Environment and Social Psychology (2025) Volume 10 Issue 4 ISSN: 2424-8975 (O)
doi: 10.59429/esp.v10i4.3215 2424-7979 (P)

RESEARCH ARTICLE

Learning activities in STEM to sustain curiosity of Gen-Z in an AI-dependent college setting

Magna Anissa A. Hayudini[1,*], Shernahar K. Tahil[2], Jeanor M. Marsin[2], Datu Al-Mujiv A. Kiram[2], Alnahar A. Amirul[3], Angela Joy Alegado Jimpoy[2], Fahra B. Sahibad[2], Adzlan P. Hamsaji[2], Abdulkamal H. Abduljalil[2], Hermie V. Inoferio[4]

[1] *College Of Health Sciences, Mindanao State University-Sulu, Jolo, Sulu, 7400, Philippines*

[2] *College Of Computer Studies, Mindanao State University-Sulu, Jolo, Sulu, 7400, Philippines*

[3] *College Of Computing Studies and Engineering, Sulu State College, Jolo, Sulu, 7400, Philippines*

[4] *College of Teacher Education, Jose Rizal Memorial State University-Katipunan Campus, Katipunan, Zamboanga del Norte, 7109, Philippines*

*** Corresponding author:** Magna Anissa A. Hayudini, agnaanissa.hayudini@msusulu.Edu.Ph

ABSTRACT

The emergence of Generative AI (GenAI) programs marks a significant shift in the educational landscape, prompting a re-evaluation of traditional teaching methodologies and curricular frameworks. As education evolves, there is growing emphasis on inquiry-based learning, which prioritizes skills such as questioning, critical thinking, and problem-solving. This article discusses how GenAI sparks curiosity among Gen Z college students, with emphasis on different learning activities applicable in Science, Technology, Engineering, and Mathematics (STEM) programs. College students (n=16) were purposively sampled to be interviewed about their experiences using GenAI and how it impacted their learning processes in STEM classrooms. Findings indicated that curiosity was notable in the educational experiences of STEM college students in GenAI-dependent classrooms, as it drives their exploration, creativity, and motivation to learn. Students exhibited strong curiosity by engaging with real-world challenges and using GenAI tools to seek answers and deepen their understanding of topics. Active learning strategies, including project-based and inquiry-based approaches, remarkably enhance students' curiosity and engagement, allowing them to apply theoretical knowledge to hands-on activities and stimulate higher-order thinking. Through experiences like lab experiments and discussions about career applications of STEM knowledge, students found abstract concepts more relatable and meaningful, reinforcing their motivation. This paper highlights the need for an active, inquiry-driven learning environment that connects academic pursuits with practical applications, cultivating curiosity and enriching students' educational experiences.

Keywords: curiosity; GenAI; inquiry-based learning; STEM education

1. Introduction

Generative artificial intelligence (GenAI) is shaping the future of various industries, including marketing, healthcare, arts and culture, software development, architecture, bioengineering, and more[1,2].

ARTICLE INFO
Received: 1 March 2025| Accepted: 10 April 2025 | Available online: 27 April 2025

CITATION
Hayudini MAA, Tahil SK, Marsin JM, et al. Learning activities in STEM to sustain curiosity of gen-z in an AI-dependent college setting. *Environment and Social Psychology* 2025; 10(4): 3215. doi:10.59429/esp.v10i4.3215

Literature indicates an increasing volume of research focused on the application of GenAI technologies within teaching and learning contexts. Recent investigations have been extensively undertaken in this regard, with scholars analyzing and examining these tools to enhance global welfare and improve modern technology[3].

GenAI creates novel content, such as text, images, and audio, by analyzing and understanding the underlying features and patterns present in existing datasets[4]. Studies indicate that the utilization of GenAI, such as text-to-image AI, markedly enhances human creative productivity and elevates the value of the generated content[5]. The expanding role of GenAI in education offers significant benefits across all levels, from elementary to university. For young students, it improves language skills by identifying grammatical errors, while educators can create engaging animated content to spark academic curiosity and maintain student engagement[6]. Interestingly, a study conducted by Abdelghani et al.[7] emphasized the potential of GenAI as an educational resource that could emulate students' natural curiosity and enhance their skills in question formulation. This study focused on the development of automated prompts designed to stimulate questioning, thus enabling more advanced inquiries.

Recent scholarly efforts have sought to systematically assess the integration of Generative AI (GenAI) in educational settings. For instance, Ogunleye et al.[8] conducted a comprehensive review of GenAI applications in higher education, highlighting the technology's potential to enhance teaching and learning practices. Their findings underscore the importance of interdisciplinary approaches and the need for robust frameworks to guide the ethical and effective use of GenAI in academia. Such studies provide a broader context for understanding how GenAI can be leveraged to foster curiosity and engagement among students.

This article explores how GenAI sparks curiosity among Science, Technology, Engineering, and Mathematics (STEM) college students. Understanding how GenAI motivates curiosity and self-driven exploration is essential for educators aiming to enhance STEM education and prepare students for future careers shaped by AI advancements. The drive for inquiry motivates individuals—both in a physical sense and an intellectual capacity—to actively interact with "other." The nature of this "other," whether it is known or unknown, compels people to engage with it through a lens of curiosity[9]. This engagement holds the capacity to transform comprehension and interactions, extending beyond the immediate subject of the inquiry and embracing the wider context of their existence[10]. Fundamentally, curiosity can be distinguished as an inherent desire to seek out novel knowledge and experiences with exploratory actions[11]. This paper characterized curiosity as an outlook to uncover, question, and relate to broader contexts, enriching both the individual and their perspective on the wider world. However, studies on how GenAI develops curiosity among students were non-existent.

Learning reflects a deliberate endeavor undertaken by an individual, resulting in alterations to behavior through the acquisition of new knowledge, skills, and the development of positive attitudes and values[12]. In healthcare education, for example, the effect of curiosity on the learning process is particularly significant as it can acquire not only knowledge but also cultivate inquiry skills that develop lifelong learning character[13]. Curiosity arises from relational awareness and stimulates learning through the learners' own agency, empowering change, practice, and reflection[9]. Inquiry-based learning environments, such as simulations and virtual laboratories, enable students to generate questions and hypotheses while receiving immediate feedback and engaging in potential collaborative experiences[14]. AI has been successfully employed in these contexts, and prior studies indicate that integrating guided exploration with tutored problem-solving tasks enhances students' comprehension of both theoretical and procedural information, just as effectively as engaging solely in tutored problem-solving[15].

This paper aims to expand the discussion about the use of GenAI in encouraging curiosity among STEM college students. It examines how curiosity emerges and is positioned within learning environments where GenAI tools are integrated, encouraging students to explore, question, and engage more deeply with their academic subjects. By analyzing student interactions with GenAI, this paper reveals how AI-driven resources can transform passive learning into active inquiry, making learning experiences more relevant, stimulating, and connected to real-world applications.

2. Literature review

Curiosity serves as a critical element in learning, driven by a strong internal motivation that manifests through observable behaviors such as exploration and active engagement[16]. This intrinsic motivation compels students to take ownership of their learning journeys, enhancing both the depth and quality of their educational experiences[17]. Curiosity not only enhances creativity but also stimulates intrinsic motivation, an essential component in both creative expression and academic achievement[18,19]. In this sense, curiosity motivates students to immerse themselves more fully in learning, laying the groundwork for deeper cognitive and creative engagement.

Curiosity also acts as a catalyst for inquiry-based learning[10]. It is characterized as "the joy of discovery and the motivation to seek answers"[20]. Curiosity is linked to a sense of wonder that can stimulate interest and enliven students' imaginative thinking[21]. A wide body of research supports the idea that curiosity is vital to early educational development and is associated with key outcomes such as cognitive growth and exploration[22].

With the growing integration of GenAI into education, there is an urgent need to understand how it nurtures student curiosity. Several studies indicate that GenAI tools can spark curiosity and foster student engagement. For instance, Steinert et al.[23] emphasized that GenAI prompts are adaptable across a wide range of topics and questions, thereby supporting inquiry-based learning. This adaptability allows students to receive immediate feedback on nearly any subject, greatly reducing teachers' workload in providing individual responses. Consequently, this showcases the ability of AI models such as GPT-4 to promote inquiry-driven learning across disciplines, enriching the educational experience.

Similarly, in chemistry education, Iyamuremye and Ndihokubwayo[24] observed that chatbot-assisted AI tools provoked significant curiosity, prompting students to explore subjects in greater depth. The on-demand access to supplementary resources and detailed explanations further enhanced student motivation, deepening their understanding of atomic structures and chemical bonding. ChatGPT's interactive features allow students to engage in Q&A sessions to better grasp difficult concepts, thereby building more comprehensive understanding[25]. This interactive method is especially beneficial in physics education, where the abstract nature of the subject often makes conceptual understanding challenging to achieve[26].

Considering the potential of GenAI in classrooms, it is essential to critically understand its practical applications and impact on learning. The AI system possesses the capability to filter information and produce relevant content[27], thus the immediate advancement of technology and the processes of globalization have led to a significant impact of AI across various educational sectors[28] where implementing innovation and promoting advancement in teaching processes is essential[29]. For example, Wang et al.[30] reported positive results from using a GenAI-based chatbot to provide personalized mathematics word problem tutoring system to students. Teachers perceive AI as a tool that enhances students' understanding of complex concepts, develop creativity, structures presentations and writing, provides guidance on assignments, identifies and corrects mistakes, aids in problem-solving, and improves assignment quality[31]. Hence, there is a need for teachers to meaningfully integrate AI into their classroom learning process to stimulate students to build their curiosity and engagement.

The emergence of GenAI programs signifies the onset of a paradigm shift In the education system[32]. Inquiry-based learning fundamentally encompasses skills such as questioning, critical thinking, and problem-solving[33], making GenAI a worthy area of exploration. There is an increasing need to reframe STEM education to address real-world challenges and equip learners with the competencies relevant to the 21st century, thereby shaping the future landscape of STEM education[34]. This includes emphasizing complex, interdisciplinary issues that are significant in both academic contexts and practical, everyday life[35].

To strengthen the connection between educational experiences and real-world problems, it is vital to adopt innovative pedagogical approaches and technological tools that allow students to investigate natural phenomena both within and beyond the classroom[33,36]. While calls to extend learning beyond traditional settings are increasing, the practical implementation of such initiatives remains ambiguous[33,37,38]. With the rise of AI, Yang et al.[38] identified two distinct phases in the integration of AI into STEM education—an initial exploratory phase followed by a rapid development phase. They also outlined four primary pathways for AI integration: refining STEM instruction, incorporating AI technologies, utilizing AI tools in classrooms, and exploring AI’s influence on student motivation and performance.

Despite GenAI’s promising potential to foster curiosity, its limitations must be acknowledged. A major concern is the potential over-reliance on AI for information retrieval, which may impede students’ development of independent critical thinking skills. Automated responses can reduce the cognitive effort involved in problem-solving. Additionally, ethical concerns—such as data privacy, algorithmic bias, and intellectual dependency—are not yet sufficiently addressed in current classroom practices involving GenAI. Students may uncritically depend on AI-generated content without assessing its sources or accuracy, raising concerns about academic integrity and critical literacy in AI-enhanced learning environments.

The pedagogical benefits, it is crucial to consider the practical and ethical challenges associated with the use of GenAI in education. Yan et al.[39] conducted a systematic scoping review that identified several concerns, including data privacy, algorithmic bias, and the potential for over-reliance on AI-generated content. These challenges highlight the necessity for educators to implement GenAI tools thoughtfully, ensuring that they complement rather than replace critical thinking and independent inquiry among students.

To further examine the role of GenAI in fostering curiosity, this paper explored emerging classroom activities that engage STEM college students. The study emphasized how GenAI can support interactive learning experiences that not only deepen students’ understanding of STEM subjects but also nurture the inquiry and creativity essential for thriving in STEM fields.

3. Methods

3.1. Research design

This study explored classroom activities that stimulate science and mathematics learning curiosity among Gen-Z college students in a GenAI-dependent academic environment. Exploratory research is particularly suited for topics that are under-documented or still emerging, as it provides a foundation for understanding complex and evolving phenomena. It typically employs qualitative methods to establish preliminary insights and generate general understanding[40,41]. Using flexible approaches—such as interviews, open-ended surveys, and observations—exploratory research captures participants’ lived experiences and perceptions without being restricted by fixed hypotheses[42,43]. This flexibility allows for the identification of recurring themes and underlying patterns in social or psychological contexts[44,45]. While it may be critiqued for lacking rigorous generalizability, exploratory research is valuable for its efficiency in gathering initial, context-rich data[41]. Polit[46] and Szabelska et al.[47] emphasized that such studies can serve as a basis for hypothesis development, supporting future in-depth investigations. Accordingly, this study aimed to establish foundational knowledge and guide subsequent research on GenAI integration in educational settings.

3.2. Participants and sampling

Exploratory studies typically emphasize depth over breadth, often using small, focused samples to gather detailed insights[48]. According to Subedi[49], qualitative research designs—such as phenomenology, narrative inquiry, and case studies—commonly involve sample sizes of 1 to 20 participants. These smaller samples facilitate intensive examination of experiences within a specific group[42,50]. This study employed purposive sampling, wherein participants are intentionally selected based on specific characteristics relevant to the research[51,52]. This approach ensured the inclusion of individuals with relevant experience, thereby enriching the data[53]. Gen-Z college students were selected based on three criteria: (1) belonging to the Gen-Z age group (10–25 years old), (2) having experience with generative AI tools (e.g., ChatGPT, DALL-E, or similar educational applications), and (3) being enrolled in science or mathematics-related programs. An initial online poll collected demographic data, from which 16 qualified college students were selected for the study. The purposive sampling method allowed for refinement of participant criteria based on emerging themes, supporting the dynamic nature of exploratory research[54]. As Campbell et al.[55] and Chavez et al.[56] noted, this adaptability is essential when studying under-researched topics, as it allows for a more precise representation of the phenomenon under investigation.

3.3. Research instrument

Before conducting the interviews, a semi-structured interview guide was developed to direct the flow and substance of the qualitative data collection process. Creating such a guide requires a well-balanced combination of structure and adaptability to ensure comprehensive yet flexible inquiry. This begins by identifying foundational elements, such as the research goals and theoretical context, which shape the construction of interview questions[57]. The guide was designed to elicit rich, detailed responses by allowing participants the freedom to share personal experiences while staying aligned with the research focus[58,59]. The Interview guide included preliminary questions that addressed key themes and concepts relevant to the study, formulated to encourage narrative and reflective answers[60,61]. Its semi-structured format permitted flexibility during the interview process, enabling researchers to pose follow-up or clarifying questions and delve into unanticipated yet relevant themes that emerged during the conversations[62].

To ensure clarity and appropriateness, a draft of the guide was pilot-tested among a sample of college students. This step aimed to identify issues related to question formulation, language, and content relevance. Feedback gathered during pilot testing was instrumental in refining the guide[60,63]. Furthermore, insights were solicited from educational experts and experienced researchers to evaluate the instrument’s clarity, alignment with research objectives, and its overall effectiveness in capturing the intended data[57]. Through these iterative stages—ranging from conceptual formulation to expert validation—the final version of the guide emerged as a practical, research-aligned tool. It enabled the collection of in-depth qualitative data while preserving the integrity of participant experiences[64,65]. **Table 1** presents the final interview guide used in this study.

Table 1. Interview guide questions.

Objectives	Guide Questions
Determine the learning strategies that Gen Z believe will develop their curiosity and interest in an AI-dependent setting.	1. Do you still get curious about science and mathematics now that GenAI can do anything for you? Explain further. 2. Based on your experience, what learning strategies do you have in the classroom that increase your curiosity and interest about science and mathematics? Enumerate and explain each. 3. As part of Gen Z, how should learning activities be done in the classroom to increase your curiosity and interest about science and mathematics? Enumerate and explain each.
Determine expected teaching strategies from their instructors that lead the Gen Z learners to be more curious on science and mathematics in spite of an AI-dependent setting.	1. What types of instructors do you expect in handling teaching strategies to increase your curiosity or interest on science and mathematics despite the GenAI-dependent setting? 2. What specific teaching strategies which are non-traditional can the teacher use to make you more curious about science and mathematics in this age of GenAI? 3. Coming from Gen Z learners, what do you think are the responsibilities of the instructors to the Gen Z and the upcoming new generations in terms of increasing their interest to science and mathematics?

3.4. Data gathering procedure

In this study, the primary method for collecting data involved conducting one-on-one interviews, which are particularly suited for eliciting rich, in-depth accounts of individuals' perceptions and experiences[66]. A systematic and ethical approach to the interview process was implemented to ensure data credibility, reliability, and relevance. The procedure began with clearly defining the research objectives and Identifying eligible participants based on predetermined inclusion criteria. Once selected, participants were provided with a full explanation of the study's purpose, data confidentiality protocols, and their rights as voluntary participants, following ethical research practices[67,68].

To foster a safe and open atmosphere, the interviews were conducted in a setting that was informal yet focused. This approach aimed to encourage honest and thoughtful responses while minimizing pressure or discomfort[69]. The interview questions were thematically structured, allowing discussions to revolve around core topics while incorporating follow-up prompts to encourage further elaboration and reflection[70]. Special consideration was given to linguistic and cultural diversity. Participants were encouraged to express themselves in the language or dialect they felt most comfortable with, thereby reducing language barriers and fostering more meaningful engagement[57].

Each session was audio-recorded—with the participants' consent—to ensure accurate transcription and data preservation. Supplementary notes were also taken during the interviews to highlight important points for subsequent analysis[71]. This study was reviewed and approved by the Institutional Research Ethics Committee of Mindanao State University-Sulu. All participants were provided with an informed consent form prior to the interviews. The consent form outlined the study's purpose, participants' rights (including voluntary participation and withdrawal), and data privacy protocols. Participants were required to sign the consent form before data collection began. Anonymity and confidentiality were strictly maintained throughout the research process in accordance with international research ethics standards.

3.5. Data analysis

Thematic analysis serves as a robust qualitative method for systematically identifying and interpreting patterns of meaning within narrative data, particularly derived from one-on-one interviews[72]. Thematic analysis provides researchers with a structured yet flexible framework for organizing and interpreting qualitative data[45,44]. The process began with coding the data at multiple levels, starting with basic descriptive codes and progressing toward deeper interpretative insights[73,74]. Reflexive thematic analysis recognizes the role of the researcher's subjectivity and reflexivity, acknowledging that personal engagement and interpretation are integral to meaning-making[75-78]. The application of an inductive approach is essential in this context, as it ensures that themes are derived directly from the data rather than imposed through preconceived theories or hypotheses. This bottom-up approach develops a stronger alignment between the analysis and the participants' actual experiences, minimizing potential biases in data interpretation[79-80]. Braun and Clarke's[81] six-phase framework was applied throughout the analysis: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. These stages were followed iteratively, allowing for continuous refinement and validation of emerging patterns. The structured yet reflective process ensured a deep and methodical engagement with the data while honoring the voices of the participants[79]. While reflexive thematic analysis provided a comprehensive framework, future studies may consider incorporating additional techniques such as peer debriefing or triangulation to further strengthen the credibility and rigor of the findings.

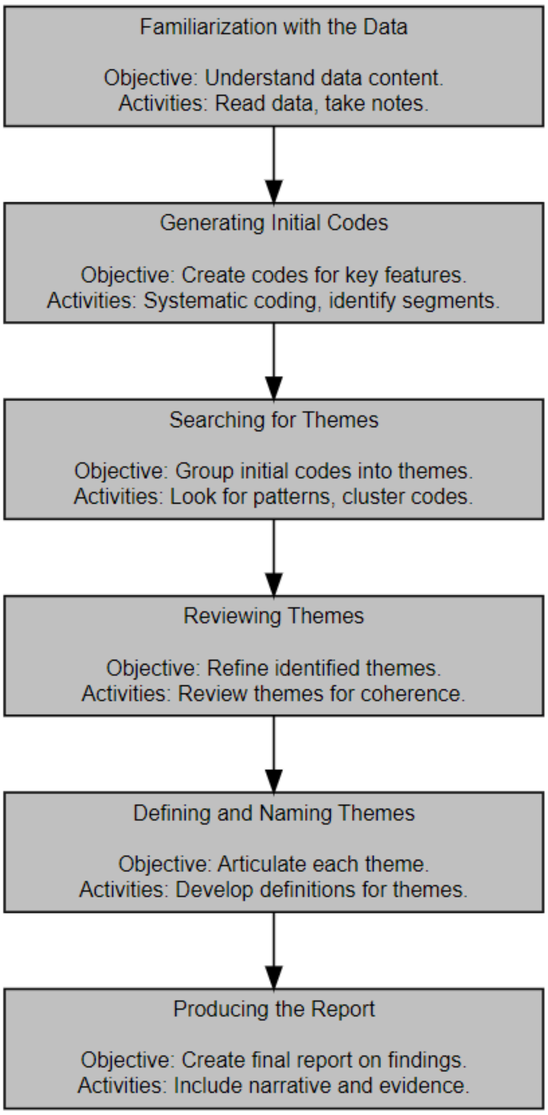

Figure 1. Six phases of reflexive thematic analysis.

4. Results

Question 1: Determine the learning strategies that Gen Z believe will develop their curiosity and interest in an AI-dependent setting.

The integration of GenAI into educational contexts has profoundly transformed how students engage with learning materials, particularly among Generation Z learners. As digital natives, these students have unique expectations and preferences for their educational experiences. Three prominent themes emerged from the narratives of participants: *Reflection*, *Application*, and *Interactive Learning*. Each theme illustrates the ways in which AI influences their learning processes and encourages deeper engagement with subjects like science and mathematics.

Theme 1: Reflection

Reflections revealed that GenAI usage encourages deeper learning by shifting students' focus from mechanical tasks to critical inquiry. Students shared that AI tools allowed them to bypass repetitive processes such as calculations, freeing up mental space for deeper questioning and conceptual exploration. Many participants expressed growing curiosity in topics they previously overlooked, particularly those with ethical and global dimensions, such as climate change and healthcare.

The nature of their reflections showed a pattern of students moving from passive knowledge intake to active questioning. Rather than simply receiving information, they became more invested in exploring implications, asking "what if" or "why" questions, and initiating their own lines of inquiry. This emerging pattern suggests that curiosity was not only present but heightened, as students described becoming more aware of what they didn't know—and more motivated to seek answers. Their curiosity became a driver for deeper academic and personal engagement.

> "I actually feel more curious about science and math now that AI is around. It takes care of tedious calculations and data analysis, which frees me up to think more critically about the concepts. I find myself asking deeper questions and exploring areas I wouldn't have considered before."
>
> "AI has made me more curious about the ethics and applications of science and math. I think a lot about how AI affects real-world issues like climate change and health."
>
> "It motivates me to learn the fundamentals so I can contribute to discussions on these topics."

Participants indicate that their curiosity has been piqued by the ways in which *AI challenges traditional ethical frameworks*, prompting them to consider the broader implications of technology in society. This reflective stance signifies a departure from viewing ethics as a static set of rules, allowing students to engage in dynamic discussions about moral reasoning and the evolving nature of ethical considerations in the age of AI.

> "AI challenges traditional ethical frameworks, and I find myself drawn to the philosophical implications."
>
> "I want to explore questions about responsibility and accountability in AI systems. This curiosity leads me to engage with both the science behind AI and its broader societal impacts."

Theme 2: Application

Application highlighted the significant ways in which students recognized the relevance of their academic learning to real-world contexts. Participants also highlighted how exposure to real-life problem-solving scenarios cultivated their critical thinking and reasoning abilities. They expressed that applying mathematical principles to issues such as resource allocation deepened their understanding of abstract content. This transition from theoretical learning to practical application demonstrates the role of curiosity in advancing students' intellectual autonomy and problem-solving competencies. Moreover, students shared that conducting experiments, especially those involving variable manipulation, ignited their sense of exploration and discovery.

> "Seeing math applied in real-world problems teaches me valuable problem-solving skills."
>
> "It's one thing to solve equations in a textbook, but another to apply those skills to issues like resource allocation."
>
> "The excitement of conducting experiments fuels my curiosity."
>
> "I love asking questions and exploring what happens when I change variables in an experiment."

Participants articulated that the application of academic knowledge to authentic, real-world contexts significantly enhanced their curiosity and motivation to learn. They emphasized that when theoretical concepts in science and mathematics were presented in relation to current global challenges, such as climate change or public health, learning became more purposeful and personally meaningful. This perspective indicates that students are not merely absorbing information but are seeking to understand how knowledge can drive societal change. Their curiosity is fueled by the recognition that their academic pursuits may yield tangible contributions beyond the classroom. Several students identified career relevance as a key motivator that enhanced their academic interest. When instructors connected course content to professional pathways, students perceived the material as more valuable and applicable to their future aspirations.

> "Working on projects that address pressing issues, like climate change or public health, gives me a sense of purpose. It feels good to know that my work could contribute to meaningful change."
>
> "Working on long-term projects that connect math or science to real-world issues, like sustainability or health, helps me see the relevance of what I'm learning and keeps me invested."
>
> "When we discuss how calculus can optimize everything from business costs to engineering designs, it makes the math feel more applicable to my life and future career."

Theme 3: Interaction

Participants described how interactive learning environments, supported by GenAI tools, significantly enhanced their curiosity by increasing autonomy, engagement, and personal responsibility for learning. The use of virtual tools, particularly simulations and experiments that could be accessed on demand, allowed students to engage with content beyond the limits of traditional classroom instruction. This flexibility enabled individualized pacing and promoted deeper comprehension of complex scientific and mathematical concepts.

> "Virtual tools allow me to access experiments and simulations anytime. This flexibility means I can review concepts outside of class at my own pace, which reinforces my understanding."

In addition to flexibility, participants emphasized the motivational benefits of gamified learning strategies. The integration of quizzes, rewards, and competitive elements into instructional delivery contributed to a more dynamic and stimulating educational experience. It demonstrate how GenAI-enabled interaction—through personalized, game-based, and exploratory approaches—serves as a catalyst for curiosity. Students reported feeling more in control of their learning journeys, more enthusiastic about the process, and more committed to understanding course material in depth. These findings suggest that when learners are granted both autonomy and incentive, curiosity becomes an enduring and intrinsic aspect of their academic experience.

> "Using game-based learning, like quizzes with rewards or challenges, turns studying into a fun experience. It motivates me to participate and learn more actively."

> "Game-based learning makes the material feel less like a chore. I find myself more invested in quizzes and challenges, which keeps my attention focused."

Question 2: Determine expected teaching strategies from their instructors that lead the Gen Z learners to be more curious on science and mathematics in an AI-dependent setting.

In the context of an AI-dependent educational setting, Gen Z learners expressed clear expectations for teaching strategies that could enhance their curiosity in science and mathematics. Through a thorough analysis of their responses, three primary themes emerged: project-based learning, applied learning, and game-based reward systems. These themes reflect the students' desire for engaging, relevant, and interactive approaches that enhance their educational experience.

Theme 1: Project-based Learning

Project-based learning emerged as a dominant theme, with students underscoring the value of long-term, collaborative projects in cultivating both engagement and a deeper understanding of science and mathematics. Participants emphasized that real-world problem-solving allowed them to apply theoretical knowledge in a practical context, which not only reinforced their learning but also kept them intellectually invested. The engagement through meaningful application is particularly significant in the context of curiosity as a psychological and pedagogical phenomenon. This approach aligns with the theory that curiosity thrives when learners are presented with challenges that are both relevant and complex, thereby stimulating their intrinsic motivation to explore and discover.

> "Engaging in long-term projects where we solve real-world problems allows us to apply what we learn in a meaningful way. It keeps us invested and curious about the outcomes."

> "Working on a long-term project allows me to explore a topic in depth. I can connect various concepts and see how they fit together, leading to a stronger grasp of the material."

> "Group projects allow us to tackle problems together. Discussing ideas with peers opens up different perspectives and makes learning more dynamic."

The critical thinking skills fostered through group discussions were also noted. Students revealed that the opportunity to defend their ideas and engage with alternative viewpoints not only deepened their understanding of the subject matter but also cultivated a sense of inquiry and intellectual exploration. This process supports Vygotsky's sociocultural theory, where collaborative dialogue fosters cognitive development and curiosity.

> "Discussing different approaches in a group pushes me to think critically. I learn to defend my ideas and consider alternatives, which strengthens my understanding of the material."

Additionally, the students highlighted the importance of peer teaching, where explaining concepts to others solidified their own understanding. This aligns with the constructivist theory, which posits that teaching others is a powerful tool for reinforcing one's own learning. The peer-driven learning environment also contributed to a culture of collaboration, where curiosity was nurtured through shared exploration.

> "Explaining concepts to others helps me solidify my own understanding. Peer teaching is incredibly effective, sometimes my classmates can explain things in a way that makes more sense to me."

> "Creating small learning communities where we can discuss ideas and work together on problems develops collaboration. This peer interaction often sparks curiosity and deeper understanding."

Theme 2: Applied Learning

Applied learning was another critical theme that emerged, illustrating its profound impact on students' engagement and comprehension in mathematics and science, particularly within the context of GenAI-dependent classrooms. Students emphasized the importance of linking abstract mathematical theories to real-world applications. For instance, when professors related mathematical theories to fields like economics or engineering, students reported that these connections made the subject matter more comprehensible and relevant to their daily lives. This practical relevance not only deepened their understanding but also enhanced their motivation to engage with the material. The application of abstract concepts to real-world contexts is consistent with research on the role of curiosity in motivating learners, as it provides both an intellectual challenge and a tangible link to real-world problems.

> "I find it fascinating when professors relate mathematical theories to real-world scenarios, like economics or engineering. It helps me see the relevance of what I'm learning."

> "Instructors should clearly connect scientific and mathematical concepts to real-world applications. Showing us how these subjects impact our daily lives makes learning more relevant and interesting."

> "When we do lab experiments, it makes the concepts come alive. Seeing the reactions and outcomes firsthand deepens my understanding and keeps me engaged."

The motivation derived from discussing *how various careers use math and science* also played a significant role in their learning experience. By learning about professionals who employed these skills daily, students recognized the practical significance of their studies, making the subjects feel more applicable to their future careers. This perspective contributed to a sense of purpose in their educational journey, as they could envision how their learning could lead to meaningful career opportunities.

> "Discussing how various careers use math and science motivates me. Learning about professionals who use these skills daily makes the subjects feel more applicable to my future."

Theme 3: Game-based Reward System

The Game-based Reward System emerged as a key factor in enhancing student engagement and motivation through the incorporation of gamification elements in the learning environment. Participants noted that *incorporating game elements into lessons*, such as challenges, rewards, and competitive quizzes, significantly enhanced their learning experience. They found that these strategies made learning in GenAI-dependent classrooms more engaging, which encouraged them to participate actively in their studies.

> "Incorporating game elements into lessons like challenges, rewards, and competitive quizzes makes learning more engaging and motivates us to participate actively."

Students expressed that *when there were challenges and rewards*, they felt a heightened sense of motivation to engage with the material. The introduction of game-like elements turned what might typically be perceived as tedious studying into an enjoyable and anticipated activity. This shift in perspective transformed their approach to learning, making it a more positive and interactive experience.

> "When there are challenges and rewards, I feel more motivated to participate. It turns studying into something I look forward to rather than a chore."

Integrating game-based elements, instructors effectively capitalized on the psychological phenomenon of "play" to maintain students' interest and curiosity. This approach highlights the role of gamification in fostering a more positive and interactive learning experience. The game-based reward system aligns with research on curiosity-driven learning, suggesting that students' engagement is heightened when the learning process is perceived as enjoyable, stimulating, and tied to tangible rewards.

5. Discussion

The psychological construct of curiosity possesses an internal foundation, yet it manifests externally through observable actions[82]. Intrinsically driven, curiosity emerges in students as they engage in exploratory behaviors and performance-based tasks. In educational contexts, reframing "why" questions into "how" questions supports exploratory learning and encourages deeper engagement[83]. The pursuit of knowledge enables students to take initiative in their explorations, linking curiosity to the depth and relevance of their learning experiences[84,82,85].

Students inherently possess curiosity, which encourages creativity and enhances motivation in learning environments[86]. Kashdan and Silvia[87] define curiosity as the recognition, pursuit, and deep interest in complex, novel, or uncertain experiences. This desire drives learners to immerse themselves in new information and tasks[82]. This was evident among STEM students in GenAI-integrated classrooms. For example, one student expressed, *"I want to explore questions about responsibility and accountability in AI systems. This curiosity leads me to engage with both the science behind AI and its broader societal impacts."* The presence of GenAI appeared to stimulate such curiosity, pushing students beyond conventional boundaries and allowing them to connect theoretical frameworks with practical, real-world issues.

Research supports the link between curiosity and intrinsic motivation[88-90]. During the COVID-19 pandemic, curiosity played a critical role in enabling students to confront learning disruptions and adapt to new challenges[91]. Motivational desires such as knowledge acquisition and recognition served as strong forces that helped students remain engaged and open to diverse perspectives[92,93]. This was similarly reflected in GenAI-supported classrooms. One student noted, “This flexibility means I can review concepts outside of class at my own pace, which reinforces my understanding.” GenAI’s accessibility[94] enables personalized learning experiences[95], which demands sustained curiosity and self-motivation[96]. Students reported that GenAI “motivates [them] to participate and learn more actively” and “frees up [time] to think more critically about the concepts.” Some used tools like ChatGPT to seek answers and explore real-world issues such as climate change and sustainability, illustrating how GenAI supported their curiosity-driven inquiry.

The learning process relies on stu”ents’ curiosity, creativity, and motivation—attributes that are equally vital in teaching practices[82]. In GenAI-supported environments, students emphasized the value of project-based learning, applied learning, and game-based assessments—hallmarks of active learning. One student shared, *“When we do lab experiments, it makes the concepts come alive. Seeing the reactions and outcomes firsthand deepens my understanding and keeps me engaged.”* Through applied learning, students were able to immerse themselves in educational activities, further supported by GenAI assistance. Promoting participation through active learning pedagogy, particularly when integrated with GenAI tools, substantially boosts curiosity and results in more meaningful learning outcomes[97].

Further, there is increasing evidence that engagement significantly enhances curiosity, and leading researchers to acknowledge its crucial role in cultivating curiosity and interest in learning [98]. Active instructional strategies are recognized for building students’ cognitive, social, and emotional skills[95]. The findings highlighted how teacher-led discussions encouraged curiosity in STEM subjects. One student remarked, *“Discussing how various careers use math and science motivates me. Learning about professionals who use these skills daily makes the subjects feel more applicable to my future.”* Through inquiry-based learning, students developed critical thinking by asking questions, investigating topics, and examining career relevance[99]. Within AI-integrated settings, students became increasingly interested in how AI might shape their careers and impact society ethically and practically. These experiences encouraged exploration of not only technological foundations but also the broader implications of AI use, leading to a more holistic educational journey.

However, while GenAI has the potential to enhance curiosity and engagement, its use warrants critical reflection. Over-reliance on AI tools for instant information retrieval may diminish students’ ability to independently analyze, evaluate, and synthesize knowledge. The automation of answers can undermine the cognitive rigor essential for developing problem-solving and critical thinking skills. Moreover, ethical concerns—such as data privacy, algorithmic bias, and intellectual dependency—raise important questions about the role of GenAI in education. There is a risk that students might accept AI-generated responses without evaluating their accuracy or origin, which could compromise academic integrity and reduce the development of critical literacy. These limitations suggest that while GenAI can support curiosity, it should be integrated thoughtfully and complemented by pedagogical strategies that promote reflection, discernment, and intellectual independence.

In addition to the ethical and intellectual limitations surrounding GenAI use, the study’s findings must also be viewed in light of methodological constraints. The small sample size of 32 college students, all from a single city, limits the generalizability of the results to broader populations or different educational contexts. While rich qualitative data were obtained, the limited scope restricts how confidently the findings can be applied across diverse student groups or institutions. Future research with a larger and more diverse sample is necessary to validate and extend these insights. Furthermore, the study would benefit from a more robust theoretical foundation. While curiosity and intrinsic motivation were adequately discussed, a broader integration of existing literature on GenAI's influence in education—particularly studies examining its impact on learning habits, digital literacy, and academic ethics—would strengthen the interpretive depth of the findings. Expanding the literature base in the earlier sections of the study would provide a more comprehensive context and help position this research more clearly within the existing academic discourse.

Despite these limitations, the study emphasizes the value of active learning strategies—such as project-based and inquiry-based approaches—in enhancing curiosity. These methods allow students to apply theoretical knowledge in practical contexts and engage in deeper cognitive processing. Experiences such as laboratory work and career-oriented discussions helped students transform abstract theories into concrete understanding, reinforcing their motivation. When instructors use techniques that promote active participation, they cultivate environments where curiosity thrives. In AI-assisted classrooms, curiosity not only connects learners to academic content but also bridges the gap between education and real-world application, contributing to a rich and meaningful learning experience.

6. Conclusion

The findings suggest that curiosity, though an intrinsic trait, manifests through observable behaviors such as inquiry, engagement, and exploration—particularly within active learning environments supported by generative AI (GenAI). In such settings, curiosity serves as a dynamic catalyst, prompting students to engage more deeply with both theoretical and practical aspects of their academic experiences. The shift from passive absorption to active exploration—evident in how students examine AI's real-world implications—positions curiosity as a vital driver of educational engagement and critical thinking development. GenAI-supported classrooms allow students the autonomy to investigate concepts independently, fostering sustained academic interest and deeper comprehension. Notably, the synergy between curiosity and technology enables students to explore complex, globally relevant topics with increased initiative and depth.

The study also emphasizes the role of teacher-facilitated open discussions, inquiry-based strategies, and the contextualization of academic content within real-world or professional scenarios. These practices further ignite student curiosity, making learning more relevant and purposeful. When academic tasks are aligned with future career contexts, learners tend to find deeper meaning in their studies. This applied and contextual approach not only encourages the development of curiosity but also sustains students' motivation and engagement in tackling complex subject matter.

Despite these encouraging findings, several limitations must be acknowledged. First, the reliance on self-reported reflections and qualitative responses may constrain the generalizability of the results. Individual expressions of curiosity and motivation might not encompass the full spectrum of student experiences in GenAI-integrated classrooms. Furthermore, the positive reception of GenAI tools may have been influenced by their novelty or the limited duration of exposure. The assumption that curiosity-driven learning elicits a uniform response may also overlook the diversity of student motivation across different disciplines and personal learning preferences. Additionally, the relatively small sample size—comprising 32 STEM students from a specific academic context—further limits the external validity of the conclusions. Therefore, while the conclusions are valid within the specific scope of STEM education, their direct application to other educational contexts or disciplines should be approached with caution. Curiosity may manifest and be stimulated differently in other academic fields, and such variations warrant further validation through discipline-specific inquiry.

Moreover, this study does not extensively address the broader ethical and intellectual concerns surrounding GenAI use. Over-reliance on AI-generated responses can potentially hinder the development of independent analytical skills. Similarly, critical issues such as data privacy, algorithmic bias, and the possibility of intellectual dependency remain unexplored within this research. A critical reflection on these areas would contribute to a more nuanced understanding of GenAI's role in education and support more responsible integration. While the study offers valuable initial insights, a more comprehensive review of the existing literature on GenAI in educational settings would provide a stronger theoretical foundation. Engaging more deeply with current academic discourse could further contextualize the findings and strengthen the scholarly significance of the study. Longitudinal studies are recommended to assess the long-term impacts of GenAI tools on students' curiosity, engagement, and learning outcomes across various disciplines.

Conflict of interest

The authors declare no conflict of interest.

References

1. Banh, L., & Strobel, G. (2023). Generative artificial intelligence. Electronic Markets, 33(1), 63.
2. Moundridou, M., Matzakos, N., & Doukakis, S. (2024). Generative AI tools as educators' assistants: Designing and implementing inquiry-based lesson plans. Computers and Education: Artificial Intelligence, 7, 100277.
3. Mittal, U., Sai, S., & Chamola, V. (2024). A comprehensive review on generative ai for education. IEEE Access.
4. Su, J., & Yang, W. (2023). Unlocking the power of ChatGPT: A framework for applying generative AI in education. ECNU Review of Education, 6(3), 355-366.
5. Zhou, E., & Lee, D. (2024). Generative artificial intelligence, human creativity, and art. Proceedings of the National Academy of Sciences Nexus, 3(3), 1–8.
6. Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. Journal of AI, 7(1), 52-62.
7. Abdelghani, R., Wang, Y. H., Yuan, X., Wang, T., Lucas, P., Sauzéon, H., & Oudeyer, P. Y. (2024). GPT-3-driven pedagogical agents to train children's curious question-asking skills. International Journal of Artificial Intelligence in Education, 34(2), 483-518.
8. Ogunleye, B., Zakariyyah, K. I., Ajao, O., Olayinka, O., & Sharma, H. (2024). A systematic review of generative AI for teaching and learning practice. arXiv. https://arxiv.org/abs/2406.09520
9. Cavicchi, E. (2024). Curiosity Opens Relationships of the World and with Others: Narratives from Doing Teaching and Learning Through Curiosity. Interchange, 55(3), 261-301.
10. Lindholm, M. (2018). Promoting curiosity? Possibilities and pitfalls in science education. Science & Education, 27, 987-1002.
11. Zhang, J., Fan, S., & Huang, Z. (2024). How Do Students Develop Creativity and Curiosity? The Role of Out-of-School Activities. ECNU Review of Education, 20965311241228282.
12. Pasaribu, A. R., Siregar, L. Y. S., & Hasibuan, N. A. P. (2024). Integrating Problem-Based Learning and Visual Media to Spark Science Curiosity in Fifth Graders. Journal of Educational Management and Learning, 2(2), 57-63.
13. Weiss, J. (2024). Learning to Learn: Fostering Intellectual Curiosity in Health Care Education.
14. Giannakos, M., Azevedo, R., Brusilovsky, P., Cukurova, M., Dimitriadis, Y., Hernandez-Leo, D., ... & Rienties, B. (2024). The promise and challenges of generative AI in education. Behaviour & Information Technology, 1-27.
15. Mavrikis, M., Rummel, N., Wiedmann, M., Loibl, K., & Holmes, W. (2022). Combining exploratory learning with structured practice educational technologies to foster both conceptual and procedural fractions knowledge. Educational technology research and development, 70(3), 691-712.
16. Singh, A., & Manjaly, J. A. (2022). Using curiosity to improve learning outcomes in schools. SAGE Open, 12(1), 21582440211069392.
17. Hunaepi, H., Suma, I. K., & Subagia, I. W. (2024). Curiosity in Science Learning: A Systematic Literature Review. International Journal of Essential Competencies in Education, 3(1), 77-105.
18. Mahama, I., Asamoah-Gyimah, K., & Dramanu, B. Y. (2024). Examining the Interrelationships Among Curiosity, Creativity, and Academic Motivation Using Students in High Schools: A Multivariate Analysis Approach. Open Education Studies, 6(1), 20240001.

19. Mussel, P. (2022). Processes underlying the relation between cognitive ability and curiosity with academic performance: A mediation analysis for epistemic behavior in a five-year longitudinal study. Journal of Intelligence, 10(2), 23.
20. Shah, P. E., Weeks, H. M., Richards, B., & Kaciroti, N. (2018). Early childhood curiosity and kindergarten reading and math academic achievement. Pediatric research, 84(3), 380-386.
21. Rees, C., Allen, H., Whitehouse, M., Harrison, M., DeVries, E., Sjokvist, G., & Miller, C. (2023). Curiosity-Driven, Inquiry-Based Science Projects Bridge Face-to-Face and Online Learning Formats During COVID-19: A Teacher's Community of Inquiry. The Canadian Journal of Action Research, 23(3), 27-57.
22. Hagtvedt, L. P., Dossinger, K., Harrison, S. H., & Huang, L. (2019). Curiosity made the cat more creative: Specific curiosity as a driver of creativity. Organizational Behavior and Human Decision Processes, 150, 1-13.
23. Steinert, S., Avila, K. E., Kuhn, J., & Küchemann, S. (2024). Using GPT-4 as a guide during inquiry-based learning. The Physics Teacher, 62(7), 618-619.
24. Iyamuremye, A., & Ndihokubwayo, K. (2024). Exploring secondary school students' interest and mastery of atomic structure and chemical bonding through ChatGPT. Educational Journal of Artificial Intelligence and Machine Learning, 1(1), 1-13.
25. Kotsis, K. T. (2024b). ChatGPT Develops Physics Experiment Worksheets for Primary Education Teachers. European Journal of Education Studies, 11(5).
26. Kotsis, K. T. (2024a). ChatGPT as Teacher Assistant for Physics Teaching. EIKI Journal of Effective Teaching Methods, 2(4).
27. Kostka, I., & Toncelli, R. (2023). Exploring applications of ChatGPT to English language teaching: Opportunities, challenges, and recommendations. Tesl-Ej, 27(3), n3.
28. Sok, S., & Heng, K. (2023). ChatGPT for education and research: A review of benefits and risks. Cambodian Journal of Educational Research, 3(1), 110-121.
29. Mai, D. T. T., Da, C. V., & Hanh, N. V. (2024, February). The use of ChatGPT in teaching and learning: a systematic review through SWOT analysis approach. In Frontiers in Education (Vol. 9, p. 1328769). Frontiers Media SA.
30. Wang, W., Chen, Y., & Heffernan, N. (2020). A Generative Model-Based Tutoring System for Math Word Problems. arXiv, 1-20.
31. Söderström, U., Hedström, E., Lambertsson, K., & Mejtoft, T. (2024, October). ChatGPT in education: Teachers' and Students' views. In Proceedings of the European Conference on Cognitive Ergonomics 2024 (pp. 1-10).
32. Law, L. (2024). Application of generative artificial intelligence (GenAI) in language teaching and learning: A scoping literature review. Computers and Education Open, 100174.
33. Lai, R. P. Y. (2023). Harnessing pedagogical innovation and educational technology to revolutionize STEM beyond the classroom: Future directions. STEM Education Review, 1.
34. Dare, E. A., Hiwatig, B., Keratithamkul, K., Ellis, J. A., Roehrig, G. H., Ring-Whalen, E. A., ... & Crotty, E. A. (2021, January). Improving integrated STEM education: The design and development of a K-12 STEM observation protocol (STEM-OP)(RTP). In ASEE Annual Conference proceedings.
35. Siregar, N. C., Warsito, W., Gumilar, A., Amarullah, A., & Rosli, R. (2024). STEM IN ACTION: REAL-WORLD APPLICATIONS OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH. Prima: Jurnal Pendidikan Matematika, 8(2), 493-507.
36. Maspul, K. A. (2024). Exploring STEM Education for Real-World Climate Change Concerns to Empower Students as Change Agents. Journal of Physics Education and Science, 1(2), 12-12.
37. Rehman, S. U. (2024). Fostering Innovation in STEM Education through Multidisciplinary Collaboration. Multidisciplinary Journal of Emerging Needs of Curriculum, 1(1), 39-48.
38. Yang, Y., Sun, W., Sun, D., & Salas-Pilco, S. Z. (2024). Navigating the AI-Enhanced STEM education landscape: a decade of insights, trends, and opportunities. Research in Science & Technological Education, 1-25.
39. Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., Li, X., Jin, Y., & Gašević, D. (2023). Practical and ethical challenges of large language models in education: A systematic scoping review. arXiv. https://arxiv.org/abs/2303.13379
40. Akhtar, F., Khan, H., & Rasheed, M. (2019). The power of positive psychological capital: An Exploratory study. Arabian J Bus Manag Review, 9(387), 2.
41. Swedberg, R. (2020). Exploratory research. The production of knowledge: Enhancing progress in social science, 2(1), 17-41.
42. Hunter, D., McCallum, J., & Howes, D. (2019). Defining exploratory-descriptive qualitative (EDQ) research and considering its application to healthcare. Journal of Nursing and Health Care, 4(1).
43. Singh, A. (2021). An introduction to experimental and exploratory research. Available at SSRN 3789360.
44. Chavez, J. V. (2022). Narratives of bilingual parents on the real-life use of English language: Materials for English language teaching curriculum. Arab World English Journals, 13(3).

45. Duhaylungsod, A. V., & Chavez, J. V. (2023). ChatGPT and other AI users: Innovative and creative utilitarian value and mindset shift. Journal of Namibian Studies: History Politics Culture, 33, 4367-4378.
46. Polit, D. F. (2008). Nursing research: Generating and assessing evidence for nursing practice. Lippin cott.
47. Szabelska, A., Pollet, T. V., Dujols, O., Klein, R. A., & IJzerman, H. (2021). A tutorial for exploratory research: An eight-step approach.
48. Asika, N. (2004). Research methodology: A process approach. Mukugamu & Brothers Enterprises, Lagos.
49. Subedi, K. R. (2021). Determining the Sample in Qualitative Research. Online Submission, 4, 1-13.
50. Olawale, S. R., Chinagozi, O. G., & Joe, O. N. (2023). Exploratory research design in management science: A review of literature on conduct and application. International Journal of Research and Innovation in Social Science, 7(4), 1384-1395.
51. Rai, N., & Thapa, B. (2015). A study on purposive sampling method in research. Kathmandu: Kathmandu School of Law, 5(1), 8-15.
52. Chavez, J. V. (2020). The effects of English as a second language on bilingual parents' English language dispositions. International Journal of Novel Research in Education and Learning, 7(1), 12-25.
53. Bernard, H. R. (2017). Research methods in anthropology: Qualitative and quantitative approaches. Rowman & Littlefield.
54. Chavez, J. V., Adalia, H. G., & Alberto, J. P. (2023a). Parental support strategies and motivation in aiding their children learn the English language. In Forum for Linguistic Studies, 5(2), 1541-1541.
55. Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. Journal of research in Nursing, 25(8), 652-661.
56. Chavez, J. V., & Ceneciro, C. C. (2023). Discourse analysis on same-sex relationship through the lens of religious and social belief systems. Environment and Social Psychology, 9(1).
57. Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. Journal of advanced nursing, 72(12), 2954-2965.
58. Barriball, K. L., & While, A. (1994). Collecting data using a semi-structured interview: a discussion paper. Journal of Advanced Nursing-Institutional Subscription, 19(2), 328-335.
59. Alshenqeeti, H. (2014). Interviewing as a data collection method: A critical review. English linguistics research, 3(1), 39-45.
60. Naz, N., Gulab, F., & Aslam, M. (2022). Development of qualitative semi-structured interview guide for case study research. Competitive Social Science Research Journal, 3(2), 42-52.
61. Rubin, H. J., & Rubin, I. S. (2011). Qualitative interviewing: The art of hearing data. Sage.
62. Hardon, A., Hodgkin, C., & Fresle, D. (2004). How to investigate the use of medicines by consumers. In How to investigate the use of medicines by consumers (pp. 89-89).
63. Pope, C., & Mays, N. (Eds.). (2020). Qualitative research in health care (pp. 111-133). Oxford, UK:: Wiley-Blackwell.
64. Monday, T. U. (2020). Impacts of interview as research instrument of data collection in social sciences. Journal of Digital Art & Humanities, 1(1), 15-24.
65. Hoyle, R. H., Harris, M. J., & Judd, C. M. (2002). Research Methods in Social Relations. London: Thomson Learning. Inc. UK.
66. Seidman, I. (2006). Interviewing as qualitative research: A guide for researchers in education and the social sciences. Teachers college press.
67. Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.
68. Chavez, J. V., & Ceneciro, C. C. (2023). Discourse analysis on same-sex relationship through the lens of religious and social belief systems. Environment and Social Psychology, 9(1).
69. Elhami, A., & Khoshnevisan, B. (2022). Conducting an Interview in Qualitative Research: The Modus Operandi. Mextesol Journal, 46(1).
70. Luo, L., & Wildemuth, B. M. (2009). Semistructured interviews. Applications of social research methods to questions in information and library science, 232.
71. Barrett, D., & Twycross, A. (2018). Data collection in qualitative research. Evidence-based nursing, 21(3), 63-64.
72. Braun, V., & Clarke, V. (2012). Thematic analysis. American Psychological Association. APA Handbook of Research Methods in Psychology, 2, 57-71.
73. Langridge, D. (2004). Introduction to research methods and data analysis in psychology. Harlow: Pearson.
74. Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic analysis. The SAGE handbook of qualitative research in psychology, 2(17-37), 25.
75. Braun, V., Clarke, V., Hayfield, N., Davey, L., & Jenkinson, E. (2023). Doing reflexive thematic analysis. In Supporting research in counselling and psychotherapy: Qualitative, quantitative, and mixed methods research (pp. 19-38). Cham: Springer International Publishing.

76. Shaw, R. (2010). Embedding reflexivity within experiential qualitative psychology. Qualitative research in psychology, 7(3), 233-243.
77. Terry, G., & Hayfield, N. (2020). Reflexive thematic analysis. In Handbook of qualitative research in education (pp. 430-441). Edward Elgar Publishing.
78. Braun, V., & Clarke, V. (2021). Can I use TA? Should I use TA? Should I not use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches. Counselling and psychotherapy research, 21(1), 37-47.
79. Braun, V., & Clarke, V. (2012). Thematic analysis. American Psychological Association. APA Handbook of Research Methods in Psychology, 2, 57-71.
80. Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic analysis. The SAGE handbook of qualitative research in psychology, 2(17-37), 25.
81. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101.
82. Mahama, I., Asamoah-Gyimah, K., & Dramanu, B. Y. (2024). Examining the Interrelationships Among Curiosity, Creativity, and Academic Motivation Using Students in High Schools: A Multivariate Analysis Approach. Open
83. Qablan, A., Alkaabi, A. M., Aljanahi, M. H., & Almaamari, S. A. (2024). Inquiry-Based Learning: Encouraging Exploration and Curiosity in the Classroom. In Cutting-Edge Innovations in Teaching, Leadership, Technology, and Assessment (pp. 1-12). IGI Global.
84. Coleman, T. C. (2014). Positive emotion in nature as a precursor to learning. International Journal of Education in Mathematics, Science and Technology, 2(3), 175-190.
85. Pekrun, R. (2019). The murky distinction between curiosity and interest: State of the art and future prospects. Educational Psychology Review, 31(4), 905-914.
86. Ma, J., & Wei, W. (2023). Curiosity causes creativity? revealing the reinforcement circle between state curiosity and creativity. The Journal of Creative Behavior, 57(4), 488-494.
87. Kashdan, T. B., & Silvia, P. J. (2009). Curiosity and interest: The benefits of thriving on novelty and challenge. Oxford handbook of positive psychology, 2, 367-374.
88. Chen, H., Teng, T., Chen, H., Liu, X., Liu, Z., Li, X., ... & Zhou, X. (2023). Motivation, self-efficacy, perception, curiosity, and barriers toward medical research among undergraduates in China. Biochemistry and Molecular Biology Education, 51(1), 18-28.
89. Paradowski, M. B., & Jelińska, M. (2023). The predictors of L2 grit and their complex interactions in online foreign language learning: motivation, self-directed learning, autonomy, curiosity, and language mindsets. Computer Assisted Language Learning, 1-38.
90. Perényi, D. (2023). Examining the Role of Academic Intrinsic Motivation, Need for Cognition and Curiosity in University Students' Experience of Flow in their Studies (Doctoral dissertation).
91. Huang, Q., Cao, S., Zhou, S., Punia, D., Zhu, X., Luo, Y., & Wu, H. (2021). How anxiety predicts interpersonal curiosity during the COVID-19 pandemic: The mediation effect of interpersonal distancing and autistic tendency. Personality and individual differences, 180, 110973.
92. Ausat, A. M. A., Purnomo, Y. J., Munir, A. R., & Suherlan, S. (2023). Do Motivation Compensation and Work Environment Improve Employee Performance: A Literature Review. International Journal Of Artificial Intelligence Research, 6(1.2).
93. Oh, J. E., Chan, Y. K., & Kim, K. V. (2020). Social media and e-portfolios: Impacting design students' motivation through project-based learning. IAFOR Journal of Education, 8(3), 41-58.
94. Chiu, T. K. (2023). The impact of Generative AI (GenAI) on practices, policies and research direction in education: A case of ChatGPT and Midjourney. Interactive Learning Environments, 1-17.
95. Lashari, A. A., & Umrani, S. (2023). REIMAGINING SELF-DIRECTED LEARNING LANGUAGE IN THE AGE OF ARTIFICIAL INTELLIGENCE: A SYSTEMATIC REVIEW. Grassroots (17260396), 57(1).
96. Cronin-Golomb, L. M., & Bauer, P. J. (2023). Self-motivated and directed learning across the lifespan. Acta Psychologica, 232, 103816.
97. Liu, J., Tahri, D., & Qiang, F. (2024). How Does Active Learning Pedagogy Shape Learner Curiosity? A Multi-Site Mediator Study of Learner Engagement among 45,972 Children. Journal of Intelligence, 12(6), 59.
98. Shin, D. D., & Kim, S. I. (2019). Homo curious: Curious or interested?. Educational Psychology Review, 31(4), 853-874.
99. Jensen, J. L., & Lawson, A. (2011). Effects of collaborative group composition and inquiry instruction on reasoning gains and achievement in undergraduate biology. CBE—Life Sciences Education, 10(1), 64-73.