

Exploring the Impact of Online Learning, Digital Access, Study Skills, and Teacher Support on Student Achievement: The Mediating Role of Learning Engagement

Mohammad Faleh Hunitie*

Department of Public Administration, School of Business, University of Jordan, Amman 11942, Jordan.

*Email: Mhunitie57@gmail.com

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ABSTRACT

In Jordan, schools are struggling with a number of challenges in improving student achievement (SA) in digital learning settings. This may be explained by the differences in the access to digital means and the different degrees of student readiness and teaching provision. On that note, it has become necessary to look at those factors that determine the achievement of students. The main aim of the research was to investigate whether online learning (OL), digital access (DA), study skills (SS) and teacher support (TS) have a significant impact on student achievement (SA). It also aimed to verify if learning engagement (LE) mediates the relationships among them. The information was collected using a number of students who are pursuing an educational program at one of the education institutions in Jordan through an online survey. All the responses were analysed in order to prove the hypotheses proposed and make inferences based on a structural equation modelling approach using PLS-SEM. Shows was the one that LE has a positive impact on SA. The findings also revealed that OL, DA, SS and TS positively influence LE and student achievement. Finally, the results confirmed that LE has a mediating effect among the aforementioned factors and SA. Given that there have been very few previous studies on these variables in Jordan, the present research contributes to the literature by examining their impact on student achievement with empirical data from the education sector in Jordan.

Keywords: Online Learning, Digital Access, Study Skills, Teacher Support, Student Achievement

JEL Classifications: D83, J24, I21

1. INTRODUCTION

The fast-paced digitalization of education has fundamentally changed the manner in which knowledge is delivered, accessed and internalized, especially in the developing and emerging economies. Over the past years, technological advancements have led to increased integration of OL systems, institutional reforms, and external disruptions like health crises worldwide, which forces educational institutions to re-evaluate the traditional models of pedagogy (Aftab, 2022; Petare et al., 2023). In this changing landscape, the determinants of SA are becoming more and more complex as they are now not only limited to classroom instruction

but also expanded to digital environments, learner autonomy, and technological infrastructure. Although its usage is on the rise, most educational systems are still grappling with unequal results, which underscores the need to take a critical look at the underlying factors that drive effective learning in online contexts (Yin and Luo, 2024; Kim et al., 2022).

The research is based on the situation in the higher and secondary education sectors, especially in developing countries where digital transformation is evident but diffuse. Such areas are marked by the growing number of enrolled students, the growing e-learning platform, and the increased investment in learning technologies.

Nevertheless, it has been reported that the inequality in digital access, unequal quality of teaching, and different degrees of student preparedness are still preventing the best learning results (Akram and Li, 2024; Shao et al., 2025). As an example, most recent estimates indicate that although more than 70% of students have some sort of internet access, only a fraction are receiving stable, high-quality digital LE, which results in disparities in achievement and engagement (Zafeer et al., 2025). These factors render the education sector especially pertinent in exploring the interaction between technological, behavioural and instructional factors. The choice of OL, DA, SS, and TS as the key determinants is both theoretically and empirically technologic OL itself represents the structural and pedagogical transformation to digital platforms affecting the content delivery and consumption (Kara et al., 2024). It, however, depends on DA, which involves the availability, affordability, and reliability of technological resources required to participate (Al-Kasasbeh et al., 2025). The benefits of OL can be realized only with equitable access as it strengthens the existing inequalities. In addition, SS demonstrates the ability of the learner to regulate himself, manage time, and think critically, which is crucial in less structured online settings (Tin et al., 2024; Jain et al., 2023). Simultaneously, TS is one of the most critical human factors, which offers guidance, motivation, and feedback to promote a better understanding and persistence (Wang et al., 2024; Ibrahim and Aldawsari, 2023). Combined, these variables represent a holistic conception of the digital learning ecosystem, and it combines technological, individual, and instructional aspects.

The key aspect of this framework is LE, which is conceptualised as a multidimensional construct that includes behavioural, emotional, and cognitive engagement in learning activities. Engagement is a widely accepted proximal indicator of academic success, as a mechanism through which external and internal factors affect achievement (Kara et al., 2024; Yang, 2023). This study addresses the call to further explore the processes which connect the inputs of education with its outcomes, instead of directly analyzing the relationships in isolation (Zhang and Zhang, 2024; Kim et al., 2022). Critical review of existing literature shows that despite numerous studies having been carried out on OL and SA, many of them have focused on developed contexts, thus limiting their generalizability to emerging economies (Sharif Nia et al., 2023). TS is also often studied in conventional contexts, and very little is integrated with digital learning frameworks (Fabian et al., 2022). Existing models are rarely used to study all these variables at a time, resulting in fragmented insights (Fabian et al., 2022). Also, researchers do not always take into account the mediating role of engagement, which also could directly affect it (Tin et al., 2024). In this area, there is also a lack of empirical research based on advanced analytical methods like PLS-SEM (Hair et al., 2019). Moreover, there is a research gap in geographical research as there is limited empirical research in developing education systems (Huang and Wang, 2023). The effects of interaction between technological and behavioural variables is under-considered (Yang, 2023).

There is also a limitation with longitudinal perspectives, which limits knowledge of sustained engagement (Sharif Nia et al., 2023).

Lastly, integrative frameworks need to be developed to unite institutional, technological, and individual factors in one model (Al Doghan and Piaralal, 2024). To address the mentioned gaps, the main goals of this study are to assess the direct effects of OL, DA, SS and TS on SA and to determine the mediating role of LE in the said relationships. In this way, the research provide a multifaceted empirically based knowledge of the interactions between the various dimensions and their effects on academic performance in digital environments. The importance of this study is that it made mixed contributions in the fields of theoretical, methodological and practical. Theoretically, it expands the current models by incorporating various constructs into a holistic model, with the flavor of centrality of engagement. It is also methodological in the sense that it uses powerful analytical approaches to prove complex relationships. In practice, it provides actionable guidance to policymakers, educators, and institutions that are interested in improving student performance in the digital environment. The study is applicable in a wide range of educational settings, which means that the findings of the research can be widely applied. The key features of this study that make it unique are the holistic approach, relevance of the context, and interest in the mediation mechanisms. It is driven by the pressing necessity to enhance educational results in the quickly digitizing systems, where the traditional models do not suffice any longer. Finally, this study added to the ever-expanding body of knowledge by providing a subtle, integrative, and context-sensitive interpretation of SA, thus contributing to the academic discourse and the practice of education in real life.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

The theoretical underpinning of the proposed study is rooted in the combination of the Social Cognitive Theory (SCT) and Constructivist Learning Theory (CLT) which offer a powerful and complementary line of understanding of SA in the context of digitally mediated learning. The choice of these theories does not come out of thin air; on the contrary, they are rooted in their high explanatory power in the context of how learners interact with the technological systems, how they regulate their own learning behaviours, and how they construct meaningful knowledge through engagement. These frameworks, combined, allow us to have a comprehensive understanding of how OL, DA, SS, and TS interact to influence SA through the mediating process of learning engagement. SCT, Bandura (1986), is the dynamic interaction between individual factors, behavioural patterns, and environmental factors. This triadic reciprocal determinism is especially pertinent in OL settings and the way students have to navigate digital environments, manage their study behaviour, and react to instructional support in the less structured environments. In this context, SS indicate the individual cognitive and self-regulatory processes of learners and OL and DA denote environmental facilitators or inhibitors. TS is a social influence which determines the motivation, confidence and persistence of learners.

There is strong empirical evidence that SCT can be applied to digital education; for example, Aftab (2022) and Shao et al. (2025)

emphasize that self-regulation is a core aspect of academic success, and that effective study strategies can significantly improve OL outcomes. Equally, Huang and Wang (2023) and Wang et al. (2024) affirm that perceived support and self-efficacy are most important predictors of engagement and achievement in OL environments. The decision to use SCT is also justified by the fact that it can be used to explain the mediating role of LE. Engagement, as a behavioral and psychological concept, demonstrates how students convert external stimuli to active engagement and persistence. In their studies, Al-kasasbeh et al. (2025) and Tin et al. (2024) focus on the interaction and agency as central themes in their studies, which is closely related to SCT. Additionally, studies by Zhang and Zhang (2024) and Kim et al. (2022) have shown that the supportive learning environment promotes the student engagement that in turn leads to the performance which supports the theoretical applicability of the SCT in the current model. In addition to SCT, CLT offers a pedagogical approach that focuses on the active process of knowledge construction through interaction, experience, and reflection (Piaget, 1972; Petare et al., 2023). This theory is especially relevant in OL settings, where digital platforms may demand that learners work independently, collaborate in a virtual team, and employ critical thinking abilities. As a variable, OL adheres to constructivist principles as it enables interactive and learner-oriented experiences. DA makes sure that students are able to engage in such experiences and teacher support is an element serving as scaffolding, which guides a learner through more complex tasks. In this regard, SS allow learners to effectively access, and internalize knowledge, and are therefore fundamental to effective constructivist learning. The rationale of introducing CLT is supported by a large amount of empirical evidence.

As emphasized by Feng et al. (2023) and Singh and Ishrat (2025), well-crafted OL environments facilitate learning by promoting deeper insight and higher-level thinking. Martin and Zen and Ariani (2022) show that instructor presence and support can greatly enhance student engagement in virtual environments, and Jain et al. (2023) provide the evidence of the importance of the use of interactive and collaborative activities in enhancing student engagement and achieving better academic results. Moreover, the authors, Uzorka and Odebiyi (2025) affirm that access to digital tools and resources are essential in facilitating constructivist learning processes, especially in technology-mediated settings. Notably, integration of the theories forms a coherent and comprehensive framework that covers both the behavioural and cognitive aspects of learning. Whereas SCT provides explanations of how students control their behaviour and react to environmental stimuli, CLT provides explanations as to how students actively construct knowledge by engaging with the environment. This two-theoretical method is justified by previous researchers who believe in multi-theoretical approach to understand the complexity of OL (Akram et al., 2017; Petare et al., 2018). Indicatively, Yin and Luo (2024) illustrates that a more detailed idea of student engagement and achievement can be achieved by mixing behavioral and constructivist views. Additionally, some of the empirical studies are in close agreement with the proposed model of this study. To illustrate, Wang et al. (2024) affirm that OL environments have a significant impact on engagement and performance. As Al Doghan and Piaralal (2024) present the crucial role of DA in

developing educational opportunities, Sharif Nia et al. (2023) and Fabian et al. (2022) emphasize the paramount importance of TS in the process of cultivating motivation and engagement. Taken together, these studies offer a solid empirical support to the proposed relationships in this study, which supports the validity of the integrated theoretical framework. Overall, the implementation of SCT and CLT is not only theoretically but also empirically valid. Their joint use does not only enhance the conceptual framework underlying the study but also allows a better insight into the mechanisms through which OL, DA, SS and TS can act on SA via LE. The combination strategy fills the gaps in existing theoretical knowledge and provides a solid platform to further research on the topic of digital education.

2.1. Online Learning and Learning Engagement

The growth of online education has greatly altered the manner in which students engage with the learning environment, with OL playing a key role in determining academic experiences. In this light, OL is not just a form of content delivery but a dynamic platform that encourages engagement, flexibility, and autonomy, all of which are significant motivators of student engagement. Well designed OL environments combine multimedia materials, collaborative tools and interactive activities that motivate students to be active participants, as opposed to passive receivers of information (Zhang and Zhang, 2024; Singh and Ishrat, 2025). This active engagement is directly linked to the increased degree of behavioral, emotional, and cognitive engagement into learning processes. Empirical studies indicate that the design and quality of OL platforms have a significant impact on the level at which students can engage course content. As an example, the design of interactive courses and the timely feedback mechanisms have been found to improve the motivation of students and their long-term attention (Ibrahim and Aldawsari, 2023; Al Yakin and Seraj, 2023). Likewise, the literature emphasizes that pacing flexibility and access enable learners to take charge of their learning journey, thus enhancing their intrinsic motivation to learn (Zafeer et al., 2025; Kara et al., 2024). Besides, the incorporation of discussion forums, virtual cooperation, and real-time communication tools results in the creation of a socially rich environment which further promotes active involvement (Wu, 2023; Huang and Wang, 2023). Theoretically, digitally mediated learning environments promote self-directed behaviors and sustained engagement with content which are both critical antecedents to meaningful engagement. The results of research are consistent, showing that students exposed to well-structured OL systems are more persistent, participate, and invest in their studies (Al-Kasasbeh et al., 2025; Wang et al., 2024). Thus, it can be argued that the changing nature of OL environments presents a strong basis on which the idea of how digital platforms provoke deeper levels of student engagement can be understood.

- H_1 : OL positively affects LE.

2.2. Online Learning and Student Achievement

Increased integration of technology in education has made OL environments one of the determinants of academic performance and defines how well students learn, process and apply their knowledge. The nature and design of technology-driven teaching in the modern contexts do not only affect the

accessibility of information but also the level of understanding and performance outcomes of learners. Properly designed online platforms offer structured information, adaptive learning pathways, and in-time feedback, which contributes to better understanding and retention of knowledge (Akram and Li, 2024; Kim et al., 2022). These characteristics help the learners to review their complex concepts, access a wide variety of learning materials, and learn at their own speed, which helps them improve their overall academic performance. As demonstrated by empirical studies, students exposed to robust and interactive OL systems are likely to exhibit superior academic performance than their counterparts who are exposed to traditional methods alone (Shao et al., 2025; Zafeer et al., 2025). Learners can acquire critical thinking and analytical skills by using multimedia resources, simulations, and problem-based tasks, which are the key to high academic achievement (Uzorka and Odebiyi, 2025). Moreover, OL environments are flexible and can support a variety of learning styles, so students can customize their learning strategies in ways that help them achieve the maximum performance (Petare et al., 2023; Zhang and Zhang, 2024). In a greater sense, the success of technology-based education can be explained by the ability to produce consistent and scalable learning experiences that are consistently quality across various settings. Research always emphasizes that structured digital learning, when coordinated with the pedagogical goals, results in quantifiable changes in academic performance (Jain et al., 2023). The importance of technology-enabled learning environments has, therefore, come to the fore in the need to understand differences in performance by students in the present day education systems.

- H_2 : OL positively affects SE.

2.3. Mediating Role of Learning Environment

To gain an appreciation of the underlying processes through which OL environments affect academic outcomes, it is important to consider the underlying processes that will translate exposure into performance. In present-day educational research, there is growing recognition of the fact that the success of the teaching and learning modes does not entirely depend on the access or design issues, but rather on how far the learners are psychologically and behaviorally immersed within the learning process. This immersion is a multidimensional state of sustained attention, emotional connection and cognitive investment, which, together, determine the manner of knowledge internalization and application (Uzorka and Odebiyi, 2025). In the absence of this active engagement, even highly-organized online learning spaces will not generate significant academic benefits. There is scholarly evidence that the technology-enabled instruction to performance outcomes pathway is often indirect and works through the levels of participation and involvement in learning activities by the students. As an example, interactive platforms that promote discussion, collaboration, and problem-solving are more likely to promote deeper cognitive processing, which, in turn will lead to better academic performance (Yang, 2023). Likewise, students who demonstrate more advanced rates of attention and persistence in the digital context are more probable to achieve better outcomes, as their engagement help to better

understand and remember (Kara et al., 2024; Petare et al., 2023). This view is also substantiated by the research that shows that behavioral and emotional engagement are where critical conduits exist that can connect the instructional inputs to measurable performance (Zafeer et al., 2025; Tin et al., 2024). Furthermore, the interactive and dynamic nature of the digital platforms opens up the prospects of sustained feedback and adaptive learning that support active engagement and strengthen learning outcomes over time (Ibrahim and Aldawsari, 2023; Akram and Li, 2024). In turn, a better overview of how educational technologies can produce significant effects can be achieved by studying the mediating mechanisms that enable instructional environments to have an academic effect.

- H_3 : LE mediates the relationship between SA and OL.

2.4. Digital Access and Learning Engagement

Reliable and equitable access to digital infrastructure has become an essential part of modern educational systems, especially as the learning processes start to become more mediated by technology. The accessibility, affordability and usability of digital tools in such contexts are highly influential in determining the effectiveness of students in effectively engaging in academic activities. When learners have regular access to internet connectivity, tools, and online platforms, they more inclined to engage in learning activities, collaborate with peers, and use educational resources in an effective manner (Singh and Ishrat, 2025; Kim et al., 2022). This elevated accessibility makes participation less obstructive and a more inclusive learning environment in which students feel valued and connected. Empirical literature is always keen on pointing out the fact that inequality in the distribution of DA leads to inequality in the participation of academic activities as well as being emotionally involved in the learning processes. With consistent access to digital resources, students are more motivated, interacted, and able to concentrate on academic activities than those with technological constraints (Al Doghan and Piaralal, 2024; Uzorka and Odebiyi, 2025). Moreover, the use of DA tools help learners work with interactive materials, online discussions, multimedia resources, which contribute to an even more engaging learning process (Zen and Ariani, 2022; Shao et al., 2025). This engagement is also enhanced when students are able to effortlessly navigate the platforms without any technical hitches, thus enabling them to focus on understanding and engagement as opposed to technical limitations. It is also shown by the research that DA helps students to improve their autonomy, allowing the students to have an opportunity to independently study the academic material and have more developed self-directed learning habits (Sharif Nia et al., 2023). This autonomy is highly linked with increased cognitive activities and prolonged participation in academic activities. Also, research highlights that continuity in participating in education is promoted by constant access to OL environments and is necessary to remain motivated and enhance learning outcomes over time (Al Yakin and Seraj, 2023; Uzorka and Odebiyi, 2025). All these findings put a strong emphasis on the importance of DA in influencing meaningful student involvement in educational processes.

- H_4 : DA positively affects LE.

2.5. Digital access and Student Achievement

The growing dependency on digital ecosystems within the education sector has demonstrated the value of technological infrastructure in terms of the outcomes of academic performance. The accessibility of digital resources that can empower students to access, process, and apply knowledge effectively is closely related to the effectiveness of instructional delivery in modern learning settings. It is also more likely that when the students receive sufficient technological assistance, such as devices, consistent internet access, and functioning learning tools, they better able to engage with academic content in a meaningful manner (Zhang and Zhang, 2024; Petare et al., 2023). This technological facilitation makes the process of learning less frictional and allows the process of interacting with the course content to be smoother. Studies have always indicated that students that are exposed to digitally enhanced learning environments, are more likely to report better academic performance because of increased exposure to various learning materials and interactive content. This type of environment enables students to work with simulations, video lectures, and adaptive assessments that support conceptual knowledge and enhance knowledge retention (Fabian et al., 2022; Shao et al., 2025). Furthermore, the nature of digital systems allows learners to retake complicated topics and thus enhances understanding and the overall level of performance (Yin and Luo, 2024; Kim et al., 2022). Moreover, the availability of integrated learning technologies facilitates customized learning patterns that enable students to learn at their own pace and cognitive ability. Such personalization promotes mastery of the content and leads to increased academic success (Al Doghan and Piaralal, 2024; Petare et al., 2023). Research also suggests that sustained exposure to organized OL environments promotes critical thinking and problem-solving skills, which are both crucial to academic success (Feng et al., 2023; Yin and Luo, 2024). Therefore, the contribution of technology-based access to educational materials is commonly known as a major contributor to the enhancement of student achievement in modern education systems.

- H_3 : DA positively affects SA.

2.6. Mediating Role of Learning Engagement

The digital evolution of education has highlighted the idea that learning outcomes are not defined by the technological availability and the design of instruction only, but rather by the inner processes through which students interpret, internalize and take action on learning experiences. In this scenario, the psychological and behavioral engagement of learners is central in the process of converting the inputs of education into quantifiable academic results. Students who are actively involved in the process of learning are more likely to demonstrate greater levels of attention, persistence, and cognitive effort, which, in turn, will result in their increased ability to comprehend and implement academic content in a more effective way (Ibrahim and Aldawsari, 2023; Wang et al., 2024). Empirical research findings are consistently clear that engagement in academic activities is an important tool that educational experiences can have on the performance outcomes. Students who exhibit a high level of involvement in discussions, assignments, and interactive activities are likely to attain better academic outcomes because of deeper intellectual

thinking and long-lasting motivation (Huang and Wang, 2023; Tin et al., 2024). In a similar way, engagement has been found as a key predictor of academic achievement in technology-mediated classroom settings, where self-regulation and active participation are crucial to successful learning (Zen and Ariani, 2022; Kara et al., 2024). This shows that the level at which performance can be enhanced usually depends on the extent to which students engage themselves in the learning processes. Furthermore, studies describe that engagement provides a better retention of information and conceptual understanding through meaningful interaction with learning material. Those learners who are willing to spend time on learning activities have a higher chance of developing critical thinking skills and attaining higher levels of academic mastery (Fabian et al., 2022; Shao et al., 2025). This effect is further reinforced by interactive learning environments, which encourage continuous participation and reflection, which enhances academic performance in the long term (Zen and Ariani, 2022; Jain et al., 2023). Therefore, the learner engagement can be viewed as one of the most crucial explanatory variables that can be used to relate the experience of education to academic achievement in digital environments.

- H_6 : LE mediates the relationship between DA and SA.

2.7. Study Skills and Learning Engagement

The increasing complexity of the contemporary educational setting has brought to the fore the role of learner competencies that allow students to effectively cope with the demands of the academic environment and remain involved in the learning process in a meaningful way. The skill to arrange studying habits, to manage time properly, and to use proper learning strategies is one of these competencies that can significantly influence how students approach learning content. The students with good academic habits are more prepared to process information, retention of knowledge, and a deeper engagement with instructional material (Zen and Ariani, 2022; Jain et al., 2023). Empirical studies have always underlined the fact that good learning behaviors play a key role in enhancing academic experiences both in the real world and the digital world. When learners take organized approaches to their studies, they are more likely to stay focused, accomplish tasks in the most efficient way, and reach a higher degree of understanding (Yang, 2023; Al Doghan and Piaralal, 2024). These behaviors involve note taking, goal setting, self-monitoring and revision strategies, which are all contributory to long term cognitive engagement in academic processes. Moreover, research shows that students who have good learning strategies can more effectively adjust to complex and self-directed learning environments, which has a positive impact on their performance (Huang and Wang, 2023; Tin et al., 2024). Moreover, the literature emphasizes that highly-developed academic habits will enhance the capability of the students to control their learning activities, especially in the setting where they need to study on their own. This self-regulatory ability allow learners to be more consistent, reduce procrastination, and have a more effective interaction with course content (Zafeer et al., 2025; Petare et al., 2023). There is also evidence to suggest that those students who actively implement structured learning techniques exhibit greater levels of cognitive engagement, which in turn directly supports better academic performance. Hence,

disciplined learning behaviors can serve as a cornerstone element in the explanation of variations in SA in different educational settings.

- H_7 : SS positively affect LE.

2.8. Study Skills and Student Achievement

The trends in the academic performance of the modern education system are growing to be dependent on the quality of the teaching support delivered by the educational facility, especially in the settings where learning is mediated by the digital platform. TS that includes guidance, feedback, and motivational reinforcement, is a crucial factor in the development of the perception, processing, and application of academic content by the students. With timely clarification and systemized support offered by instructors, students more likely to feel confident and engage in learning processes (Al-kasasbeh et al., 2025; Tin et al., 2024). Empirical studies have always shown that instructional support is an important factor in improving the academic experiences of learners by bringing about clarity and lowering the level of cognitive uncertainty. The ability to maintain focus during learning activities and a better grasp of complex concepts is demonstrated by students who receive coherent academic guidance (Ibrahim and Aldawsari, 2023; Tin et al., 2024). Additionally, supportive instructional practice is also associated with the formation of a favorable learning environment that promotes students to pay more attention to the course content and to continue to struggle with difficult academic tasks (Feng et al., 2023; Singh and Ishrat, 2025). Other research articles point out that positive feedback and emotional support by the instructors go a long way in motivating and persisting students. This type of academic reinforcement helps learners to surmount the challenges and stay focused on their educational objectives (Zhang and Zhang, 2024; Kara et al., 2024). Also, it has been demonstrated that a high level of instructional presence in learning environments positively affects students in terms of their sense of belonging and reduction of feelings of isolation, which in turn positively influences the academic performance of students (Al Doghan and Piaralal, 2024; Sharif Nia et al., 2023). Altogether, instructional guidance of instructors can be viewed as one of the enabling factors that enhance the capacity of the learners to process information effectively and reach a higher level of academic success in various learning contexts.

- H_8 : SS positively affect SA.

2.9. Mediating Role of Learning Engagement

The psychological and behavioral processes whereby instructional and technological variables are translated into academic ones have received a large amount of academic interest in the modern day educational setting. The extent of sustained engagement with academic work by the learner is one of the most important processes in the process of learning. This type of engagement is generally known as one of the key factors in academic success, especially in an environment where the primary source of information is independent learning and online interaction (Al Doghan and Piaralal, 2024; Shao et al., 2025). An extensive amount of empirical research shows that the experiential and

perceptual judgments of learning inputs, including instructional design, accessibility, and pedagogical interaction, are usually refracted through the level of active participation (Feng et al., 2023). The meaningful involvement of learners is more likely to positively interpret academic stimuli and convert them into improved cognitive outcomes (Zafeer et al., 2025; Ibrahim and Aldawsari, 2023). Research also shows that such engagement enhances persistence, regulation of attention, and emotional resilience, which are all vital in achieving effective academic performance (Al Yakin and Seraj, 2023). Furthermore, the engagement has been suggested as one of the primary explanatory mechanisms in educational psychology, connecting external conditions of learning with internal cognitive processes. Studies indicate that the students, who demonstrate increased rates of participation, are more likely to develop more robust comprehension skills and, more importantly, demonstrate a higher level of academic consistency in the long run (Uzorka and Odebiyi, 2025). Also, engagement allows to engage deeper with the content, allowing learners to more effectively integrate knowledge and perform better on tests (Fabian et al., 2022; Yang, 2023). In general, academic involvement can be considered an important interpretive pathway where educational experiences are transformed into measurable achievement, which can be regarded as important in the understanding of SS in complex learning environments.

- H_9 : LE mediates the relationship between SS and SA.

2.10. Teacher Support and Learning Engagement

Digital and blended learning environments are not only as effective as the technological infrastructure they rely on, but also as effective as the quality of the instructional interaction delivered to the learners. In this context, teacher facilitation is one of the key factors that contribute to cognitive growth, motivation and academic stability in students. A well-structured, responsive, and adaptive instructional guidance create an environment, which can promote a better understanding and sustain academic effort (Al Doghan and Piaralal, 2024; Shao et al., 2025). Numerous research works in the field of pedagogy reveal that pedagogical facilitation plays a crucial role in shaping the ways in which students interpret academic material and stay engaged in the learning activities. Clear explanations, organized guidance, and regular academic guidance can help in reducing cognitive overload, which allow learners to process complex concepts more effectively (Zen and Ariani, 2022; Ibrahim and Aldawsari, 2023). Moreover, the research shows that positive instructional settings can help learners gain more confidence and perseverance, which are necessary to continue making progress in academic tasks (Yin and Luo, 2024; Jain et al., 2023). Moreover, empirical data indicate that high quality instructional interaction can lead to positive learning climate, which, in turn, promotes active engagement and more intellectual involvement. The students who exposed to effective teaching practices more likely to develop better analytical skills and enhanced conceptual understanding (Feng et al., 2023; Wang et al., 2024). It is also found that regular academic guidance improves students capacity to plan their learning process, and academic outcomes over time (Al Doghan and Piaralal, 2024; Yang, 2023). On the whole, the quality of

instruction is a core determinant of academic achievement in the various learning contexts.

- H_{10} : TS positively affects LE.

2.11. Teacher Support and Student Achievement

In modern education systems, the shift to digitally enabled instructional delivery models has enhanced the significance of learning how the instructional delivery methods impact the measurable academic outcomes. The usefulness of modern learning ecosystems is now being measured not just in terms of content accessibility but also in the quality of pedagogical design that facilitates learner understanding and skill acquisition. Properly designed instructional strategies enable the acquisition of knowledge by organizing the information in a manner that maximizes its clarity, accessibility, and cognitive uptake (Huang and Wang, 2023; Kim et al., 2022). Empirical research always illustrates that well-constructed educational delivery systems enhance better performance of learners by assisting the students to relate better with academic information. The integration of multimedia, adaptive instructions, and flexible pacing enable learners to revisit concepts and reinforce understanding, which leads to improved academic outcomes (Uzorka and Odebiyi, 2025; Huang and Wang, 2023). Furthermore, studies have shown that the instructional models that lay stress on clarity and logical sequence, make the learning process significantly easier and enhance students retention rates (Yin and Luo, 2024; Kara et al., 2024). Additional evidence indicates that formal online learning improves the capacity of learners to acquire higher-order thinking processes including analysis, evaluation, and application. The competencies are crucial to the academic achievement of learners in complex and dynamic learning environments (Zafeer et al., 2025; Singh and Ishrat, 2025). Also, research indicates that when the educational material is well-organized, a learner becomes more autonomous, which means that students assume a greater responsibility when it comes to their academic progress (Fabian et al., 2022; Singh and Ishrat, 2025). Altogether, the quality and organization of instructional delivery in digital education settings is a strong predictor of SA, determining how well learners process, understand and apply knowledge across a variety of educational settings.

- H_{11} : TS positively affects SA.

2.12. Mediating Role of Learning Engagement

With modern digital education space, the effectiveness of the learning systems is more and more comprehended through the interplay of the quality of instruction, the features of the learners and the mechanism of cognitive processing that combine to form the academic success. Instead of an isolated operation, the inputs of education are often influenced in an internal psychological process that defines how the students perceive and react to learning experiences. According to this view, it is significant to consider intermediate learning processes that transform an educational exposure into a measurable performance result (Al Yakin and Seraj, 2023; Weng and Wirda, 2025). Large volumes of empirical evidence indicate that the dependence between the educational inputs and academic performance is seldom direct with the

level of active involvement on the part of the students playing a central role in determining the level of learning effectiveness. Once learners show that they are sustaining attention, investing emotionally, and putting mental effort into it, they better equipped to benefit with instructional resources and transform them into better academic outcomes (Feng et al., 2023; Uzorka and Odebiyi, 2025). The studies further show that such participation improves the processing of information, the strength of memory storage, and the conceptual understanding of the information in different learning environments (Zafeer et al., 2025; Ibrahim and Aldawsari, 2023). Moreover, the literature underlines the fact that active academic engagement is a bridging process that mediates external learning conditions with internal cognitive development. Students, who continuously perform academic tasks, are more likely to demonstrate a high level of analytical thinking, improved problem-solving skills, and enhanced academic persistence (Uzorka and Odebiyi, 2025; Jain et al., 2023). This further engagement also promotes motivation and resilience which is essential in achieving long term educational success (Al Doghani and Piaralal, 2024; Zafeer et al., 2025). In general, there is considerable evidence suggesting that academic performance in contemporary learning settings is largely influenced by the degree to which the learner actively engages in his or her learning experiences, and in doing so, turns inputs into outputs.

- H_{12} : LE mediates the relationship between TS and SA.

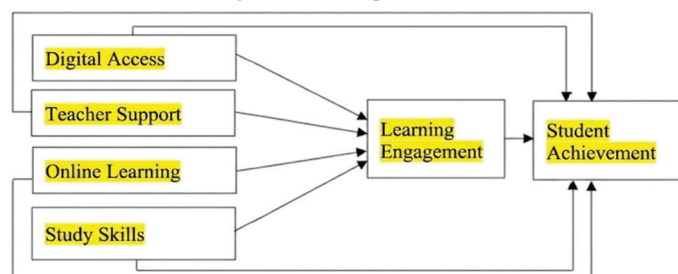
In accordance with the literature review and underlying theories discussed above, the conceptual model for this research is displayed in Figure 1.

3. METHODOLOGY AND DATA

3.1. Data Collection and Sampling

The research data was acquired based on an online survey from students of different educational institutions in Jordan. In the collection of the data, we used the convenience sampling method. According to the literature, it is only appropriate but a wise idea to use a convenience sample when carrying out a multivariate statistical analysis and a study of student behavior in the light of online learning outcomes. First, the targeted respondents were asked to participate in the current study by responding whether they had any previous experience in engaging in online learning platforms in Jordan-based educational institutions. The approached respondents received the survey via emails and social media channels like Facebook, Instagram, WhatsApp, and Twitter. We used the highest ethical standards in the process of

Figure 1: Conceptual model



data collection. The respondents were informed that their identity would be confidential and that their answers optimized to be used in research. Overall, the survey among the respondents allowed retrieving 342 questionnaires. There were nine such responses that were not considered because they were not complete. Finally, a 333 valid responses were used to analyze the data. Just 44.2% of answers were from females, compared to 55.8% from males. In addition, 25.6% of the participants were in the age range of 36-44 years, 34.9% were between the ages of 26 and 35, 24.8% were between the ages of 18 and 25, and just 14.7% were beyond the age of 45. Lastly, a considerable number of respondents (79.4%) were at least at the university level of education.

3.2. Measures

A validated scale was used to measure each construct in our model. In the two meetings, two professors, and two education experts also offered their expertise to ensure the content validity of the survey. Their suggestions were adopted and few changes were done to the measurement scales to ensure that they were appropriate in our research setting. The finalized questionnaire broken into two key sections. The former contains generic questions that are aimed at obtaining information on the demographics of respondents. The second part however contained the measurement items of the constructs. Five items that were selected in (Al-Kasasbeh et al., 2025) were administered to measure OL. A four-item scale, which was an adaptation of (Kim et al., 2022), was used to measure SS. Additionally, TS was assessed using three items based on (Sharif Nia et al., 2023). The paper also utilized four items derived by the researches of Tin et al. (2024) to measure LE. Lastly, we assessed SA using three items modified (Al Doghan and Piaralal, 2024). All the responses were measured using a 5-point Likert scale where 1 was strongly disagree, and 5 strongly agree.

4. ANALYSIS OF RESULTS

All the responses collected were statistically analysed by the PLS-SEM method. PLS-SEM offers better flexibility in comparison to the covariance-based methods Zen and Ariani (2022) like AMOS or LISRE, making it is advantageous to use it when analyzing the data for small sample sizes, especially when normality assumptions are not necessary to be attained (Kim et al., 2022). Moreover, PLS-SEM can be used to analyze the intricate models including many variables, particularly, mediators/moderators (Yang, 2023). The fact that SmartPLS is able to model reflective and formative constructs only further supports the methodological strength of the approach compared to others (Zafeer et al., 2025). Lastly, this software is quite adapted to the analysis of data on behavioral intention in the context of applied research, and, therefore, it focuses on the explanation of variance (R^2) rather than on strict criteria of model fit, hence, it fits the main objectives of the current research (Fabian et al., 2022). Due to the utilization of a self-reported technique and cross sectional survey design in gathering the data, there is a possibility for the occurrence of a common technique bias, which might result in systematic measurement error and bias the estimates of the connections among the constructs. To deal with this, the confirmatory factor analysis (CFA), the collinearity test that was proposed by Zafeer et al. (2025), and the single-factor test that was proposed by Harman Jain et al. (2023)

were all applied to deal with common method bias. The analysis shows that the common method bias of the estimated model is not present in this study, since when all the items of constructs are under the threshold, the bias is absent in the study.

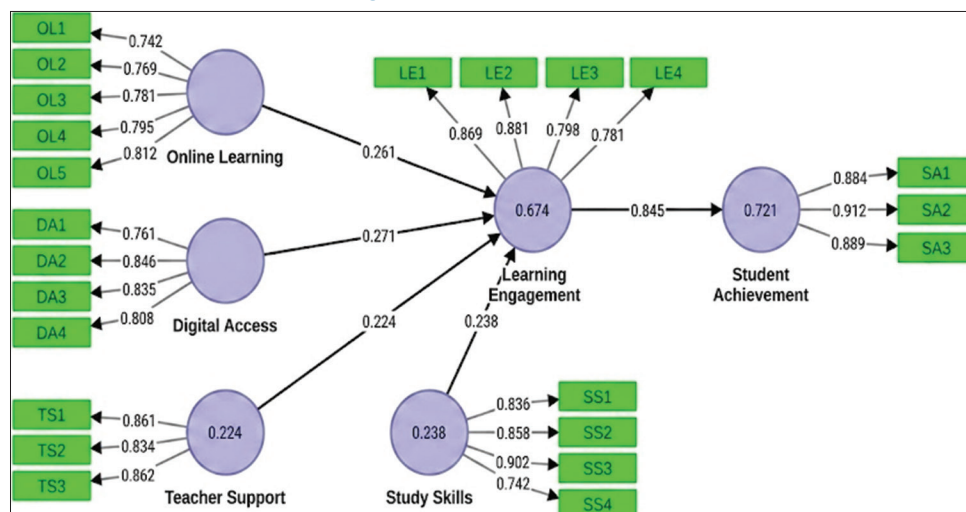
The percentage of variance explained was not more than 50% (Feng et al., 2023). Furthermore, the overall collinearity test revealed that all the VIFs were not above 4, which indicates the lack of pathological collinearity. To estimate the measurement model, firstly, the reliability analysis, the discriminant validity testing, and the convergent validity were used. Specifically, to verify convergent validity and reliability among the measurement items, factor loadings, Cronbachs alpha, average variance extracted (AVE) and composite reliability were all used. Based on the analysis provided Table 1 and Figure 2, it is evident that all the factor loadings of the remaining items were greater than the threshold value of 0.50. In addition, the composite reliability and the Cronbach alpha were also calculated to ensure the internal consistency between the measurement items of each variable. As it can be seen in Table 1, all the values are larger than the cut-off point of 0.7; hence, the assumptions of reliability are met (Al Yakin and Seraj, 2023). More so, the findings indicate that the values of AVE are more than the cut-off value of 0.5. At that, one can say that the assumptions of convergent validity have been fulfilled. The following are the correctly drawn and typed tables with uniform alignment and easy presentation.

In order to assess the discriminant validity between the measurement scales, it was compared in terms of the correlation between the constructs and the square roots of the AVEs (Table 2). The square roots of the AVEs usually exceed the correlations between the variables in the same rows and raw (Wu, 2023). The results demonstrate that discriminant validity as shown in Table 3 is satisfactory. To provide further proof in support of the discriminant

Table 1: Analysis of reliability and convergent validity

Constructs	Items	Loadings	Cronbach's alpha	Composite reliability	AVE
Online learning	OL1	0.742	0.841	0.842	0.603
	OL2	0.769			
	OL3	0.781			
	OL4	0.795			
	OL5	0.812			
Digital access	DA1	0.761	0.828	0.830	0.657
	DA2	0.846			
	DA3	0.835			
	DA4	0.808			
Study skills	SS1	0.836	0.859	0.862	0.698
	SS2	0.858			
	SS3	0.902			
	SS4	0.742			
Teacher support	TS1	0.861	0.823	0.839	0.731
	TS2	0.834			
	TS3	0.862			
Learning engagement	LE1	0.869	0.855	0.856	0.692
	LE2	0.881			
	LE3	0.798			
	LE4	0.781			
Student achievement	SA1	0.884	0.871	0.873	0.799
	SA2	0.912			
	SA3	0.889			

Figure 2: Measurement model



validity requirements, the cut-off value of 85 % was not exceeded by any correlations between constructs. The test of collinearity was evaluated with the help of the VIF after the validity of the measurement scales was checked and the conditions of establishing reliability were met, based on the result of the measurement model. The results showed that there were no collinearity problems as the VIF values were significantly <5. Once the measurement model was determined the structural model was estimated to test the proposed hypotheses. As it can be seen in Table 4, the findings show that SA is positively influenced by OL ($\beta = 0.176$; $t = 3.462$, $P < 0.05$), DA ($\beta = 0.198$; $t = 2.128$, $P < 0.05$), SS ($\beta = 0.251$; $t = 2.637$, $P < 0.05$), and TS ($\beta = 0.162$; $t = 2.241$, $P < 0.05$), with SS having the strongest effect. Finally, the results showed that LE is positively impacted by OL ($\beta = 0.271$; $t = 2.995$, $P < 0.05$), SS ($\beta = 0.224$; $t = 2.163$, $P < 0.05$), DA ($\beta = 0.261$; $t\text{-value} = 2.276$, $P < 0.05$), and TS ($\beta = 0.238$; $t\text{-value} = 3.158$, $P < 0.05$). Therefore, the results of this research support all the direct hypotheses.

In addition, the predictive power, i.e., the explanatory power in addition to the in-sample predictive power among the constructs were determined by calculating R Square (R^2) and the effect size (f^2). In particular, the total variance explained by the independent (exogenous) variables, namely: OL, DA, SS and TS on the mediator and independent (endogenous) variables were measured by R^2 . Moreover, the effect size (f^2) is supposed to quantify the impact of each exogenous variable on both endogenous variables. Table 4 depicts that the independent variables explain around 67.4% of total variance in LE. All these independent, along with LE account 72.1% of total variance in SA. According to Zafeer et al. (2025), the exogenous latent variable f^2 can be classified into small, medium, and large effects based on the corresponding values of 0.02, 0.15 and 0.35 respectively. On the other hand, values <0.02 indicates that there is no Interpreting the value of f^2 leads to the following conclusion. Table 4 indicates that there is a small yet significant effect of DA on SA ($f^2 < 0.02$). Moreover, the analysis reveals that all the independent variables have a moderate effect size on LE ($0.02 < f^2 < 0.35$) and the highest is for TS on SA ($f^2 = 0.109$). To verify the mediating role of LE and SA and selected variables, this study followed the formula which was proposed by (Ibrahim and Aldawsari, 2023). To begin with, the

Table 2: Hypotheses' results

Hypotheses	Relationship	Standard estimate	Standard deviation	t-value	P-value
H ₁	OL→LE	0.271	0.118	2.276	0.023
H ₂	OL→SA	0.176	0.073	2.241	0.028
H ₃	SS→LE	0.224	0.104	2.163	0.033
H ₄	SS→SA	0.251	0.095	2.637	0.008
H ₅	DA→LE	0.261	0.076	3.158	0.002
H ₆	DA→SA	0.198	0.094	2.128	0.036
H ₇	TS→LE	0.238	0.091	2.995	0.003
H ₈	TS→SA	0.162	0.050	3.462	0.001

$P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 3: Discriminant validity (Fornell-Larcker criterion)

Constructs	1	2	3	4	5	6
DA	0.832					
TS	0.381	0.856				
SS	0.486	0.657	0.808			
SA	0.598	0.579	0.617	0.894		
LE	0.622	0.659	0.695	0.846	0.833	
OL	0.683	0.606	0.708	0.673	0.739	0.775

Table 4: Effect size (R^2 and f^2 values)

Endogenous variable	Predictor variable	R^2	f^2
LE	OL	0.674	0.024
	SS	—	0.036
	DA	—	0.067
	TS	—	0.054
SA	OL	0.721	0.022
	SS	—	0.095
	DA	—	0.017
	TS	—	0.109

relationship between OL, DA, SS and TS (independent variables) and SA (dependent variable) should be established. In their rules, when the p-value has statistical significance, then the first condition of the existence of a mediating effect is met. Then the values of upper level (UL) and lower level (LL) are to be determined. In the event that zero value does not exist between lower and upper level value with confidence of 95%, then it could be proved that the independent variable has an indirect effect on the dependent variable. Otherwise, in that case there is not enough evidence

Table 5: Mediation test

Hypotheses	Indirect Effect	SE	t-value	95% LL	95% UL	Decision
H ₃ : OL	0.219	0.098	2.219	0.031	0.407	Supported
H ₆ : SS	0.181	0.084	2.162	0.019	0.362	Supported
H ₉ : DA	0.206	0.066	3.032	0.074	0.338	Supported
H ₁₂ : TS	0.233	0.074	3.018	0.081	0.385	Supported

available to justify the mediating hypotheses. The results that are presented in Table 5 indicate that indirect relationship between OL and SA is confirmed ($\beta = 0.219$, LL = 0.031, UL = 0.407) and, therefore, H₃ is supported. The results also displayed that the indirect effect of SS ($\beta = 0.181$, LL = 0.019, UL = 0.362) on SA is positive and significant, thus, H6 is accepted. Similarly, the mediating role of LE between DA and SA is also supported. Specifically, the findings showed that the indirect effect of DA ($\beta = 0.206$, LL = 0.074, UL = 0.338) on SA is significant, thus, H9 is accepted. Finally, the analysis indicated that the indirect impact of TS on SA is supported ($\beta = 0.233$, LL = 0.081, UL = 0.385), thus, H₁₂ is accepted.

5. DISCUSSION AND IMPLICATIONS

The current research offers a clear insight into the ways in which OL ecosystems affect SA via various interrelated mechanisms, especially the role of LE as a mediator. In general, the results show a stable trend where all the analyzed factors-OL, DA, SS and TS- have a positive impact on both LE and SA. These findings are greatly consistent with existing educational and behavioral theories, as well as complementing previous empirical studies in the digital education settings (Aftab, 2022). To begin with, the dramatic impact of OL on LE as well as student achievement proves that well-organized OL settings help increase student engagement and achievement. This is aligns with Kim et al. (2022); Tin et al. (2024), who discovered that online learning systems enhance academic performance due to the interactive and flexible structures of learning. On the same note, Yin and Luo (2024); Petare et al. (2023) also reinforce the idea that OL improves the student performance when the instructional design is such that it encourages active participation by the students. Nonetheless, other previous studies like Al Yakin and Seraj (2023) indicate that OL alone cannot do the work without engagement mechanisms which is consistent with the mediating role found in this study. Second, DA showed a significant positive impact on engagement, as well as achievement, which shows that access to technological resources is the key to successful involvement in learning. These results coincide with those of Jain et al. (2023); Uzorka and Odebiyi (2025) who asserted that unequal DA causes disparities in SA.

Nonetheless, there is conflicting evidence by Wang et al. (2024) that access alone does not produce improved outcomes, which supports the fact that engagement is a critical linking mechanism, as presented by this study. Third, the study skills were observed to considerably improve the engagement and achievement. This is aligns with Huang and Wang (2023) and Yang (2023) who point out self-regulated learning as one of the fundamental predictors of academic success. Ibrahim and

Aldawsari (2023) also support the validity of study strategies in enhancing OL performance. Moreover, Al Doghan and Piaralal (2024) point out that structured learning strategies result in improved retention and understanding. But Shao et al. (2025) claim that the effects of study skills differ according to the learning environments, which implies that they are contextually sensitive, an aspect that is taken into consideration in this study through its integrated model. Fourthly, TS became a good predictor of both engagement and achievement, which confirms its necessity to influence learning behavior. These results are aligns with Feng et al. (2023) and Wang et al. (2024), who cite teacher feedback and guidance as key driving academic factors. Huang and Wang (2023) also approve of the positive effect of teacher-student relationships on engagement. Likewise, Zen and Ariani (2022) discovered that instructional support increases motivation and persistence. Nevertheless, Feng et al. (2023) observe that the effects of TS might be less pronounced in highly autonomous learning settings, which is partially in contrast to the strong effects demonstrated in this study. Fifthly, LE was established as an important mediator between all independent variables and SA. This is in accordance with Shao et al. (2025); Ibrahim and Aldawsari (2023) who stress the nature of engagement as a multidimensional construct that connects the environmental inputs and scholarly outputs.

Engagement is also a key process of academic success identified by Yin and Luo (2024) and Kara et al. (2024). Wu (2023) and Jain et al. (2023) also affirm that engagement is a significant part of OL environments. Notably, the studies conducted by Al Yakin and Seraj (2023) and Sharif Nia et al. (2023) support the notion that engagement is the reason why there is variability in the performance of students across contexts. Furthermore, Zen and Ariani (2022) and Kara et al. (2024) posit that engagement enhances persistence and cognitive effort, which is in line with the mediation effects being observed. Ibrahim and Aldawsari (2023) and Al Doghan and Piaralal (2024) also assert that engagement helps to improve the learning outcomes in online settings. Moreover, the psychological process found in the present study is supported by Petare et al. (2023); Zhang and Zhang (2024) as engagement transforms external inputs into academic achievement. However, some conflicting evidence exists. As an example, Fabian et al. (2022) indicate that the level of engagement in online contexts may differ significantly because of the difficulties with self-regulation, whereas Uzorka and Odebiyi (2025) shows inconsistent effects of online participation on academic performance. Regardless of this difference, the present research supports the claim that engagement is a consistent and core mediating variable. In general, the results of the current study have a very strong consistency with the findings achieved in the previous studies as well as with the literature extending the previous studies by incorporating a variety of determinants

into one explanatory framework. The consistency of findings demonstrated in all constructs supports the strength of the suggested model and emphasizes the interdependence of all factors in the proposed model on shaping the academic success of students.

5.1. Theoretical Implications

The study contributes well to the theoretical aspect as it incorporates SCT and CLT in explaining a unitary explanatory framework of understanding SA in OL environments. In a Social Cognitive view, the results support the notion that the learning outcomes are determined through the ongoing interaction of the personal capabilities, environmental conditions, and processes of engagement of behavior. The great impact of OL, DA, SS, and TS confirm the triadic reciprocal determinism concept, showing that academic success is not identified by one factor but is the result of dynamic interplay of contextual and cognitive factors. Meanwhile, the evidence is also strong in supporting CLT on the basis that students actively build knowledge by engaging, interacting, and guided learning experiences. The constructivist assumption that meaningful learning takes place when learners are actively involved instead of receiving information passively is reinforced by the mediating role of LE. The paper adds to the theories by empirically relating environmental inputs to academic outputs by getting engaged as a psychological and behavioral process. Furthermore, it also adds to theory by showing that digital education systems can be both a cognitive and a social learning environment with access, interaction, and instructional support shaping knowledge construction. The synthesis of these theoretical lenses makes the study provide a more profound explanation of the learning processes in the contemporary educational settings, satisfying a conceptual gap in the previous fragmented research, and providing a stronger theoretical coherence in the OL literature.

5.2. Practical Implications

The results of this study have powerful practical implications to educational institutions, policymakers and instructional designers. To begin with, the high level of importance of OL brings into consideration the necessity of institutions investing in high quality and interactive, user friendly and pedagogically structured OL platforms. These systems must be in such a way that they will actively encourage student interaction as opposed to merely passing information. Secondly, the significance of the concept of DA implies that the decrease in technological inequality should be a priority, especially in developing settings, as the absence of access directly affects the level of engagement and academic achievement. The institutions and governments are required to see that the students have access to affordable and reliable devices and internet networks. Thirdly, the effect of SS implies that training programs must be provided in the curriculum in order to promote self-control in time management and independent learning skills in students. Fourthly, TS turns out to be an essential aspect, making it necessary that instructors must maintain active communication, give timely feedback, and provide supportive learning environments even in virtual environments. Moreover, engagement mediates the impacts of engaging with the course material, and the active learning process should be

focused on raising the level of student engagement through interactive content, activities, and periodic feedback mechanisms. In general, the research offers practical implications that can be used to advance the quality of education through the alignment of technological infrastructure, instructional methods, and student development strategies to increase engagement and ultimately, academic success.

6. CONCLUSION

This paper offers a detailed analysis of the conditions that affect SA in OL environments with a specific focus on OL, DA, SS, TS, and LE. The results clearly indicate that all the factors studied play a vital role in improving SA, both directly and indirectly with the aid of LE. The findings affirm that engagement is an important psychological and behavioral process that converts the educational contributions into significant academic outputs. The high levels of interrelations between variables demonstrate that the modern educational systems are interconnected, so that technological, instructional and student related factors are united to determine whether a student succeeds or not. The research also confirms that students have increased performance whenever they are supported with the available online learning resources, effective instructional support, good study habits and well designed online learning systems. The study offers a high quality of theoretical background to the understanding of these relationships in a structured and meaningful manner by integrating SCT and CLT. Moreover, the fact that the empirical evidence produced as a result of using sophisticated statistical techniques supports the strength of the proposed model. Comprehensively, this research work is significant to the sphere of digital education due to the holistic explanation of the mechanisms of engagement improving SA. It points out that the key to improving academic results must be based actually on the combination of technology and strategic focus on student engagement, instructional quality, and learning support systems in a coordinated and integrated manner.

Although this study has made important contributions, it has some weaknesses which must be mentioned. First, a cross-sectional design does not allow establishing causal relationships between variables as data were collected at one point in time. In future studies it is recommended to use longitudinal designs to explore the dynamics of relationships as they change with time. Second, the use of self reported data can create a response bias where the respondents may over or under estimate their real behaviors and experiences. In future research, objective academic performance data or mixed-method research could be used to increase validity. Third, the study is geographically specific and this could restrict the generalizability of results to other educational systems with different technological infrastructures and cultural orientation. The model can be expanded to several countries to enhance external validity. Fourth, other relatively significant variables as motivation, peer influence and institutional quality were not addressed despite the presence of key variables in the study. These constructs should be combined in the future study to come up with a more holistic model. Moreover, it was possible to employ more sophisticated analysis techniques, like multi-group analysis, to examine

dissimilarities among demographic groups. Lastly, qualitative research may shed more light on how students perceive being engaged in the digital learning environment. Overcoming these limitations will empower future research and further develop the knowledge on digital learning dynamics.

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