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Learning Challenges in Science and Mathematics among STEM Students: A Phenomenological Study

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ABSTRACT

Science and mathematics are essential subjects, yet many students experience difficulty in learning them. This study explored the learning challenges of Grade 11 STEM students in science and mathematics and examined teachers' perceptions and instructional strategies. A qualitative phenomenological design was used. Participants included four Grade 11 STEM students, two science teachers, and two mathematics teachers from Sultan Kudarat State University-Laboratory High School. Data were collected through semi-structured in-depth interviews and analyzed using thematic analysis. Fifteen themes emerged, including engagement fluctuation, cognitive struggle, instructional barriers, effective teaching practices, two-way learning, burdened learning process, facilitation dependence, personalized learning, and diversified engagement. Students' learning challenges are shaped by subject complexity and teaching strategies. Adaptive, interactive, and student-centered instruction is recommended to improve learning experiences in science and mathematics.

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1. INTRODUCTION

Science and mathematics are core subjects in secondary education because they develop students' logical reasoning, problem-solving ability, analytical thinking, and readiness for higher education and STEM-related careers (Camilon *et al.*, 2025; Ortencio *et al.*, 2025). These subjects help students understand natural phenomena, interpret quantitative information, and apply knowledge to real-life situations. However, despite their importance, science and mathematics are often perceived by students as difficult, abstract, and demanding. Many students struggle with formulas, scientific concepts, problem-solving procedures, and the transfer of classroom knowledge to practical contexts. Students' difficulties in science and mathematics are influenced by both cognitive and instructional factors. Cognitive challenges may arise when students encounter abstract ideas, unfamiliar symbols, complex procedures, or word problems that require multiple steps of reasoning. In mathematics, students may experience pressure and anxiety when solving problems, especially when they are expected to perform quickly or accurately (DeCaro *et al.*, 2010). In science, students may also struggle when lessons involve conceptual explanations, technical vocabulary, and abstract relationships that are not clearly connected to prior knowledge or everyday experience. Engagement is another important issue in science and mathematics learning. Students may begin a lesson with interest but lose motivation when the subject becomes difficult, when explanations are unclear, or when they feel unable to follow the pace of instruction. Perceived difficulty and limited autonomy support can contribute to disengagement in science learning (Patall *et al.*, 2018). Similarly, student engagement is strongly connected to academic performance, especially in STEM-related learning contexts (Schnitzler *et al.*, 2020). Learning challenges are not only about content difficulty but also about how students experience the learning process emotionally and behaviorally.

Teaching strategies also play a major role in shaping students' learning experiences. Traditional lecture-based approaches may limit students' opportunities to ask questions, collaborate, practice problem-solving, and connect abstract ideas with real-life applications. When teachers move too quickly or provide limited scaffolding, students may experience confusion and frustration. Cooperative learning, active learning, and guided instruction have been shown to support deeper understanding and improve students' problem-solving skills in mathematics and science (Henderson *et al.*, 2018; Zakaria and Syamaun, 2017). Therefore, effective instruction should not only deliver content but also provide interaction, feedback, and support.

In the Philippine context, science and mathematics learning challenges remain a continuing concern. Students' performance in international assessments has raised questions about learners' conceptual understanding, problem-solving ability, and readiness for higher-order STEM learning. Studies in the local context have also highlighted the need to improve teaching and learning strategies in mathematics and science education (Cardino and Dela Cruz, 2020; Torrena, 2020). These concerns are especially relevant for students in the STEM strand, who are expected to build strong foundations in science and mathematics for future academic and career pathways.

Teachers' perspectives are important in understanding these challenges because teachers directly observe students' learning behaviors, attitudes, difficulties, and responses to instruction. Teachers can identify whether students' struggles are caused by subject complexity, weak background knowledge, low confidence, anxiety, passive participation, or instructional barriers. They also play a central role in designing strategies that can improve learning experiences. Personalized feedback, scaffolding, resource optimization, and adaptive teaching can help students develop confidence and improve learning outcomes (Futalan *et al.*, 2024; Zakariya, 2022).

Recent studies also emphasize the value of student-centered and adaptive learning environments. Autonomous learning can encourage students to take responsibility for their progress, while multimedia resources, worksheets, collaborative activities, and inquiry-based strategies can make learning more accessible and engaging (Mondal *et al.*, 2024; Qablan *et al.*, 2024; Soe *et al.*, 2025). Diversified engagement strategies, such as group work, games, problem-solving activities, and real-life applications, may also help students participate more actively and reduce anxiety in difficult subjects (Dwipoyanti *et al.*, 2024).

Although many studies have examined student difficulties, teaching strategies, and academic performance in science and mathematics, there remains a need to understand students' lived experiences and teachers' instructional perspectives within one qualitative framework. A phenomenological approach is useful because it allows researchers to explore how students personally experience learning challenges and how teachers interpret and respond to those challenges. This perspective can provide deeper insight into the emotional, cognitive, and instructional dimensions of learning science and mathematics.

This study explored the learning challenges of Grade 11 STEM students in science and mathematics. It focused on students' experiences related to subject complexity and teaching strategies, as well as teachers' perceptions and instructional approaches. Specifically, the study examined students' learning experiences, teachers' perceptions of these experiences, and the strategies used by science and mathematics teachers to maintain meaningful learning. The findings are expected to contribute to the improvement of adaptive, interactive, and student-centered teaching practices in science and mathematics education.

2. METHODS

This study used a qualitative research design, specifically a phenomenological approach, to explore students' learning challenges in science and mathematics. This design was appropriate because the study focused on the lived experiences of Grade 11 STEM students and the perceptions of science and mathematics teachers regarding students' difficulties, engagement, and learning support. A phenomenological approach allowed the researchers to understand how participants experienced and interpreted learning challenges in science and mathematics.

The study was conducted at Sultan Kudarat State University-Laboratory High School. The participants consisted of eight individuals: four Grade 11 STEM students, two science teachers, and two mathematics teachers. The participants were selected using purposive sampling. The student participants were chosen because they were enrolled in the Grade 11 STEM strand and had direct learning experiences in science and mathematics subjects. The teacher participants were selected because they were handling science or mathematics subjects and could provide insights into students' learning difficulties and instructional needs.

The inclusion criteria for the participants were as follows: willingness to participate in the study, current enrollment or teaching assignment during the academic year 2024-2025, enrollment in the Grade 11 STEM strand for student participants, and active teaching of science or mathematics subjects for teacher participants. Participants who did not meet these criteria or were unwilling to participate were not included in the study.

Data were collected through semi-structured in-depth interviews. The interview guide was prepared to gather information about students' experiences in learning science and mathematics, particularly in relation to subject complexity and teaching strategies. For teachers, the interview guide focused on their perceptions of students' learning experiences and the strategies they used to support meaningful learning. The use of semi-structured interviews allowed the researchers to ask common guiding questions while also allowing participants to explain their experiences in detail.

Before the interviews were conducted, permission was obtained from the school administration. The participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses. Informed consent was secured from all participants. The interviews were audio-recorded with permission, transcribed verbatim, and translated into English when necessary while preserving the meaning of the participants' responses.

Data were analyzed using thematic analysis. The researchers first read and reviewed the interview transcripts to become familiar with the data. Significant statements related to students' learning challenges, teachers' perceptions, and instructional strategies were then identified. These statements were coded and grouped into categories. Similar codes were organized into themes that represented the main patterns in the participants' experiences. The data-gathering and analysis process is illustrated in **Figure 1**.

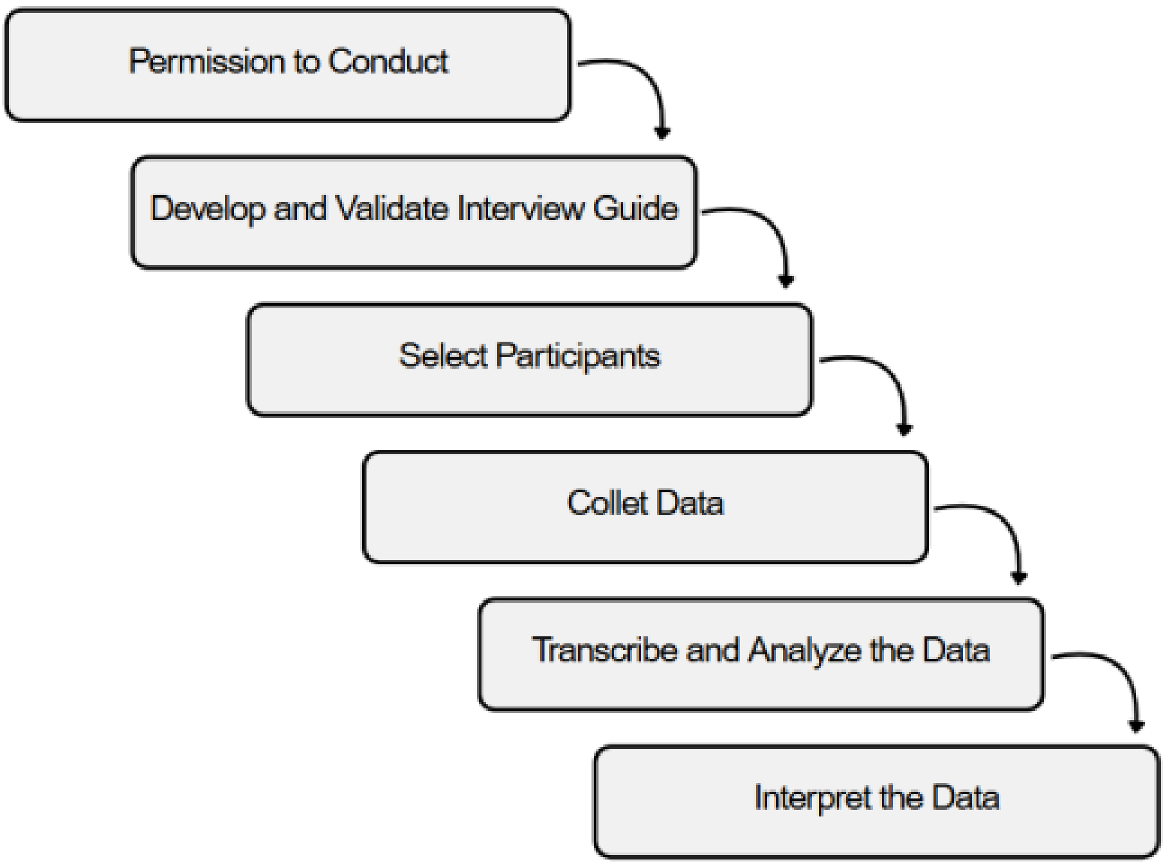

Figure 1. Waterfall diagram of the data-gathering process.

To ensure the trustworthiness of the findings, the study used expert validation of the interview guide and careful checking of the interview transcripts and themes. The researchers also maintained consistency in coding and theme development to ensure that the results accurately reflected the participants' responses. The final themes were used to describe students' learning experiences, teachers' perceptions, and teaching strategies in science and mathematics. Credibility was supported through careful transcript checking and repeated review of participants' responses, while dependability was strengthened through consistent coding procedures and discussion among the researchers during theme development.

3. RESULTS AND DISCUSSION

This section presents the emergent themes from students' learning experiences and teachers' perceptions and strategies in science and mathematics learning. After the interview data were transcribed and analyzed, fifteen themes emerged. These themes were grouped into three main categories: students' learning experiences, teachers' perceptions, and teachers' instructional strategies. The summary of emergent themes is presented in **Table 1**. Students' learning challenges in science and mathematics were shaped by both subject-related and instruction-related factors. Students experienced difficulty when lessons became abstract, fast-paced, or insufficiently explained. Teachers also recognized that learning in science and mathematics was affected by students' cognitive load, attitude, classroom participation, and the quality of instructional facilitation.

Table 1. Summary of emergent themes.

CATEGORY	SUBCATEGORY	THEMES
Students' learning experiences	Subject complexity	Engagement fluctuation; Cognitive struggle
Students' learning experiences	Teaching strategies	Instructional barriers; Effective teaching practices; Two-way learning
Teachers' perceptions	Learning experiences	Burdened learning process; Facilitation dependent; Attitude influenced; Group-driven; Personalized learning; Growth thwarting
Teachers' strategies	Instructional approaches	Autonomous learning; Resource optimization; Strategy adjustment; Diversified engagement

3.1. Students' Learning Experiences in Terms of Subject Complexity

Two themes emerged under subject complexity: engagement fluctuation and cognitive struggle. Students reported that their interest in science and mathematics changed depending on lesson difficulty, teacher explanation, and the clarity of learning activities. Some students were interested at the beginning of the lesson, but became less engaged when the topic became abstract or difficult to follow. This finding supports previous research showing that student engagement is closely connected to learning performance in STEM education (Schnitzler *et al.*, 2020).

Cognitive struggle was also evident in students' responses. Students experienced difficulty understanding complex concepts, solving word problems, remembering formulas, and connecting new lessons with prior knowledge. These difficulties were especially noticeable when topics required multi-step reasoning or abstract thinking. In mathematics, performance pressure may also affect problem-solving ability, particularly when students feel anxious or uncertain about their answers (DeCaro *et al.*, 2010). These findings suggest that students' learning challenges are not limited to a lack of interest but also involve deeper cognitive demands.

Subject complexity influenced both students' motivation and comprehension. When students could not understand the lesson clearly, their engagement decreased. This indicates that science and mathematics learning requires instruction that connects abstract ideas to concrete examples, prior knowledge, and real-life applications.

3.2. Students' Learning Experiences in Terms of Teaching Strategies

Three themes emerged under teaching strategies: instructional barriers, effective teaching practices, and two-way learning. Instructional barriers included fast-paced teaching, limited explanation, lack of scaffolding, and insufficient opportunities for clarification. Students reported that they felt overwhelmed when teachers moved to new lessons without ensuring that the class had understood the previous topic. This supports the view that traditional or teacher-centered approaches may limit deep understanding when students are not actively supported in the learning process (Zakaria and Syamaun, 2017).

In contrast, students identified effective teaching practices that helped them learn better. These included clear explanations, guided instruction, examples, real-life applications, and step-by-step problem solving. These strategies helped students understand abstract concepts and reduce confusion. Similar findings show that scaffolding techniques can support mathematics learning by helping students work through difficult tasks gradually (Futalan *et al.*, 2024).

Two-way learning also emerged as an important theme. Students valued classroom interaction, group discussion, peer collaboration, and opportunities to ask questions. Interactive learning made them feel more confident and less anxious. Active learning approaches have been shown to improve comprehension and student satisfaction in science and mathematics education (Henderson *et al.*, 2018). Therefore, students' learning experiences improved when teachers created opportunities for dialogue rather than relying only on one-way explanation.

3.3. Teachers' Perceptions of Students' Learning Experiences

Teachers described students' learning experiences through six themes: burdened learning process, facilitation dependent, attitude influenced, group-driven, personalized learning, and growth thwarting. Teachers perceived science and mathematics as cognitively demanding subjects that often caused student fatigue, anxiety, and disengagement. This burdened learning process was visible when students struggled with abstract concepts, formulas, and problem-solving tasks. Academic stress and learning difficulties have been linked to science achievement challenges in previous studies (Jufrida *et al.*, 2019).

Teachers also emphasized that students' success was facilitation-dependent. This means that students' learning experiences were strongly affected by how teachers explained concepts, provided examples, asked questions, and adjusted instruction. Even when the curriculum is well-designed, poor facilitation can still hinder student understanding (Dogru, 2015). Teachers recognized that their instructional decisions could either support or limit students' learning progress.

Students' attitudes were also perceived as important. Teachers observed that learners who viewed science and mathematics negatively were less motivated to participate and more likely to avoid difficult tasks. This is consistent with research showing that students' attitudes toward mathematics influence their learning engagement and performance (Mazana *et al.*, 2019). Teachers also noted that group-driven learning helped students understand lessons through peer support and shared problem-solving.

Personalized learning was another important perception. Teachers believed that students had different levels of readiness, confidence, and learning pace. Therefore, individual feedback, differentiated support, and flexible explanations were needed. Personalized feedback has been linked to students' self-efficacy in mathematics learning (Zakariya, 2022). However, teachers also recognized that rigid or inappropriate teaching strategies could limit student growth. This theme of growth thwarting highlights the need for reflective and adaptive teaching.

3.4. Teaching Strategies Employed by Teachers

Four themes emerged in relation to teachers' instructional strategies: autonomous learning, resource optimization, strategy adjustment, and diversified engagement. Teachers promoted autonomous learning by encouraging students to take responsibility for their own progress, complete tasks independently, and develop persistence in solving problems. Autonomy-supportive learning environments have been associated with improved achievement in science and mathematics (Soe *et al.*, 2025).

Resource optimization was also used to support learning. Teachers used worksheets, multimedia materials, online resources, and other instructional tools to make lessons more accessible and engaging. Multimedia resources can improve comprehension and retention when they are used to support, rather than replace, clear instruction (Mondal *et al.*, 2024). In science and mathematics, these resources are useful because they can help students visualize abstract ideas and review lessons outside the classroom.

Strategy adjustment was another important approach. Teachers modified their teaching methods based on students' needs, lesson difficulty, and classroom responses. This included revisiting difficult concepts, changing examples, adjusting pace, and using alternative explanations. Inquiry-based and adaptive teaching strategies can enhance understanding by allowing teachers to respond to learners' needs more flexibly (Qablan *et al.*, 2024).

Diversified engagement strategies included games, collaborative tasks, problem-solving activities, and interactive discussions. These approaches helped maintain student interest and participation. Collaborative worksheets and varied learning activities have been shown to improve engagement and science learning outcomes (Dwipoyanti *et al.*, 2024). These findings suggest that teachers need to combine autonomy, resources, flexibility, and engagement to support meaningful learning in science and mathematics.

3.5. Synthesis of Findings

Students' learning challenges in science and mathematics are shaped by the interaction between subject complexity and teaching strategies. Students struggle when lessons are abstract, cognitively demanding, or insufficiently scaffolded. However, their learning improves when teachers provide clear explanations, real-life applications, guided practice, interaction, and collaborative opportunities.

Teachers' perceptions supported the students' experiences. Teachers recognized that science and mathematics learning can be burdensome and that students' success depends heavily on instructional facilitation, attitude, peer interaction, and personalized support. The strategies used by teachers, including autonomous learning, resource optimization, strategy adjustment, and diversified engagement, show that adaptive and student-centered teaching can reduce learning barriers.

Improving science and mathematics learning requires more than content delivery. Teachers need to design learning experiences that are interactive, scaffolded, flexible, and responsive to students' cognitive and emotional needs. These findings support the need for adaptive teaching practices that help students understand difficult concepts, sustain engagement, and develop confidence in science and mathematics learning.

4. CONCLUSION

This study concluded that Grade 11 STEM students experienced learning challenges in science and mathematics due to both subject complexity and teaching strategies. Students showed fluctuating engagement and cognitive struggle, especially when lessons involved abstract concepts, formulas, word problems, and fast-paced instruction. Instructional barriers such as limited explanation and lack of scaffolding made learning more difficult, while clear explanations, real-life applications, guided practice, collaboration, and two-way learning improved comprehension and motivation. Teachers perceived students' learning as affected by cognitive demands, attitude, facilitation, peer interaction, and the need for personalized support. To respond to these challenges, teachers used autonomous learning, resource optimization, strategy adjustment, and diversified engagement. The findings highlight the importance of adaptive, interactive, and student-centered teaching practices in improving students' learning experiences in science and mathematics.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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