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Cognitive and behavioral engagement challenges in open and distance learning and potential solutions from artificial intelligence

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Introduction: Open and Distance Learning (ODL) broadens educational access but often limits student engagement due to cognitive overload and weak self-regulation. Artificial Intelligence (AI) offers potential solutions through adaptive support.

Methods: This study employed a qualitative descriptive case study. Data from two focus group interviews, reflective reports, and LMS records were analyzed using reflexive thematic analysis and triangulation.

Results: Students reported cognitive challenges such as processing complex content, information overload, and limited academic writing and quantitative skills, alongside behavioral challenges including procrastination, task prioritization, and difficulties with independent learning. Triangulation confirmed these patterns.

Discussion: Targeted support measures such as structured study planners, writing guidance, and tailored resource recommendations can help learners strengthen self-regulation and engagement. Embedding such supports into ODL can reduce overload and sustain active participation.

KEYWORDS

open and distance learning, cognitive engagement, behavioral engagement, challenges, artificial intelligence

1 Introduction

Open and Distance Learning (ODL) is an educational approach that allows learners to access instruction and resources without being physically present in a traditional classroom. Instead, learning is facilitated remotely through various technologies such as the internet, video conferencing, printed materials, and multimedia tools (Neroni et al., 2018). ODL plays a vital role in expanding access to education by offering greater flexibility, inclusiveness, and convenience. It removes geographical barriers, enabling students in remote or underserved regions to pursue learning opportunities (UNESCO-UNEVOC, 2020). Additionally, ODL accommodates individuals with work, family, or other personal responsibilities by allowing them to study without the need to relocate or disrupt their daily routines. The flexibility in scheduling and pacing also supports diverse learning styles and needs.

In ODL environments, where instructors and learners are physically separated, fostering strong student engagement is essential for achieving successful learning outcomes. ODL has developed rapidly during the epidemic and is also the direction of future education. Student engagement, a multifaceted construct encompassing cognitive, emotional, and behavioral dimensions, lies at the heart of practical learning experiences in ODL environments. It refers to the extent to which learners actively participate, invest effort, and connect meaningfully with their educational pursuits. In ODL, where physical separation between instructors and learners is the norm, fostering robust student engagement is desirable and essential for facilitating successful learning outcomes (Nsamba and Makoe, 2017).

Recent studies on student engagement in online learning have examined the various dimensions and influencing factors that shape learners' participation in digital education environments. A widely accepted framework categorizes engagement into three key dimensions: behavioral, cognitive, and emotional. Behavioral engagement refers to students' active involvement and persistence in learning tasks; cognitive engagement involves deep learning strategies and self-regulation; and emotional engagement encompasses learners' feelings, attitudes, and affective reactions toward the learning experience (Henrie et al., 2015). A study by Al Mamun and Lawrie (2023) emphasizes that student engagement in online settings can be achieved through various forms of interaction, including behavioral, emotional, and cognitive formats. The authors argue that engagement serves as the foundation for a positive teaching and learning experience, highlighting the responsibility of faculty to provide an environment conducive to meaningful engagement.

In addition, Chiu (2021) explores the predictive value of individual characteristics such as online self-efficacy, adaptability to uncertainty, and sources of stress during online learning on learning engagement. Their findings suggest that these relationships could be mediated by online self-regulated learning strategies, indicating the importance of personal attributes and self-management in fostering engagement. This study found that fulfilling these psychological needs is crucial for enhancing student engagement, suggesting that online learning environments should be designed to support these needs to promote active participation. The rapid development of open and distance learning (ODL) has been fueled by advancements in technology and the increasing global demand for flexible education. However, student engagement remains one of the primary challenges in this educational mode. The lack of face-to-face interactions and immediate feedback often leads to issues related to self-regulation, motivation, and technical difficulties, all of which can significantly diminish student participation and impact academic performance (Jin et al., 2023).

With the rapid growth of artificial intelligence (AI), its potential in the educational field is gaining considerable attention. AI can provide personalized learning pathways, real-time feedback, and intelligent tutoring systems that can help students overcome engagement challenges (Xu et al., 2025). Therefore, this study aims to explore the specific behavioral and cognitive engagement challenges faced by students in open and distance learning (ODL) environments and examine how artificial intelligence (AI) technologies might offer solutions to alleviate these challenges. The primary objective is to identify and analyze barriers that hinder student engagement, including time management, independent learning, cognitive overload, and AI trust, and to propose AI-supported strategies based on learner needs. Accordingly, this study is guided by the central research question: what behavioral and cognitive engagement challenges do students face in Open and Distance Learning (ODL), and how can artificial intelligence (AI) technologies be leveraged to address these challenges and enhance student engagement and learning?

Although previous research has identified key barriers to student engagement in ODL, such as difficulties with self-regulation, technical limitations, and feelings of social isolation (Nambiar, 2020), there is still a lack of comprehensive studies offering practical and scalable solutions. While existing AI research often emphasizes personalized recommendation systems, automated assessments, and feedback mechanisms, limited attention has been paid to how AI can directly support student engagement, particularly in fostering emotional involvement and enhancing self-regulation. Furthermore, many studies overlook the influence of cultural factors and varying levels of technological acceptance, both of which may significantly affect the effectiveness of AI-based interventions in diverse learning contexts.

This study contributes to the existing literature by systematically examining the challenges of student engagement in ODL environments and proposing practical solutions supported by artificial intelligence (AI) technologies. By analyzing these challenges from multiple perspectives, the research not only identifies key barriers but also offers theoretical insights into how AI can be used to address them, thereby enhancing learning outcomes. The study adopts a novel cross-disciplinary approach by integrating AI applications into strategies for improving student engagement in ODL. Specifically, it explores personalized learning support, intelligent feedback, and mechanisms for regulating engagement, providing both a theoretical framework and technical guidance for the practical implementation of AI in distance learning (Xu et al., 2025). Emphasizing the importance of individualized needs, this research proposes AI-driven personalized interventions, especially aimed at enhancing learning engagement. By providing real-time feedback and assistance through intelligent learning systems, students can improve their engagement and sense of agency in the learning process (Nambiar, 2020).

Given the centrality of engagement and AI in this study, it is essential to clarify how these concepts are defined and operationalized in the present research. The following section outlines the operational definitions adopted, ensuring that subsequent analysis is interpreted within a consistent conceptual framework. Open and Distance Learning (ODL): in this study, ODL refers to a mode of education in which learners and instructors are spatially separated, and instruction is mediated through digital platforms and other technological tools. This definition is consistent with UNESCO-UNEVOC (2020), which emphasizes ODL's role in expanding access to flexible and inclusive learning opportunities. Cognitive engagement is defined as the mental effort and strategies students use to process, understand, and apply learning content (Fredricks et al., 2004). In this study,

it was operationalized through students' reports of information-processing difficulties, critical and academic writing challenges, and quantitative analysis, as well as LMS. Behavioral Engagement: behavioral engagement refers to students' observable participation and persistence in learning tasks, such as attendance, effort, and task completion (Skinner and Pitzer, 2012). In this study, it was operationalized through focus group reports of procrastination, time management, and adaptation to new tasks, complemented by LMS behavioral indicators including login frequency and forum participation. Artificial Intelligence (AI) Support: AI support in this study refers to the use of AI-powered educational technologies, such as adaptive learning systems, writing assistants, and personalized study planners, to address learning challenges. This operationalization was guided by participants' perceptions and trust in using AI tools (e.g., ChatGPT) to overcome barriers in their ODL learning experiences (Zawacki-Richter et al., 2019; Kasneci et al., 2023).

Despite the rapid growth of ODL, a clear understanding of the specific cognitive and behavioral challenges that hinder student engagement remains limited, particularly in relation to how these barriers can be addressed through artificial intelligence (AI). Previous studies have identified general issues such as self-regulation difficulties, technical barriers, and isolation, but there is still a lack of research that systematically connects these challenges with practical, AI-driven solutions. Building on this gap, the present study is guided by the following research problem: students in ODL environments face persistent cognitive and behavioral engagement challenges, yet there is insufficient clarity on how these challenges can be systematically identified and how artificial intelligence (AI) may provide effective support. Accordingly, this study addresses two interrelated questions: what are the main cognitive and behavioral challenges that students encounter in ODL environments? How can AI technologies, as highlighted in existing literature and practice, help to alleviate these challenges and enhance student engagement?

In the Discussion, we critically analyze the findings, linking them to the broader literature on AI in education and the specific challenges of open and distance learning. We also address the practical implications of these solutions and identify areas for future research. Finally, the Conclusion summarizes the key findings of the study and reflects on its contributions to both academic research and practical applications in educational settings.

2 Literature review

Fredricks et al. (2004) conceptualize learning engagement from a psychological perspective, proposing it as a meta-construct that integrates behavioral, emotional, and cognitive components. Behavioral engagement is defined as an individual's involvement in both academic and extracurricular activities throughout the academic year. The concept includes behaviors such as consistent attendance, active participation in learning tasks, and diligent completion of assignments (Cleary et al., 2021). Fredricks extended the conceptualization of student engagement to include not only behavioral, emotional, and cognitive dimensions but also a social engagement dimension. The broader model emphasizes the importance of social interactions and relationships in the learning process, recognizing that these factors significantly influence student engagement and educational outcomes.

Focusing on student engagement is critical for enhancing learning outcomes and fostering meaningful educational experiences. Research has consistently shown that engaged students tend to achieve higher academic success due to increased motivation, persistence, and application of effective learning strategies (Fredricks et al., 2004; Skinner and Pitzer, 2012). Engagement, which encompasses behavioral, cognitive, emotional, and social dimensions, supports active learning, helps students self-regulate their learning, and mitigates feelings of isolation, particularly in open and distance learning environments (Zimmerman, 2002; Shernof et al., 2017). Furthermore, engagement is directly linked to reducing dropout rates and fostering long-term motivation, which is essential for lifelong learning. By considering engagement as a multifaceted construct, educators can design personalized, contextually relevant learning experiences that align with students' interests and needs, thereby improving both short-term performance and long-term educational outcomes (Kahu, 2013).

Students in distance education (DE) environments face several challenges that significantly impact their engagement, which is essential for successful learning outcomes. One major issue is social isolation, as DE students lack the in-person interactions that help build a sense of community and belonging in traditional classrooms (Hollister et al., 2022). This emotional disengagement, coupled with limited opportunities for peer and instructor support, can decrease motivation and participation in course activities, resulting in poorer academic performance and higher dropout rates (Cho and Cho, 2014). Furthermore, the challenges of self-regulation and time management in the absence of structured schedules often lead to procrastination and poor academic habits (Zimmerman, 2002). The lack of immediate feedback also contributes to cognitive disengagement, as students struggle to clarify doubts or understand complex concepts without timely support from instructors (Hollister et al., 2022).

In addition to these issues, technological barriers present another significant obstacle to engagement. Inadequate access to reliable internet or technical support can prevent students from fully participating in online classes and completing assignments, leading to frustration and emotional disengagement (Gan and Sun, 2022). Moreover, the increased cognitive load in distance learning environments, where students must independently navigate large volumes of information without immediate guidance, further compounds the problem by overwhelming students and reducing their ability to engage deeply with the material (Sweller, 2011). Addressing these challenges requires targeted strategies to improve social interaction, provide timely feedback, support self-regulation skills, and ensure technical accessibility, which could enhance both cognitive and emotional engagement, and ultimately improve student success in distance education settings (Shernof et al., 2017; Kahu, 2013).

Recent advancements in artificial intelligence (AI) have significantly enhanced student engagement in education by addressing common challenges such as isolation, lack of

personalized support, and low participation. AI facilitates personalized learning paths by tailoring content to students' individual needs, preferences, and learning speeds, thereby improving both motivation and engagement (Jin et al., 2025). Additionally, AI-powered intelligent tutoring systems provide 24/7 support, offering real-time feedback and individualized assistance to help students overcome obstacles and stay engaged. Overall, AI applications in education help mitigate the barriers to student engagement, fostering a more dynamic and supportive learning environment.

Artificial intelligence (AI) has increasingly been recognized as a promising solution to address engagement challenges experienced by learners in distance learning environments. Learning engagement, characterized by active mental investment in learning tasks, is crucial for meaningful learning and academic success, yet ODL students often encounter obstacles such as information overload, difficulty in processing complex materials, and insufficient instructional support (Wang et al., 2021). Recent research has emphasized the transformative potential of artificial intelligence (AI), especially ChatGPT, in addressing these cognitive engagement issues. A systematic review and meta-analysis by recent scholarship examined ChatGPT's broad impacts on student engagement, concluding that AI-driven conversational agents significantly enhance cognitive engagement (Heung and Chiu, 2025). Specifically, ChatGPT effectively facilitates deeper comprehension and personalized learning experiences by providing timely, relevant feedback and stimulating critical thought through interactive dialogues. Such personalized, interactive experiences directly address the cognitive barriers that distance learners frequently encounter.

A study exploring the perceptions of students and lecturers at a South African ODL university provided practical insights into ChatGPT's potential for improving cognitive engagement. According to Sevnarayan (2024), students reported that ChatGPT reduced feelings of isolation by offering continuous cognitive support through immediate, personalized interactions, while lecturers acknowledged its capacity to augment teaching effectiveness. The findings underscored ChatGPT's ability to transform perceptions of distance learning by mitigating typical cognitive barriers such as delayed feedback, unclear explanations, and insufficient instructional support. Based on the identified engagement challenges, this study proposes potential AI-assisted solutions informed by participants' experiences and current AI affordances in education (e.g., Zawacki-Richter et al., 2019; Chan and Hu, 2023). Table 1 summarizes these recommendations, which serve as a practical reference rather than an exhaustive solution framework.

This study is significant in several ways. From a theoretical perspective, it contributes to literature by bridging two strands of research that have rarely been integrated: ODL student engagement and AI-supported learning. It highlights the underexplored link between specific engagement challenges and targeted AI interventions. From a practical perspective, the findings provide actionable recommendations for ODL institutions and educators, including the integration of AI-powered tools for time management, writing support, and personalized resource recommendation. These insights can inform the design of learner-centered, technology-enhanced ODL programs, ultimately improving student engagement and learning outcomes.

TABLE 1 Challenges and potential AI solutions.

Challenges	Potential AI solutions
Cognitive challenges	
Trust and reliance in technology	AI literacy training; reliable AI feedback tools
Understanding and processing information	AI-curated resources; adaptive study planners
Advanced academic skills challenge	AI writing assistants; adaptive self-study guides
Specialized knowledge challenges	Interactive AI tutorials; step-by-step guidance tools
Behavioral challenges	
Adapting to new tasks and circumstances	Adaptive learning paths; AI-enabled peer support
Resource searching and independent learning	AI resource aggregators; progress-tracking dashboards
Time and task management	AI scheduling tools; automated task reminders

3 Data and methodology

3.1 Data collection

This study employed a qualitative descriptive case study design (Sandelowski, 2000; Creswell and Clark, 2017) to explore the challenges students face regarding their engagement in open and distance learning (ODL) environments, with a particular focus on how these challenges influence their behavioral and cognitive participation. This design is well-suited for understanding the complex, context-specific experiences of learners in ODL environments, as it enables an in-depth exploration of participants' perspectives while providing rich descriptive accounts of their engagement levels (Maxwell, 1992; Sandelowski, 2000).

Focus groups were selected as the primary method of data collection due to their effectiveness in fostering interactive discussions that allow participants to share perspectives, reflect on experiences, and collaboratively explore challenges encountered in online learning environments (Casey, 2014). The group dynamics within focus groups help generate rich, context-specific insights that might not emerge through individual interviews or surveys. Moderators played a crucial role in guiding the conversations, ensuring equitable participation, and maintaining alignment with the study's central research questions. To enrich the data and facilitate triangulation, two additional sources were incorporated: structured reflective reports and learning management system (LMS) analytics. The reflective reports were designed to elicit detailed accounts of students' cognitive and behavioral engagement throughout the semester. Participants documented their learning experiences, perceived challenges, self-regulation strategies, and interactions with peers and instructors. These narratives offered

TABLE 2 Demographics of focus group participants.

Participant ID	Gender	Marital status	Education level	Year of study	Background	Number of ODL courses attended
P1	Male	Unmarried	Bachelor	Semester 4	Work at Asia Pacific University	12
P2	Female	Unmarried	Bachelor	Semester 4	Primary school teacher	12
P3	Female	Unmarried	Bachelor	Semester 4	Teacher for 3 months	12
P4	Female	Unmarried	Bachelor	Semester 4	English teacher	12
P5	Female	Married and have 3 kids	Bachelor	Semester 4	College chemistry lecturer	12
P6	Female	Married	Bachelor	Semester 4	Teacher for 12 years	12
P7	Male	Married	Bachelor	Semester 5	Teacher	12
P8	Female	Married and have 2 kids	Bachelor	Semester 5	15 years in a primary school	12
P9	Female	Married and have 4 kids	Bachelor	Semester 5	A lecturer at UIA in the Department of Anesthesiology and Intensive Care	12

nuanced insights into students' internal states and meaning-making processes, thereby complementing the more social and discursive data generated from the focus groups. In parallel, objective behavioral data were extracted from the institutional LMS platform. This included metrics such as login frequency, completion rates for formative assessments, and forum participation activity (Henrie et al., 2015; Broadbent and Poon, 2015). Login frequency reflects students' persistence and routine interaction with the learning environment. Completion rates of formative assessments provide measurable indicators of goal setting, time management, and task follow-through, which are essential to behavioral engagement. Forum participation captures students' social interaction and cognitive processing through dialogue, questions, and knowledge construction. These metrics were coded using a percentage-based scale and triangulated with qualitative data from interviews and reflections. This allowed for cross-verification of engagement themes and reduced dependence on potentially biased self-reports, enhancing the study's rigor and trustworthiness.

Participants were recruited through an open email invitation sent to all students enrolled in ODL courses, and those who voluntarily agreed to participate were included in the study. This approach reflects a form of voluntary convenience sampling, which is appropriate in qualitative case study research where the aim is to obtain rich, context-specific insights rather than statistical representativeness (Creswell and Clark, 2017; Sandelowski, 2000). While this sampling strategy may introduce certain self-selection bias, the adequacy of the sample was supported by data saturation, which was reached after two focus groups and nine reflective reports, with no new themes emerging. Data were collected through 2 focus groups, each consisting of 4–5 participants. While participants were drawn from a single institution and academic level, efforts were made to include individuals with varying life circumstances, including differences in gender, employment roles (teachers, lecturers, administrative staff), caregiving responsibilities, and digital literacy. These demographic variations introduced a degree of perspective diversity within the scope of a focused qualitative case study. However, future research should expand to include learners across multiple academic levels, institutions, and disciplines to better capture the full range of engagement challenges in ODL environments. The demographics of the focus group participants are summarized in Table 2. Reflective reports were collected from nine participants as part of their final course assignment. These reports required participants to critically reflect on their learning experiences, challenges encountered, and strategies utilized throughout the course duration, thereby providing insightful qualitative data relevant to their cognitive and behavioral engagement. Quantitative behavioral data was obtained directly from the institution's Learning Management System (LMS) through formal cooperation with relevant administrative departments.

The focus groups were moderated by four lecturers from the department who had previously taught the cohort. While this familiarity helped create a comfortable and trusting environment, it also presented a risk of social desirability bias, where participants might tailor responses to align with perceived academic expectations. To mitigate this, moderators were trained to adopt a neutral stance and emphasize their role as researchers rather than evaluators. At the beginning of each session, participants were assured that their responses would remain confidential, would not affect their academic standing, and were solely for research purposes. Additionally, the inclusion of reflective reports and LMS behavioral data enabled methodological triangulation, which helped cross-validate the findings and reduce the influence of potential response bias. The focus groups were designed to generate informal discussions around students' experiences of their studies. Students were invited to meet in a conference room for the interview and split into two groups, and all participants were treated to lunch and afternoon refreshments as a thank you for their participation. At the beginning of each focus group, students were asked to briefly introduce themselves. This helped students get to know each other in the same group, as most of the students were studying in Open and distance learning. This was followed by a discussion related to their experiences of their studies, focusing on several areas related to their experiences.

A flexible approach was used to allow participants to identify salient topics and talk openly (Silverman and Marvasti, 2008). This helped them to maintain focus on important experiences in their first year of study. The focus groups lasted approximately 1 h and 45 min.

The final sample consisted of nine participants, which is consistent with the requirements of qualitative case study research, where the emphasis is on in-depth exploration rather than representativeness or statistical generalization (Creswell and Clark, 2017; Sandelowski, 2000). Although the total number of participants was relatively small, data saturation was monitored throughout the data collection process to ensure the adequacy of thematic representation. After conducting two focus group interviews and collecting nine reflective reports, no new categories or conceptual insights emerged during preliminary review and open coding. Recurrent themes—such as time and task management issues, uncertainty in trusting AI-generated feedback, and academic writing challenges were consistently reported by participants across both interviews and written reflections. As additional data began to reinforce rather than expand existing codes, thematic saturation was deemed achieved.

To ensure the validity and reliability of the study tools, several strategies were employed. For the focus group interviews, moderators were trained to adopt a neutral stance, confidentiality was assured, and the same semi-structured guiding questions were used across both groups to enhance credibility. For the reflective reports, participants followed a structured template that elicited detailed accounts of their learning experiences, which facilitated consistency and comparability of responses. The LMS data were drawn directly from the institution's official learning management system, ensuring accuracy and reliability of behavioral indicators such as login frequency and assignment completion. In addition, the integration of these three sources through methodological triangulation further strengthened the validity of the findings (Lincoln and Guba, 1985).

3.2 Data analysis

Data was analyzed using reflexive thematic analysis (Braun and Clarke, 2022), a method well-suited for identifying patterns and generating thematic interpretations across qualitative datasets. This approach acknowledges the interpretive role of the researcher and treats their subjectivity as an asset in the analytical process. The integration of data from interviews, reflections, and LMS analytics provided a multidimensional understanding of student engagement challenges in ODL, informing the development of targeted strategies to enhance participation and mitigate identified barriers. Both authors collaboratively engaged in a detailed review of the textual transcripts, immersing themselves deeply in the data. The first author transcribed audio recordings into text. Meaningful segments of the data were systematically identified by both authors, with the first author primarily conducting independent coding reviews to ensure consistency. From these codes, we generated key themes representing critical patterns in students' learning engagement challenges within Open and Distance Learning (ODL) environments. Before finalizing the analysis, these themes underwent multiple rounds of discussion, refinement, and review.

To ensure rigor and trustworthiness, this study adhered to Lincoln and Guba's (1985) principles of qualitative research credibility, dependability, and confirmability. Credibility was enhanced through researcher reflexivity, where both authors actively reflected on their interpretations throughout the thematic analysis process. An audit trail was maintained to document coding decisions, theme development, and any modifications made during the analysis. To enhance the credibility of the qualitative findings, this study adopted a triangulation strategy by incorporating multiple data sources: focus group interviews, reflective reports, and behavioral data extracted from the Learning Management System (LMS). Each data source provided a unique perspective on students' engagement challenges in the open and distance learning (ODL) context. The integration of these sources allowed for cross-validation of themes and patterns, thus increasing the trustworthiness of the interpretations (Creswell and Clark, 2017).

4 Results

4.1 Cognitive engagement challenges

The primary aim of this study is to explore the barriers to student engagement encountered in open and distance learning (ODL) environments, with a particular focus on challenges related to behavioral and cognitive engagement. Analysis revealed prominent cognitive challenges, including difficulty processing complex course materials, information overload, uncertainty in trusting AI-generated content, and lack of critical academic skills, such as writing and quantitative analysis. Behavioral engagement was impeded by students' struggles with unclear task expectations, procrastination, limited time management abilities, and difficulties adapting to new online tasks and digital tools. These findings were consistently confirmed through triangulation across student focus group interviews, reflective reports, and behavioral indicators from Learning Management System (LMS) data, providing robust evidence of students‘ lived experiences and behaviors in the ODL context. The reflexive thematic analysis identified several cognitive engagement challenges, which are summarized in Table 3.

4.1.1 Trust and reliance in technology

Students expressed hesitation in fully relying on AI-driven learning tools. There were concerns about uncertainty in trusting AI, the accuracy of AI-generated feedback, and whether AI tools could genuinely enhance their learning experience.

> *"Again in 2022 it is in the direction of AI. So, say ChatGPT. When I already know ChatGPT, it's really a good friend and then we have an assignment too. Like we sometimes have mental blocks, right, ask ChatGPT. He went out a lot. This idea is good, present near the group. If he can accept it, we will try to realize it*

TABLE 3 Cognitive challenges: reflexive thematic analysis coding summary.

Theme	Sub-theme	Coding
Trust and reliance in technology	Ambivalence toward AI use	Uncertainty in trusting AI-generated content
		Over-reliance on AI for idea generation
		Lack of AI literacy
		Fear of academic misconduct when using AI
	Technical skill difficulties	Difficulty operating animation software, Statistical tools
		Challenges with statistical tools
Cognitive load in resource evaluation	Information overload	Stress due to fragmented content
		Overwhelmed by large amounts of information
	Lack of focus	Difficulty maintaining focus on new assignments
		External distractions
		Tendency to multitask
	Independent resource searching	Frustration from limited LMS materials
		Difficulty finding relevant resources independently
Advanced academic skills challenge	Academic writing and publishing	Difficulty in academic writing and publishing
		Uncertainty about publication process
		Low confidence in writing skills
	Challenges learning quantitative materials	Extra reliance on external books
		Challenges in analyzing quantitative materials
	Critical writing skills	Lack of critical writing skills
		Struggle with argument construction

> *in the form of a video. Because sometimes we don't have ideas. So, ask him (ChatGPT) for his opinion, then rediscover back. (P2 Interview)"*

> *"For me, the AI is very helpful because he is not for us to get his ideas wholeheartedly. But at least I got an idea. I don't know why you can trust AI, right? But his idea is very good. (P2 Reflective report)"*

Participants expressed both appreciation and concern regarding the role of AI particularly ChatGPT in their learning processes. One student described ChatGPT as a "good friend" when facing mental blocks during assignment work, emphasizing how AI could generate ideas quickly when they felt stuck. This sentiment reflects a growing tendency to rely on AI tools not just as a supplementary aid, but as a primary solution to cognitive challenges like ideation and creativity. However, the same narrative reveals a layer of uncertainty about the reliability and originality of AI-generated suggestions. Phrases such as "if he can accept it" and "rediscover back" suggest a need for human validation, implying that while AI offers convenience, its contributions are not always trusted or fully understood.

> *"Whether I do it morning or night like that. ChatGPT also plays many roles. Sometimes for us to get an idea. It's just that near UIA if you use AI, even if we have Turnitin, it can detect AI. So, we have to learn how to use AI, but we also must be good at being humanists. (P1 Interview)"*

Participants demonstrate a heightened concern regarding potential academic integrity issues associated with AI, revealing an underlying tension between their reliance on AI and fears of academic misconduct. The necessity to balance AI usage with original human input increases their cognitive load, while also necessitating further exploration of how teachers determine successful originality. This usage pattern reflects a surface-level interaction with AI, where students turn to it for immediate answers without deeply engaging in critical thinking or knowledge construction. The excerpt illustrates a form of over-reliance, where students lean on AI in moments of uncertainty but remain unsure about how much they can genuinely integrate AI-generated content into their academic work. This ambivalence points to a lack of digital literacy and critical evaluation skills, highlighting that students are not only dependent on AI but also hesitant and untrained in navigating its strengths and limitations.

> *"So, for him, there may be a few parts that might be a challenge in terms of that kind of research, right? methods or related to statistics right. When we study this master's degree, we see that there are qualitative, quantitative, research methods. So, I think it's a bit stuck at the beginning. (P6 Interview)"*

> *"Couldn't create the assignment because I didn't know how to use the statistical software. (P6 Reflective review)"*

Students highlight practical challenges in mastering technical tools necessary for completing academic tasks. Difficulties using specialized software such as animation and statistical tools indicated barriers, indicating that adequate technical assistance may not be in place and that there is room for help in how students can better complete their majors.

The analysis indicates that while AI tools like ChatGPT are recognized as valuable aids in generating ideas and overcoming mental blocks, students maintain substantial uncertainty and caution around their trustworthiness, specifically regarding originality and academic integrity. This tension generates a dual cognitive load: managing the balance between reliance on AI-generated content and maintaining their authentic scholarly contributions. Furthermore, practical difficulties in mastering technical software amplify these challenges, further complicating their cognitive engagement in the learning process. This suggests a critical need for structured guidance and skill training in AI literacy and specialized technological tools to effectively support students' cognitive engagement in open and distance learning contexts.

4.1.2 Cognitive load in resource evaluation

Students reported difficulty in adapting to new assignments, searching for additional online resources, and processing new information.

> *"Related to sharing with classmates, like I change groups every semester because we have mixed with other semesters, it means we are different cohorts, so that one will change whether we take the same cohort (P2 Interview)"*

> *"They help me understand difficult terms, both from the concept of Educational Technology to sections on Augmented Reality, VR, and the like.(P3 Reflective report)"*

> *"I find it difficult to use animation software for my assignments. It takes so much time to learn the basics. (P3 Interview)"*

Students acknowledge that while online tools and resources support understanding complex topics, difficulties persist in effectively utilizing specialized technological resources (e.g., animation software, statistical tools), revealing a need for structured technical skill support.

> *"The reason is that if you follow the note, it is indeed complete but sometimes we need additional reading or examples that are close to the internet. (P2 Interview)"*

Participants feel overwhelmed due to the large volume and complexity of provided information, leading them to seek additional resources, thus increasing cognitive load and stress in their learning process. Due to the huge amount and complexity of the information provided, when participants encountered content, they did not know how to understand but could not find the corresponding content on the school learning system, they sought additional resources, which increased the cognitive load and stress during the learning process.

> *"Due to busy work. We focused on doing work, so we forgot. I kept checking my phone. I do admit it. I was indeed in the middle. (P5 Reflective report)."*

> *"When I encounter a difficult problem during my study, I'd like to watch a short video. (P5 Interview)"*

Students experience significant distractions and competing priorities, particularly from external responsibilities, causing reduced concentration and diminished engagement in academic tasks.

> *"If it's like me, it's related to new things. So, there are times when there are things that we don't know. So that is a challenge for me to look up again on the internet. So that's also looking for something other than. The notes are provided, so we will also look for additional reading. (P3 Interview)"*

Students encounter challenges when independently seeking relevant and reliable information, often requiring significant effort and additional cognitive resources to identify and access suitable academic materials.

This thematic analysis reveals how students struggle significantly with processing information due to overwhelming content volumes, maintaining consistent focus amidst external demands, and independently accessing suitable learning resources. The findings illustrate how cognitive engagement is heavily influenced by environmental and personal factors such as work responsibilities, the complexity of provided content, and technical skill limitations. Students' proactive attempts to seek additional resources and peer support indicate an adaptive response; however, without structured assistance, this independent resource search can further exacerbate cognitive overload. Therefore, it is essential to consider more integrated, accessible learning frameworks and targeted technical skill training to support students' cognitive engagement in open and distance learning contexts.

4.1.3 Advanced academic skills challenge

Students found self-study difficult, particularly in terms of understanding concepts, quantifying course materials, and critical writing.

> *"I have one more thing, then I remember. Our batch of this cohort is actually a bit slow to know the journal publication article. (P5 interview)"*

> *"So is waiting for publication. After submitting it, I'm just waiting for publication. The publishing cycle is a bit long, and I don't know how to publish in a high-quality journal. That's it. (P7 Interview)"*

> *"Submitted late due to unclear journal process. (P7 Reflective report)"*

Students struggle significantly with the process of academic writing and publishing due to limited experience and insufficient understanding of scholarly publishing processes, resulting in frustration and uncertainty.

> *"I buy a lot of books... The reason why the note provided is not understood...I did not understand the note in the portal." (P2 Interview)*

> *"Like if there is an assignment that... What is the name of Tu. the quantitative one, right... I buy a lot of books. I bought a book. The reason why the note provided is not understood. I did say frankly that I did not understand the note in the portal. So, I bought a lot of books. It was expensive. To prepare for me how to do it. The answer to the question. (P9 Reflective report)"*

Students face substantial barriers in comprehending quantitative course content. This challenge necessitates additional

effort, such as purchasing extra resources and highlighting a gap in provided materials and effective instruction.

> *"I think the challenge for me, critical writing. Because at first I wanted to do it in Malay, but I couldn't." (P9 Interview)*

Students encounter significant difficulties in executing critical writing tasks, especially when language constraints are involved, affecting their confidence, engagement, and the quality of academic outputs.

This thematic analysis demonstrates that advanced academic skill challenges significantly affect students' cognitive engagement, particularly in academic writing, quantitative analysis, and critical thinking. Students experience pronounced struggles with scholarly writing and publication processes due to limited experience and inadequate support. Additionally, quantitative materials present consistent comprehension barriers, driving students toward external resources and further increasing their cognitive load. Critical writing skills further complicate students' engagement, especially where linguistic proficiency is insufficient. Overall, these advanced academic skill challenges highlight the need for targeted support strategies, including structured academic writing guidance, accessible quantitative learning resources, and comprehensive language support to enhance student cognitive engagement in open and distance learning contexts.

4.2 Behavioral engagement challenges

Behavioral challenges in ODL focus on learners' ability to manage tasks and adapt to the demands of independent learning. Many learners find it difficult to adjust to new learning environments, requiring them to adopt unfamiliar strategies and routines. The reliance on self-directed resource searching and independent learning further adds to the challenge, as learners must identify and utilize additional materials to supplement their understanding. Time and task management also emerge as critical barriers, with learners often struggling to balance academic responsibilities with personal and professional commitments. Managing time effectively, meeting deadlines, and maintaining consistent progress visibility remain significant hurdles in the ODL context. These behavioral challenges are summarized in Table 4.

4.2.1 Difficulties in managing independent learning tasks

Adapting to new tasks and circumstances in ODL environments represents a major challenge for many students, especially those with limited prior experience in managing independent learning. For many students, lack of experience in online or distance learning environments often leads to difficulties in completing assignments and understanding new tasks. The shift from traditional classroom settings to online platforms can be overwhelming, particularly when students encounter new learning tools or unfamiliar instructional methods (e.g., combining pedagogy with lesson planning).

> *"But my work experience to my assignment is not much because the work experience is not, I don't have much experience with educational technology. So, when, go to assignments all, assign-ments are all new to me. Indeed, there are many new things. Learning alone feels tough. So, I want to say that the challenge is there. (P4 Interview)"*

> *"I feel overwhelmed by new learning tasks and find them difficult and unwilling to face them. I often do things that are not related to learning but make me happy. (P4 Reflective report)"*

TABLE 4 Behavioral challenges: reflexive thematic analysis coding summary.

Theme	Sub-theme	Coding
Difficulties in managing independent learning tasks	Difficulties adjusting to new tasks	Unable to manage multiple assignments effectively
		Difficulty creating required animations
	Self-study	Struggle with self-learning
		No supervising and procrastinate
Difficulties in managing learning resources	Difficulties in independent resource searching	Information retrieval difficulty
		Lack of guidance
	Difficulty of data collection methods	Low efficiency in data collection
		Difficulty of data collection methods
Challenges in time and task management	Goal ambiguity	Schedule management
		Planning difficulties
	Balancing responsibilities	Task prioritization, Editing tasks
		Conflict between family/work and study
	Avoidance and procrastination behaviors	Missing deadlines, Time-consuming
		Delay in progress due to procrastination

Students find it challenging to adapt to unfamiliar tasks due to limited relevant prior experience, creating feelings of overwhelm and affecting their ability to manage multiple simultaneous assignments effectively. The struggle to adapt to new circumstances points to the lack of readiness in handling the online learning environment. Many students are forced to relearn basic academic skills such as time management, self-monitoring, and task prioritization.

> *"What should I do? How many pages do you have to make? What exactly do I have to do? I don't know. What I want to do is just Google near UKM has a website and format for UKM thesis. In LMS there are no articles in the format of your thesis directly. My self-study schedule is still a bit unplanned. (P6 Reflective report)"*

Students encounter significant barriers during independent study due to unclear expectations, lack of structured guidelines, inadequate planning skills, increasing uncertainty, stress, and reducing their self-efficacy.

This thematic analysis highlights students' prominent struggles in adapting to new, unfamiliar academic tasks and independent learning environments. The independent nature of ODL requires a high degree of self-regulation and resource management. Students report feeling overwhelmed due to limited experience with specific educational technologies and a lack of clear instructions, thus hindering effective task management and completion. Moreover, independent learning emerges as particularly challenging, revealing a critical need for structured guidance, clearer learning expectations, and supportive resources to enhance student autonomy and confidence in open and distance learning contexts. These insights suggest that targeted interventions to enhance students' ability to self-regulate their learning, such as structured instructional plans, detailed instructional support, and skills-specific training, could significantly improve students' adaptability and independent learning effectiveness.

4.2.2 Difficulties in managing learning resources

Resource searching and independent learning pose significant challenges for students, especially in an ODL context. The demand for students to search online for additional resources is compounded by distractions, both within the online environment (e.g., social media, unrelated websites) and external factors (e.g., family responsibilities, part-time work). Furthermore, students often struggle with progress visibility, which makes it difficult to gauge whether they are on track with their learning goals.

> *"If it's like me, it's related to new things. So, there are times when there are things that we don't know. So that is a challenge for me to look up again on the internet. So that's also looking for something other than. The notes are provided, so we will also look for additional reading. (P3 Interview)"*

> *"I don't know what's reliable online, I have to Google. (P3 Reflective report)"*

Students experience significant challenges independently retrieving relevant academic information, highlighting inefficiencies and uncertainties in their search processes. Students feel compelled to seek external resources due to perceived gaps or inadequacies in provided materials, resulting in additional cognitive load and effort. Students indicate a clear lack of structured guidance or adequate instructions, significantly complicating the data collection process and heightening their cognitive demands and anxiety.

This thematic analysis reveals that students in open and distance learning contexts encounter notable challenges when independently searching for academic resources and collecting data. The analysis shows that students frequently face difficulty in retrieving relevant information independently, primarily due to inadequate initial resources and a lack of effective guidance, prompting them to invest considerable time and cognitive effort in locating supplementary materials. This challenge underscores the necessity of structured support systems, including clear instructions, guidance in effective information retrieval strategies, and carefully curated resources to mitigate cognitive overload and enhance students' resource-searching competencies and independent learning experiences.

4.2.3 Challenges in time and task management

Time and task management is one of the most prevalent behavioral challenges faced by students in ODL. Many students struggle with balancing responsibilities (such as work, family, and studies), which exacerbates the pressure of completing assignments on time. Time constraints make it even harder to stay on top of course materials and tasks, leading to stress and overwhelm. Students often report a heavy workload, which makes it difficult to prioritize tasks effectively.

> *"Because of the briefing at the beginning, we have informed that for the graduation requirements, students must publish an article with the supervisor, but it may not be clear. (P4 Reflective report)"*

> *"I didn't complete the tasks before the deadline." (P3 Interview)"*

> *"I remembered the publication article. But it's okay, we have a batch and settle all those things. But I suggest, maybe for the other batches, for the second batch that has already been with us at that time, the next batches may be notified or briefed on the journal article earlier so that they are more prepared. Like us, everyone was a bit surprised. So maybe after this, the briefing notification may be made earlier. (P3 Interview)"*

Students experience confusion about learning objectives and requirements due to unclear or inconsistent initial guidance, making effective schedule management challenging. Students face difficulty in effective long-term planning and scheduling due to initial unclear or delayed communication regarding critical academic requirements.

> *"Because maybe you just learned not to get footing, but the second semester is like it's a little smart where their priority list. So, this kind of work must be done first, this one comes second then so there is a checklist first and so that happy. It has settled. (P4 Interview)"*

Students recognize the importance of task prioritization and acknowledge initial struggles with identifying and organizing academic responsibilities effectively. Students imply significant challenges in effectively managing and editing tasks due to competing priorities, suggesting a need for clearer task management strategies.

> *"I am still concerned about the attitude where I always lag behind in the current learning methods. I also sometimes procrastinate. (P8 Reflective report)"*

Students indicate persistent issues with meeting deadlines due to procrastination, significantly affecting their academic progress and learning outcomes. Students describe academic tasks as overly time-consuming, leading to avoidance behaviors, procrastination, and resulting stress. Students identify consistent delays in their academic progress because of procrastination and ineffective time management practices.

This analysis highlights students' considerable challenges in managing time and tasks within open and distance learning settings. Unclear initial briefings and delayed or inconsistent information contribute to significant confusion and ineffective schedule management, causing students to struggle with clear task prioritization and planning. Furthermore, balancing multiple responsibilities and academic tasks becomes increasingly difficult without structured and explicit guidance. Students also frequently exhibit avoidance behaviors such as procrastination, leading to missed deadlines and delayed academic progress. These findings emphasize the urgent need for clear and consistent communication of academic expectations, structured planning tools, and effective support mechanisms aimed at enhancing students' time management skills and reducing procrastination tendencies in the learning process.

Time management and the ability to balance various aspects of life can significantly hinder student engagement and academic success. The pressure of managing multiple responsibilities alongside academic tasks can lead to procrastination, stress, and academic burnout. Distractions hinder students' ability to focus, while a lack of progress visibility makes it difficult to stay motivated. This can lead to a disconnect between the students' efforts and their perceived outcomes.

To enhance the trustworthiness and depth of the qualitative findings, this study employed a triangulation strategy, which is commonly used in case study and interpretive research to validate themes across different data sources. Triangulation enables researchers to cross-check the consistency of observed patterns

TABLE 5 Triangulation: cognitive and behavioral engagement challenges.

Challenge type	Focus group interview (observation)	Reflection (incidents)	Learning management system data (behavioral indicators)
Trust and reliance in technology	P2: "Like we sometimes have mental blocks, right, ask ChatGPT. He went out a lot. This idea is good."	P2: "I don't know why you can trust AI, right? But his idea is very good."	Scored 0/12 in 7 out of 13 courses (e.g., GGGP6193, GGGB6065, GGGP6133) avg. formative score: 1.58% in GGGB6043
Goal ambiguity	P3: "So maybe after this, the briefing notification may be made earlier."	P3: "I didn't complete the tasks before the deadline."	7 out of 13 courses with 0% average formative score (e.g., GGGP6193, GGGP6153) GGGB6063: 158/13 = 12.15% – highest formative score
Lack of focus	P5: "During my study, I'd like to watch a short video."	P5: "I kept checking my phone."	GGGP6133: 1088.89/12 = 90.7%; GGGP6193: 83.18%; GGGP6053: 600/10 = 60%, GGGB6063: 14.06%,
Difficulty adapting to new tasks	P4: "Learning alone feels tough."	P4: "I feel overwhelmed by new learning tasks and find them difficult."	GGGP6113: 96.6%, GGGP6193: 74.7%, GGGP6223: 8.3%, GGGB6063: 20%
Difficulty with technical tools	P6: "Struggled using animation/statistical software."	P6: "Couldn't create the assignment because I didn't know how to use it."	3 out of 13 courses with 0% average formative score (e.g., GGGP6133, GGGP6223) GGGP6193:37.5%
Difficulty in resource searching	P3: "So that is a challenge for me to look up again on the internet."	P3: "I don't know what's reliable online, I have to Google."	7 out of 13 courses with 0% average formative score (e.g., GGGP6193, GGGP6153) GGGB6063: 158/13 = 12.15% – high-est formative score
Academic writing challenge	P7: "I don't know how to publish a journal article."	P7: "Submitted late due to unclear journal process."	GGGB6063: 2.3% GGGP6223: 9.63% GGGP6014: 86.6% GGGP6193: 89.51%
Advanced academic skills challenge	P9: "I buy a lot of books... The reason why the note provided is not understood."	P9: "I did not understand the note in the portal. So, I bought a lot of books."	GGGP6193: 99.51% GGGP6063: 2.31% GGGP6213: 0.83% GGGP6043: 74.62%
Procrastination	P8: "Things are always left to the last minute"	P8: "I am still concerned about the attitude where I always lag behind in the current learning methods."	GGGP6063: 2.3% GGGP6213: 0.83% GGGP6193: 94.02% GGGP6053: 69.3%

and gain a more comprehensive understanding of complex phenomena. In this study, data were collected through focus group interviews, reflective reports, and Learning Management System (LMS) behavioral data. Each source offers a distinct lens: interviews capture verbalized experiences, reflective reports reveal internal self-perceptions, and LMS data provide observable behavioral evidence. The integration of these sources allows for deeper analysis and enhances the reliability of the thematic conclusions. The convergence of findings across focus group interviews, reflective reports, and LMS behavioral data provides strong evidence of students' cognitive and behavioral engagement challenges, as summarized in Table 5.

To enhance the credibility and validity of the findings in this study, a triangulation strategy was adopted by integrating data from three key sources: focus group inter-views, student reflective reports, and behavioral indicators extracted from the Learning Management System (LMS). Each source provided unique and complementary perspectives on students' cognitive and behavioral engagement challenges within the open and distance learning (ODL) context. For example, the theme of goal ambiguity was reflected in participant P3/s observation that early briefing notifications were insufficient, which was further supported by their reflection that they "didn't complete the tasks before the deadline", a pattern confirmed in the LMS data where seven out of thirteen courses had 0% formative assessment scores. Similarly, trust and reliance on technology, particularly the use of AI tools like ChatGPT, was thematically supported by 2/s reliance on AI during mental blocks and mirrored by low formative performance (e.g., 0/12 scores in multiple courses), suggesting a mismatch between AI use and meaningful learning engagement. Themes such as lack of focus, technical tool difficulties, and procrastination also showed consistent patterns across qualitative in-sights and LMS data, reinforcing the reliability of the themes. This convergence of data sources allows for cross-validation of the findings and strengthens the trustworthiness of the study's interpretations, aligning with methodological standards in qualitative educational research (Creswell and Clark, 2017).

5 Discussion and conclusion

This study aims to understand the cognitive and behavioral challenges affecting student engagement in open and distance learning (ODL) environments. A qualitative methodology, using focus group interviews, was employed to allow participants to express the key difficulties they encountered in their learning experiences. Students highlighted various obstacles related to independent learning and time management, which often hindered their engagement. Their narratives align with existing literature, emphasizing that effective learning engagement in ODL requires institutions to provide greater support mechanisms, enhance interactive communication channels, and integrate adaptive learning strategies to address the diverse needs of distance learners.

This study explored the learning engagement challenges faced by Malaysian students in open and distance learning (ODL), particularly focusing on cognitive engagement challenges and behavioral engagement challenges. The findings highlight that students encounter obvious intellectual difficulties in four key areas: understanding and processing information, developing advanced academic skills and trusting and relying on technology. The findings revealed three prominent behavioral challenges: difficulties in adapting to new tasks and circumstances, resource searching and independent learning, and effective time and task management. These challenges impact students' ability to engage effectively with course content and require targeted interventions to enhance learning outcomes. Participants expressed that the absence of real-time guidance and structured learning pathways often led to feelings of confusion and disengagement. These findings suggest that students in ODL contexts face a significant cognitive load—not only in processing academic content but also in managing the logistics of their own learning. This aligns with Zimmerman's (2002) theory of self-regulated learning, which emphasizes the importance of planning, monitoring, and self-reflection in academic success, especially in autonomous learning environments.

Moreover, the behavioral difficulties reported—such as procrastination, unclear task prioritization, and lack of time management—reinforce earlier findings by Broadbent and Poon (2015), who identified time management and metacognitive strategies as key predictors of success in online learning. Students in this study demonstrated a need for clearer learning objectives and more responsive support systems to help them adapt to the demands of asynchronous, self-paced instruction.

A primary cognitive challenge students face is the difficulty in processing complex course materials and adapting to new assignments. Without immediate instructor support, many learners find themselves overwhelmed, struggling to structure their workload and locate reliable learning resources. This challenge directly affects their ability to keep up with coursework, leading to frustration and disengagement. These findings are consistent with recent literature highlighting that online learners often experience cognitive overload due to fragmented content and a lack of personalized guidance (Wiitavaara and Widar, 2025; Adedoyin and Soykan, 2020). Research also indicates that insufficient instructional scaffolding in open and distance learning (ODL) environments contributes to students' difficulty in making sense of learning materials, particularly when navigating self-regulated learning tasks (Martin et al., 2020).

Recent studies highlight the transformative potential of artificial intelligence (AI) in addressing the cognitive and behavioral challenges faced by students in open and distance learning (ODL). From a cognitive engagement standpoint, learners often grapple with information overload, ambiguous learning objectives, and difficulty comprehending complex content. To address these issues, AI-driven resource aggregation platforms can automatically curate and recommend personalized content tailored to individual learners' knowledge levels and goals, thereby reducing cognitive load and enhancing content relevance (Zawacki-Richter et al., 2019). Additionally, AI-powered study planners can deconstruct large academic tasks into manageable subcomponents, aiding in workload organization and promoting clearer cognitive processing (Chan and Hu, 2023). Furthermore, AI-based writing assistants provide real-time, context-sensitive feedback on academic writing, fostering

students' critical thinking and argumentation skills—essential elements of higher-order cognitive engagement (Kasneci et al., 2023). Adaptive AI tutoring systems, which emulate human-like questioning and guidance, can also support learners in navigating complex concepts, offering a digital substitute for instructor interaction in fully online settings (Villegas-Ch et al., 2025).

On the behavioral engagement front, common challenges in ODL include time management, task prioritization, and the maintenance of self-regulated learning behaviors. AI tools can help overcome these barriers through progress tracking dashboards that visualize learning milestones and provide real-time performance feedback, enabling students to monitor progress and adapt their strategies accordingly (Hasnine et al., 2023). For learners unfamiliar with specific digital tools—such as animation or statistical software—AI-enhanced adaptive learning environments offer scaffolded support, adjusting content delivery based on user interaction and learning pace (Chen et al., 2020). Moreover, fostering AI literacy is essential to ensure meaningful engagement. Training students to critically assess AI-generated content not only enhances digital literacy but also promotes reflective and responsible technology use (Chiu, 2024). Integrating AI literacy into the curriculum can help prevent passive reliance on these tools. Finally, AI-based peer and mentor recommendation systems can strengthen social support networks by connecting learners with appropriate guidance at pivotal moments in their academic journey (Daher, 2025). This is consistent with previous reviews on AI chatbots, which also highlighted both the supportive role and the challenges of integrating such tools in education (Hwang and Chang, 2021).

Students reported that self-study is particularly difficult due to challenges in critical writing, quantifying course materials, and conducting high-level analysis. The absence of structured guidance in ODL environments often leaves students feeling lost, affecting their academic confidence and performance. This study found that these difficulties are linked to metacognitive regulation, where students struggle with planning, monitoring, and evaluating their own learning. AI-powered writing assistants and adaptive self-study companions could serve as effective solutions by offering real-time feedback and guiding students through complex concepts. Another major challenge identified was the difficulty in mastering specialized knowledge areas, such as quantitative methods, technology integration, and pedagogy-based lesson planning. Many students lacked prior experience in these domains, making it harder for them to engage with the coursework effectively. Specific challenges included difficulty in using animation software and technical tools required for assignments. Addressing this challenge requires AI-assisted learning tools that offer step-by-step tutorials and interactive guidance, helping students acquire essential technical skills more efficiently.

Many students expressed uncertainty and hesitation in fully trusting AI-driven learning tools. Concerns about the accuracy of AI-generated feedback and whether AI can genuinely enhance the learning experience were prevalent. This aligns with the Technology Acceptance Model (TAM), which emphasizes that students' perceived usefulness and trust in technology significantly influence adoption. If students struggle to evaluate AI-generated content, they may experience cognitive overload, expending additional mental effort to verify information rather than focusing on learning. The study suggests that institutions can help mitigate this challenge by incorporating AI literacy programs and digital critical thinking training to enable students to effectively assess AI-generated content.

The diversity of the participants, though limited in sample size, offers meaningful insight into how individual demographic factors shape engagement and AI acceptance in ODL contexts. All nine participants were Bachelor-level students in later semesters, but their professional and personal profiles varied considerably. For instance, P1 and P7, both male, held positions in higher education and school teaching respectively, suggesting moderate familiarity with educational technology, yet both still reported difficulties with adapting to new tools and managing workloads. Several female participants, such as P5, P8, and P9, were married with multiple children (3–4), and simultaneously held demanding professional roles challenges that amplified their time management and cognitive load, often resulting in procrastination and fragmented engagement. P2, P3, and P6, though unmarried or early-career teachers, also struggled with academic writing and information processing, reflecting the challenges of transitioning into academic learning while balancing teaching responsibilities. Notably, AI acceptance appeared to differ based on technological exposure and workload pressure: P2 and P5 expressed cautious optimism toward ChatGPT, using it as a brainstorming tool, while P6 and P9 exhibited greater skepticism, concerned about trust, originality, and alignment with academic standards. These patterns underscore that engagement and AI use are deeply shaped by individual life contexts—including gender roles, caregiving duties, career stage, and prior technological exposure. Thus, future AI-supported ODL strategies should consider such demographic variations to provide more equitable and responsive learner support.

The primary aim of this study was to identify and understand the behavioral challenges faced by Malaysian students in open and distance learning (ODL) environments. Learners frequently experienced significant difficulties in transitioning from face-to-face learning to fully online modes, highlighting a notable lack of readiness and necessary skills to manage independent online learning effectively. Consistent with prior research, students struggled considerably with balancing academic demands alongside personal and professional commitments, often reporting feelings of stress, overwhelm, and burnout. Furthermore, the need for independent resource searching was exacerbated by frequent distractions, diminishing students' focus and perceived learning progress. These insights address the study's central research question, illustrating that behavioral engagement in Malaysian ODL contexts is heavily influenced by students' capacity for self-regulation, adaptation, and effective task management. To mitigate these challenges, AI-driven tools, such as adaptive resource aggregators, personalized learning planners, and automated task-management systems, could offer significant support, facilitating a smoother transition to ODL and enhancing students' capacity to maintain sustained, productive engagement.

In addition to the pedagogical and technological dimensions, cultural factors play a crucial role in shaping students' engagement and perceptions of AI in ODL environments. Within the

Malaysian and broader Southeast Asian context, learners often come from collectivist societies that emphasize respect for authority, deference to teachers, and conformity to academic expectations (Hofstede, 2001). These cultural norms may influence how students engage with online learning platforms, prioritizing compliance and external guidance over independent exploration. Such dynamics may partly explain the hesitation expressed by participants in fully trusting AI tools, particularly when these systems lack direct human oversight. Moreover, high power distance in educational settings may lead students to feel less confident in questioning AI-generated feedback or seeking clarification autonomously. These cultural tendencies contrast with Western ODL contexts, where individualism and learner autonomy are more strongly emphasized, potentially facilitating quicker adoption and experimentation with AI-assisted tools. Therefore, future AI design and implementation in ODL must consider cultural expectations around hierarchy, trust, and student-teacher interaction to ensure that technologies are both usable and culturally resonant. Acknowledging and integrating these contextual nuances is essential to advancing inclusive and effective AI-supported education in Southeast Asia.

From a practical perspective, the findings call for institutions to re-evaluate how they structure ODL programs. Institutions should consider implementing AI-driven tools that assist with personalized time management, scaffolded self-study guidance, and intelligent feedback systems that mimic the presence of instructors. Interactive dashboards and real-time progress tracking could help mitigate the sense of disconnection and provide timely prompts for re-engagement. These tools not only support cognitive processing but also address behavioral engagement by encouraging goal setting, monitoring, and reflection.

The contribution of this study lies in its detailed qualitative exploration of the dual-layered nature of learning challenges—cognitive and behavioral—in ODL settings, which are often discussed separately in the literature. While much of the literature on student engagement in distance education is based in Western contexts, this study provides a culturally and contextually grounded perspective by focusing on Malaysian students in an ODL environment. It highlights the unique cognitive and behavioral challenges they face, such as struggling with complex assignments, lack of academic writing experience, procrastination, unclear learning goals, and difficulty in time and task management. By capturing the voices of Malaysian learners through interviews, reflections, and LMS behavioral data, the study offers localized insights that can inform learner support strategies within the Southeast Asian higher education context. It offers actionable insights for educators and system designers aiming to create more responsive, learner-centered digital learning environments.

While this study provides valuable insights into student engagement challenges in ODL and the role of AI as a potential solution, several limitations should be acknowledged. First, the study employed a qualitative case study approach with a limited number of participants, which may restrict the generalizability of the findings to broader ODL populations. The research is based on a small sample of only nine participants from a single institution in Malaysia. This limited sample size restricts the generalizability of the findings and calls for caution in applying these results to broader populations. Rather than claiming universal applicability, the findings should be understood as exploratory and context-specific, offering localized insights into the learning experiences of a particular group of ODL students. Future studies are encouraged to broaden participant recruitment across multiple institutions and diverse demographic groups to enhance the representativeness and external validity of the results. The themes identified were specific to the experiences and contexts of the students interviewed and may not fully capture the diversity of challenges faced by learners across different disciplines, institutions, or cultural settings.

Second, although the study employed triangulation across three data sources (focus group interviews and reflective reports), and LMS behavioral analytics two of these are self-reported and subject to social desirability or recall bias. Additionally, LMS data, while objective, primarily reflect observable actions and may not fully capture internal cognitive or emotional states. For example, emotional engagement or motivational fluctuations are difficult to infer from login frequency or task completion data alone. Given that this study intentionally focused on behavioral and cognitive engagement, the nuances of emotional engagement and underlying motivation were not within the present scope. Future studies may benefit from incorporating more longitudinal methods, such as diary studies, experience sampling, or biometric data (e.g., eye-tracking, facial expression analysis), which can provide deeper, real-time insights into learners' emotional and motivational experiences. Furthermore, embedding validated psychological instruments to assess emotions and motivational orientations could complement LMS and self-report data to form a more complete picture of engagement in ODL environments. These areas remain important for a holistic understanding of student engagement and will be explored in future research.

Finally, the AI solutions proposed, such as adaptive learning paths, intelligent writing assistants, and AI-generated feedback, remain conceptual in this study. These suggestions were grounded in participants expressed needs and supported by current literature but have not yet undergone empirical validation. A key recommendation for future research is to design pilot studies or quasi-experimental interventions that implement these AI tools within ODL settings. Such studies should assess the actual impact of AI-driven systems on students' engagement, self-regulation, and academic outcomes over time. This empirical testing is necessary to move from theoretical promise to practical effectiveness and to inform scalable, evidence-based integration of AI in open and distance learning.

This study explored the complex cognitive and behavioral engagement challenges faced by students in open and distance learning (ODL) environments, while also examining the potential of artificial intelligence (AI) to mitigate these barriers. Using a triangulated approach that incorporated focus group interviews, student reflective reports, and learning management system (LMS) behavioral data, the analysis identified persistent issues such as information overload, concentration difficulties, technical skill gaps, procrastination, and challenges in academic writing and

information retrieval. These obstacles significantly undermined students' motivation, self-regulation, and academic success in self-paced learning contexts.

The findings highlight the potential of AI-driven tools to address these engagement barriers. Technologies such as adaptive learning platforms, AI-powered study planners, intelligent writing assistants, and real-time progress dashboards can offer personalized support and timely feedback, enabling students to manage their workload more efficiently and cultivate critical learning strategies. However, the effective implementation of these tools depends on students' digital literacy and institutional guidance to promote responsible and reflective AI use. By aligning AI applications with the authentic challenges faced by ODL learners, this study contributes to a more grounded, student-centered perspective on technology-enhanced education. Future research should investigate the long-term effects of AI interventions on learner autonomy and sustained engagement, particularly across varied educational contexts, disciplines, and learner demographics.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Universiti Kebangsaan Malaysia's ethical guidelines. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YX: Data curation, Visualization, Formal analysis, Methodology, Conceptualization, Writing – original draft. FK: Methodology, Writing – review & editing, Resources. AK: Conceptualization, Project administration, Writing – review & editing, Supervision.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Gen AI was used in the creation of this manuscript. Artificial intelligence (AI) tools were used during the preparation of this manuscript to assist with language refinement, improve clarity of expression, and help structure academic content.

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References

Adedoyin, O. B., and Soykan, E. (2020). COVID-19 pandemic and online learning: the challenges and opportunities. *Interact. Learn. Environ.* 28, 1–13. doi: 10.1080/10494820.2020.1813180

Al Mamun, M. A., and Lawrie, G. (2023). Student-content interactions: exploring behavioural engagement with self-regulated inquiry-based online learning modules. *Smart Learn. Environ.* 10:1. doi: 10.1186/s40561-022-00221-x

Braun, V., and Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qual. Psychol.* 9, 3–26. doi: 10.1037/qup0000196

Broadbent, J., and Poon, W. L. (2015). Self-regulated learning strategiesacademic achievement in online higher education learning environments: a systematic review. *Internet High. Educ.* 27, 1–13. doi: 10.1016/j.iheduc.2015.04.007

Casey, R. A. (2014). *M.A., Focus Groups: A Practical Guide for Applied Research*. Thousand Oaks: SAGE Publications.

Chan, C. K. Y., and Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *Int. J. Educ. Technol. High. Educ.* 20, 43. doi: 10.1186/s41239-023-00411-8

Chen, L., Chen, P., and Lin, Z. (2020). Artificial intelligence in education: a review. *IEEE Access* 8, 75264–75278. doi: 10.1109/ACCESS.2020.2988510

Chiu, T. K. (2024). Future research recommendations for transforming higher education with generative AI. *Comput. Educ. Artif. Intell.* 6:100197. doi: 10.1016/j.caeai.2023.100197

Chiu, T. K. F. (2021). Applying the self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic. *J. Res. Technol. Educ.* 54, S14–S30. doi: 10.1080/15391523.2021.1891998

Cho, M.-H., and Cho, Y. (2014). Instructor scaffolding for interaction and students' academic engagement in online learning: mediating role of perceived online class goal structures. *Internet High. Educ.* 21, 25–30. doi: 10.1016/j.iheduc.2013.10.008

Cleary, T. J., Slemp, J., and Pawlo, E. R. (2021). Linking student self-regulated learning profiles to achievement and engagement in mathematics. *Psychol. Schools* 58, 443–457. doi: 10.1002/pits.22456

Creswell, J. W., and Clark, V. L. P. (2017). *Designing and Conducting Mixed Methods Research*. Thousand Oaks, CA: SAGE Publications.

Daher, R. (2025). Integrating AI literacy into teacher education: a critical perspective paper. *Discov. Artif. Intellig.* 5:217. doi: 10.1007/s44163-025-00475-7

Fredricks, J. A., Blumenfeld, P. C., and Paris, A. H. (2004). School engagement: potential of the concept, state of the evidence. *Rev. Educ. Res.* 74, 59–109. doi: 10.3102/00346543074001059

Gan, I., and Sun, R. (2022). Digital barriers and individual coping behaviors in distance education during COVID-19. *Int. J. Knowl. Manage.* 18, 1–15. doi: 10.4018/IJKM.290023

Hasnine, M. N., Nguyen, H. T., Tran, T. T. T., Bui, H. T., Ak?apinar, G., and Ueda, H. (2023). A real-time learning analytics dashboard for automatic detection of online learners' affective states. *Sensors* 23:4243. doi: 10.3390/s23094243

Henrie, C. R., Halverson, L. R., and Graham, C. R. (2015). Measuring student engagement in technology-mediated learning: a review. *Comp. Educ.* 90, 36–53. doi: 10.1016/j.compedu.2015.09.005

Heung, Y. M. E., and Chiu, T. K. F. (2025). How ChatGPT impacts student engagement from a systematic review and meta-analysis study. *Comp. Educ. Artif. Intell.* 6:100361. doi: 10.1016/j.caeai.2025.100361

Hofstede, G. (2001). *Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations Across Nations, 2nd Edn.* Thousand Oaks, CA: SAGE Publications.

Hollister, B., Nair, P., Hill-Lindsay, S., and Chukoskie, L. (2022). Engagement in online learning: student attitudes and behavior during COVID-19. *Front. Educ.* 7:851019. doi: 10.3389/feduc.2022.851019h

Hwang, G. J., and Chang, C. Y. (2021). A review of opportunities and challenges of chatbots in education. *Interact. Learn. Environ.* 31, 4099–4112. doi: 10.1080/10494820.2021.1952615

Jin, S.-H., Im, K., Yoo, M., Roll, I., and Seo, K. (2023). Supporting students' self-regulated learning in online learning using artificial intelligence applications. *Int. J. Educ. Technol. High. Educ.* 20:37. doi: 10.1186/s41239-023-00406-5

Jin, Y., Yan, L., Echeverría, V., Gašević, D., and Martinez-Maldonado, R. (2025). Generative AI in higher education: a global perspective of institutional adoption policies and guidelines. *Comp. Educ. Artif. Intell.* 8:100348. doi: 10.1016/j.caeai.2024.100348

Kahu, E. R. (2013). Framing student engagement in higher education. *Stud. High. Educ.* 38, 758–773. doi: 10.1080/03075079.2011.598505

Kasneci, E., Sessler, K., Küchenhoff, H., and Bannert, M. (2023). ChatGPT for good? *On opportunities and challenges of large language models for education. Learn. Individual Differ.* 103:102245. doi: 10.1016/j.lindif.2023.102274

Lincoln, Y. S., and Guba, E. G. (1985). *Naturalistic Inquiry*. Thousand Oaks, CA: Sage. doi: 10.1016/0147-1767(85)90062-8

Martin, F., Polly, D., and Ritzhaupt, A. (2020). Bichronous online learning: blending asynchronous and synchronous online learning. *EDUCAUSE Rev.*

Maxwell, J. A. (1992). Understanding and validity in qualitative research. *Harvard Educ. Rev.* 62, 279–299. doi: 10.17763/haer.62.3.8323320856251826

Nambiar, D. (2020). The impact of online learning during COVID-19: students' and teachers' perspective. *Int. J. Indian Psychol.* 8, 783–793. doi: 10.25215/0802.094

Neroni, J., Meijs, C., Leontjevas, R., Kirschner, P. A., and de Groot, R. H. M. (2018). Goal orientation and academic performance in adult distance education. *Int. Rev. Res. Open Distrib. Learn.* 19, 192–208. doi: 10.19173/irrodl.v19i2.3440

Nsamba, A., and Makoe, M. (2017). Evaluating quality of students' support services in open distance learning. *Turkish Online J. Distance Educ.* 18, 91–103. doi: 10.17718/tojde.340391

Sandelowski, M. (2000). Whatever happened to qualitative description? *Res. Nurs. Health* 23, 334–340. doi: 10.1002/1098-240X(200008)23:4<334::AID-NUR9>3.0.CO;2-G

Sevnarayan, K. (2024). Exploring the dynamics of ChatGPT: students and lecturers' perspectives at an open distance e-learning uni versity. *J. Pedagogical Res.* 8, 212–226. doi: 10.33902/JPR.202426525

Shernof, D. J., Csikszentmihalyi, M., Schneider, B., and Shernoff, E. S. (2017). Student engagement as a general factor of classroom experience. *Front. Psychol.* 8:994. doi: 10.3389/fpsyg.2017.00994

Silverman, D., and Marvasti, A. (2008). *Doing Qualitative Research: A Comprehensive Guide*. Thousand Oaks, CA: Sage.

Skinner, E. A., and Pitzer, J. R. (2012). "Developmental dynamics of student engagement, coping, and everyday resilience," in *Handbook of Research on Student Engagement*, eds. S. L. Christenson, A. L. Reschly, and C. Wylie (Boston, MA: Springer), 21–44. doi: 10.1007/978-1-4614-2018-7_2

Sweller, J. (2011). "Cognitive load theory," *in Psychology of Learning and Motivation, Vol. 55*, eds. J. P. Mestre, and B. H. Ross (San Diego, CA: Academic Press; Elsevier), 37–76. doi: 10.1016/B978-0-12-387691-1.00002-8

UNESCO-UNEVOC (2020). "Open and distance learning," in *TVETipedia Glossary*. UNESCO-UNEVOC. Available online at: https://unevoc.unesco.org/bilt/tvetipedia+glossary/lang=en/show=term/term=Open+and+distance+learning (Retrieved March 20, 2025).

Villegas-Ch, W., Buenano-Fernandez, D., Navarro, A. M., and Mera-Navarrete, A. (2025). Adaptive intelligent tutoring systems for STEM education: analysis of the learning impact and effectiveness of personalized feedback. *Smart Learn. Environ.* 12, 1–31. doi: 10.1186/s40561-025-00389-y

Wang, F., Meng, F., Liu, S., Wang, S., Pan, L., Lin, Z., et al. (2021). Understanding learners' metacognition of online teacher feedback amid COVID-19: a case study in a university livestream instruction context. *Front. Psychol.* 12:861845. doi: 10.3389/fpsyg.2022.861845

Wiitavaara, B., and Widar, L. (2025). Challenges and opportunities related to online studies in higher education. *Educ. Inf. Technol.* 1–26. doi: 10.1007/s10639-025-13406-x

Xu, Q., Liu, Y., and Li, X. (2025). Unlocking student potential: How AI-driven personalized feedback shapes goal achievement, self-efficacy, and learning engagement through a self-determination lens. *Learn. Motiv.* 91:102138. doi: 10.1016/j.lmot.2025.102138

Zawacki-Richter, O., Marín, V. I., Bond, M., and Gouverneur, F. (2019). Systematic review of research on artificial intelligence applica tions in higher education. *Int. J. Educ. Technol. High. Educ.* 16, 1–27. doi: 10.1186/s41239-019-0171-0

Zimmerman, B. J. (2002). Becoming a self-regulated learner: an overview. *Theory Into Practice* 41, 64–70. doi: 10.1207/s15430421tip4102_2