic boredom because emotional experiences are closely connected to students' perceptions of instructional practices, classroom interactions, and learning environments.

Participants

The participants were 35 students who had experienced technology-based mathematics instruction. Participants were selected through purposive sampling based on criteria relevant to the research objectives. The inclusion criteria required students to participate in mathematics learning supported by digital technologies actively, have experience using online platforms or educational applications during mathematics lessons, and be willing to share their learning experiences through interviews and observations.

Although IPA studies commonly involve smaller samples of 6 to 15 participants, the inclusion of 35 participants was considered appropriate, as the study aimed to capture diverse experiences from students with different backgrounds and levels of engagement in technology-supported mathematics learning. To maintain the depth of phenomenological analysis, each participant's account was analyzed individually before cross-case comparisons were conducted. This procedure ensured that the uniqueness of each participant's experience remained central throughout the analytical process.

Participants were male and female students aged 13-15 years enrolled in secondary-level mathematics classes integrating educational technology. The participants represented varying levels of mathematics achievement, ranging from high to low, as well as different frequencies of technology use in learning activities. This diversity was intentionally considered to obtain a richer understanding of academic boredom experiences across different learner profiles.

Research Setting and Data Collection

The study was conducted in mathematics classrooms that integrated educational technology into teaching and learning activities. Technology-supported learning involved the use of digital learning platforms, multimedia resources, interactive presentations, and educational applications. Educational technology has been recognized as an important tool for supporting engagement and conceptual understanding in mathematics learning [14]. Nevertheless, previous studies have also reported that poorly designed digital learning environments may contribute to emotional disengagement and boredom among students [15].

Data were collected through semi-structured interviews, classroom observations, reflective notes, and supporting documents. Semi-structured interviews served as the primary source of data because they enabled participants to describe their experiences in depth while allowing flexibility for probing and clarification. Each interview lasted approximately 45–60 minutes, while follow-up interviews lasting 20–30 minutes were conducted when additional clarification was required. Classroom observations were conducted over six weeks during technology-based mathematics lessons, with each observation session lasting approximately 60–90 minutes. Reflective notes were written immediately after observations to document contextual information and emerging insights.

The interview protocol focused on students' emotional experiences during technology-based mathematics learning. Participants were asked questions such as: how they felt when learning mathematics using technology; situations that caused boredom during mathematics lessons; factors contributing to boredom; the influence of digital tools and instructional practices on their learning experiences; and conditions that made mathematics learning more or less engaging.

Ethical Considerations

This study received approval from the relevant institutional ethics committee (Approval No.: XXX/2025). Permission was also obtained from participating schools before data collection commenced. Written informed consent was obtained from all participants and their parents or legal guardians. Participants were informed about the study's purpose, voluntary participation, confidentiality procedures, and their right to withdraw from the study at any time without consequences. To ensure confidentiality, pseudonyms were used throughout the analysis and reporting process, and all personal information was removed from the research records.

Data Analysis

Data were analyzed using Interpretative Phenomenological Analysis (IPA) following the procedures proposed by Smith and colleagues. The analysis began with reading and re-reading the interview transcripts to become familiar with participants' narratives. Initial noting was then conducted to identify descriptive, linguistic, and conceptual aspects of the data. Significant statements and meaning units were subsequently transformed into emergent themes that represented important dimensions of participants' experiences. Related themes were grouped into broader thematic categories to identify patterns across participants. Cross-case analysis was then performed to compare similarities and differences among participants while preserving the uniqueness of individual experiences. Finally, the identified themes were interpreted through the perspectives of academic boredom theory, Control-Value Theory, Didactical Situation Theory, and Didactical Design Research.

Trustworthiness

To ensure trustworthiness, the study employed triangulation, member checking, and peer debriefing [16]. Triangulation was achieved by comparing findings obtained from interviews, observations, reflective notes, and supporting documents. Member checking

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involved returning interview summaries and thematic interpretations to participants for verification. Peer debriefing was conducted with qualitative research experts and mathematics education scholars to challenge interpretations and reduce potential researcher bias. These procedures enhanced the credibility, dependability, and confirmability of the findings.

Through this phenomenological framework, the study sought to generate a comprehensive understanding of students' experiences of academic boredom and to interpret these experiences through a mathematics didactical perspective. The findings are expected to contribute to the development of emotionally responsive and pedagogically meaningful technology-based mathematics learning.

3. RESULTS AND DISCUSSION

3.1. RESULTS

The phenomenological analysis reveals five central themes related to students' experiences of academic boredom in teaching mathematics using technology. These themes show how students emotionally perceive mathematics learning, interact with the digital environment, and interpret teaching practices from a mathematical didactic perspective. These themes emerged from in-depth interviews, classroom observations, and participants' reflective narratives.

Theme 1 — Emotional Exhaustion in Mathematics Learning

One of the main outcomes of this study is the emotional exhaustion students experience during the math learning process. Many participants described maths learning as mentally and emotionally draining, requiring high cognitive focus and constant digital instruction without significant interaction. Students report fatigue, reduced attention, and a lack of emotional engagement after repeatedly dealing with math procedures and problem-solving tasks.

Some participants noted that technology-based math learning can contribute to mental fatigue because students must concentrate on screens for long periods while simultaneously processing complex math information. Although digital platforms offer visual explanations and multimedia presentations, some students still find the learning process to be very cognitively taxing. This leads to decreased motivation and increased boredom during classroom activities.

Participants also said that the repetition of math exercises greatly contributed to their emotional exhaustion. They often describe math lessons as exhausting because the main focus of the learning activities is completing procedures rather than understanding concepts. As a result, students feel emotionally alienated from the learning process and slowly lose interest in actively participating during learning activities.

These findings suggest that academic boredom in math learning is closely related to emotional fatigue stemming from excessive cognitive strain and limited emotional engagement. From a didactic point of view, these results suggest that learning design should strike a balance between cognitive challenges and emotionally supportive learning experiences to prevent students from experiencing persistent mental exhaustion.

Theme 2 — Passive Engagement in Digital Mathematics Learning

Another significant theme identified in this study is the passive engagement that exists during technology-based mathematics learning. Many students mentioned that although digital technology is integrated in mathematics teaching, their participation is mostly passive. Students often play only an observer role, listening to explanations, viewing digital presentations, or completing online assignments without meaningful interaction or collaboration.

Participants reported that the digital environment sometimes reduced opportunities for active communication in the classroom and social interactions. Some students say they rarely ask questions during online learning or through technology because they feel disconnected from teachers and classmates. As a result, learning activities become less interactive and lack emotional engagement.

Some students also suggested that technology-based learning sometimes triggers mechanical learning behaviors. They tend to follow procedures on digital platforms without understanding mathematical concepts in depth. This way of passive engagement contributes to boredom because students tend to see learning activities as routine obligations rather than meaningful intellectual experiences.

From a didactic mathematical perspective, these results emphasize the relevance of creating a technology-based learning atmosphere that supports active engagement, conversation, and shared mathematical thinking. Simply incorporating technology is not enough to build real engagement unless the learning process encourages learners to be actively involved in knowledge creation.

Theme 3 — Monotonous Learning Experience

The third theme that occurs from the analysis is the monotonous learning experience in a mathematics classroom that utilizes technology. Many participants described teaching mathematics as a repetitive activity because learning activities are often carried out with similar teaching patterns, the same exercises, and a limited variety of teaching methods. Students state that digital learning environments often mimic traditional teacher-oriented practices in digital formats without significantly improving the quality of the learning experience.

Participants reported that being exposed to the same math task over and over again, along with similar study routines, made the learning process feel predictable and boring. Some students assert that boredom arises because they are constantly doing the same problem-solving exercises without the opportunity to explore, discuss, or think creatively. This monotonous learning model reduces students' curiosity and emotional engagement during math lessons.

In addition, some participants reported that technology is often used only for presentations, not as an interactive means of learning. As a result, digital learning feels monotonous because students only watch explanations or complete assignments independently, without meaningful engagement with mathematical concepts. These results suggest that boredom in the math learning process can arise when teaching practices do not offer variety, interaction, and intellectual stimulation. From a didactic point of view, monotonous learning experiences point to the need for a more dynamic teaching design that incorporates exploration, problem-based learning, and interactive math activities.

Theme 4 — Didactic Factors That Fuel Boredom

The fourth theme in this study concerns didactic factors that contribute to students' academic boredom. Participants highlighted that teachers' strategies, learning designs, and patterns of interaction in the classroom have a huge impact on their emotional experiences while taking math lessons.

Many students reveal that learning strategies that place too much emphasis on procedural explanations and completion of individual tasks often lower their interest and participation. Participants explained that teachers tend to prioritize curriculum achievement more than facilitating in-depth understanding and interactive learning experiences. As a result, math teaching is dominated by one-way communication and repetitive exercises.

The students also noted that limited classroom interaction greatly contributed to boredom. Some participants stated that they rarely engage in collaborative discussions or math exploration, or that they rarely get the opportunity to pitch their ideas during the lesson. The lack of dialogue interaction makes the learning environment feel rigid and emotionally disconnected.

In addition, some participants noted that learning materials and digital activities were sometimes disconnected from students' daily experiences. This causes students to have difficulty in understanding the relevance and meaning of mathematical concepts, which further exacerbates their feelings of boredom.

From a didactic perspective in mathematics, these findings show that boredom is not only an individual's emotional state but is also influenced by learning situations and classroom interactions. Didactic design plays an important role in determining whether students experience math learning as meaningful, engaging, or emotionally exhausting.

Theme 5 — Students' Expectations for Meaningful Learning

The last theme identified in the analysis concerns students' aspirations for an interesting and meaningful mathematics learning experience. Participants expressed strong expectations for an interactive, collaborative, and emotionally supportive learning environment. Students want math instruction that involves more discussion, exploration, visual interaction, and real-world problem-solving.

Many participants emphasized that interactive digital technology has the potential to reduce boredom when designed to encourage active participation rather than passive observation. Students tend to prefer learning activities that include simulations, educational games, collaborative problem-solving, and interactive multimedia that help them explore math concepts more actively.

Participants also hope that teachers can create a more communicative and emotionally responsive classroom atmosphere. Some students reported becoming more motivated when teachers encouraged dialogue, provided constructive feedback, and linked math concepts to everyday experiences. Emotional support and positive interactions in the

3 classroom are considered key elements for reducing boredom and increasing engagement in the learning process.

These results show that students want a math learning experience that integrates cognitive challenges with significant emotional engagement and interaction. From a didactic point of view, meaningful mathematics learning requires a learning design that understands students' emotional needs while also developing cognitive aspects. Therefore, technology-based learning environments should be designed not only to deliver material efficiently but also to stimulate active participation, build emotional connections, and create meaningful math experiences.

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3.2. DISCUSSION

The findings of this study indicate that academic boredom in technology-based mathematics learning cannot be understood solely as an individual emotional response. Rather, boredom emerged from the interaction among students' perceptions of learning activities, instructional design, and the quality of didactic interactions during mathematics lessons. Students frequently described learning situations characterized by repetitive procedures, limited opportunities for exploration, and passive participation. These experiences suggest that boredom develops when technology-mediated learning fails to provide meaningful cognitive and emotional engagement. This interpretation extends previous research on academic boredom, which has primarily focused on individual perceptions and motivational factors, by demonstrating that boredom may also arise from deficiencies in didactical structures that shape students' learning experiences [17], [18].

21 From the perspective of Control-Value Theory, boredom arises when students perceive limited value in learning activities and experience low control over their learning processes [19]. The participants in this study often viewed technology-supported mathematics learning as procedural and disconnected from their personal interests and learning needs. Such perceptions reduced the perceived value of learning activities and
25 weakened emotional engagement. However, the present findings suggest that the relationship between control, value, and boredom is strongly influenced by instructional design. In other words, students' emotional responses were not determined solely by personal appraisals but were also shaped by the structure of learning environments. This finding contributes to the literature by indicating that academic boredom in mathematics should be examined not only through psychological factors but also through didactical and pedagogical dimensions [20].

23 A major contribution of this study lies in its didactical interpretation of boredom. Previous studies have generally explained boredom in terms of motivation, engagement, self-regulation, or academic emotions [21]. The present study advances this perspective by showing that boredom may emerge when didactical interactions fail to create meaningful relationships between students and mathematical situations. According to Brousseau's Theory of Didactical Situations, effective mathematics learning occurs when students actively engage with mathematical problems and construct knowledge through interactions with learning situations [22]. The findings indicate that many technology-supported learning activities were dominated by information transmission and procedural exercises, limiting

students' opportunities to explore, investigate, and negotiate mathematical meaning. Consequently, technology functioned primarily as a delivery tool rather than as a medium for creating productive mathematical situations.

The concept of the didactical contract provides further insight into these findings. A didactical contract refers to the implicit expectations that regulate interactions between teachers and students during learning activities [23]. The experiences reported by participants suggest that many classrooms maintained traditional didactical contracts in which teachers were expected to provide procedures and students were expected to follow instructions. The integration of technology did not fundamentally alter these expectations. As a result, students remained passive recipients of information despite learning within digital environments. This finding suggests that technological innovation alone is insufficient to transform learning experiences unless accompanied by changes in didactical relationships and classroom interaction patterns.

The findings can also be interpreted through the concept of adidactical situations. Brousseau argued that meaningful mathematical learning occurs when students are given opportunities to independently interact with mathematical problems and develop their own strategies before receiving direct teacher intervention. However, participants rarely described experiences involving exploration, inquiry, or autonomous problem solving. Most learning activities focused on completing assigned tasks and following predetermined procedures. The absence of adidactical situations may explain why students experienced limited intellectual curiosity and increasing boredom during mathematics learning. These findings suggest that technology-based instruction should create opportunities for exploration, experimentation, and mathematical discovery rather than merely digitizing conventional teaching practices.

Another important interpretation concerns didactical obstacles. Didactical Design Research emphasizes that students' learning difficulties may originate from instructional designs that fail to anticipate cognitive and affective responses [24]. The boredom reported by participants may therefore be understood as a didactical obstacle emerging from instructional environments that insufficiently support emotional engagement. This interpretation expands existing literature by positioning boredom not only as an outcome of learning experiences but also as an indicator of potential weaknesses in didactical design. Consequently, boredom can serve as valuable feedback for improving instructional planning and learning environments.

The present findings differ from several studies reporting positive emotional outcomes associated with educational technology. Previous research has shown that digital mathematics platforms, interactive simulations, gamified learning environments, and adaptive technologies can increase motivation, engagement, and enjoyment in mathematics learning [25], [26], [27]. These studies suggest that technology has considerable potential to support positive emotional experiences when appropriately implemented. The discrepancy between those findings and the present study highlights the importance of instructional implementation. Technology itself does not automatically generate engagement; rather, its effectiveness depends on how it is integrated into meaningful learning activities. When digital tools merely replicate traditional teacher-centered instruction, their potential to support emotional engagement may remain unrealized [28].

The phenomenological approach adopted in this study further contributes to understanding boredom by revealing how students subjectively interpret their experiences. Unlike survey-based studies that typically measure boredom through predefined indicators, the present research captured the lived experiences underlying students' emotional responses [29]. Participants described boredom not only as a feeling of disinterest but also as a sense of emotional disconnection, reduced relevance, and limited participation in learning activities. This finding suggests that boredom represents a multidimensional experience involving cognitive, emotional, and social components. Such an interpretation provides a richer understanding of academic boredom within mathematics education and expands existing affective research beyond purely psychological explanations.

The findings also have important implications for mathematics teaching. Technology-based mathematics learning should be designed to promote active participation, collaborative problem solving, reflective dialogue, and meaningful mathematical exploration. Teachers play a crucial role in creating didactical situations that encourage students to engage with mathematical ideas rather than reproduce procedures. Learning environments that support autonomy, interaction, and contextualized problem solving may strengthen students' perceived value of mathematics while reducing boredom and emotional disengagement [30].

Overall, this study demonstrates that academic boredom in technology-mediated mathematics learning emerges not only from individual perceptions but also from limitations in didactical interactions, instructional design, and learning situations. By integrating Control-Value Theory, Theory of Didactical Situations, and Didactical Design Research, the study provides a more comprehensive explanation of boredom within mathematics education. These findings contribute to the growing field of affective mathematics education by positioning boredom as both an emotional experience and a didactical phenomenon that deserves greater attention in the design of technology-supported learning environments.

4. CONCLUSION

This study contributes to the growing literature on affective mathematics education by demonstrating that academic boredom in technology-based mathematics learning should not be understood solely as an individual emotional outcome but also as a manifestation of ineffective didactical interactions, instructional design, and limited opportunities for meaningful engagement within digital learning environments. The findings extend current theoretical perspectives by integrating Control-Value Theory, Theory of Didactical Situations, and Didactical Design Research to explain how emotional experiences are shaped through the interaction between learners, technology, and instructional practices. Practically, the study highlights the importance of designing technology-supported mathematics learning that promotes exploration, collaboration, dialogue, and reflective thinking to foster stronger emotional engagement. This research is limited by its focus on a single educational context, reliance on self-reported experiences, cross-sectional data collection, and the relatively large sample size for an Interpretative Phenomenological Analysis study, all of which may

22 influence the depth and transferability of the interpretations. Future studies are encouraged to investigate academic boredom across diverse educational settings, employ longitudinal and mixed-method approaches, and further examine how specific didactical designs and digital learning environments influence students' emotional experiences. Overall, this study provides valuable insights for educators, researchers, and instructional designers seeking to create more meaningful, emotionally responsive, and engaging mathematics learning experiences in technology-rich educational contexts.

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