

Research Article

Cite this article: Alam, M. N., Alharbi, S. H., Mustafa, Z., Alotaibi, H. S., Hashim, F., Bhuiyan, A. B., & Gazi, M. A. I. (2025). From Distraction to Engagement: Exploring Smartphone Use and Digital Learning among Generation-Z Students. *Educational Process: International Journal*, 17, e2025329.
<https://doi.org/10.22521/edupij.2025.17.329>

Received April 23, 2025

Accepted May 29, 2025

Published Online July 12, 2025

Keywords: Smartphone use; educator behavior; democratic teaching practices; digital competency; the digital informal learning.

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From Distraction to Engagement: Exploring Smartphone Use and Digital Learning among Generation-Z Students

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Abstract

Background/purpose: Smartphones have evolved into indispensable learning tools, offering continuous access to information across both formal and informal educational environments. Recent research illuminates the complex interplay between students' academic engagement (SAE), digital competency (DC), and the digital informal learning (DIL) experiences of Generation-Z students. This interplay is further nuanced by educators' roles in promoting constructive smartphone use (SPU) in the classroom. This study investigates into the relationship between SPU and the academic engagement of Generation-Z students, focusing specifically on the moderating role of educators' democratic behavior towards knowledge acquisition (EDBTKA).

Materials/methods: Utilizing a positivist paradigm, deductive approach, and quantitative methodology, cross-sectional survey data were gathered from 384 students at private universities in Bangladesh through convenience sampling. Data were analyzed using SPSS (v26) and Smart-PLS 4.0.

Results: The findings reveal that SPU exerts a direct and positive influence on the SAE of Generation-Z students. Additionally, digital EDBTKA was found to moderate the relationship between SPU and DC, as well as between SPU and DIL, albeit without a significant moderating effect on the relationship between SPU and academic engagement.

Conclusion: This study underscores the positive impact of smartphones on the SAE of Generation-Z students and emphasizes the mediating role of DC and informal learning, as well as the moderating influence of educators' democratic behavior. To enhance SAE and informal learning experiences among Generation-Z students, educators are encouraged to integrate smartphones positively in classrooms, cultivate DC, and foster democratic behavior.



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1. Introduction

In contemporary educational environments, it is increasingly common to observe students immersed in their smartphones, simultaneously engaging with academic content and social interactions. This pervasive presence of smartphones in classrooms has triggered an ongoing debate among educators and researchers: do smartphones serve as effective educational tools that enhance students' academic engagement (SAE), or do they function as distractions that hinder the learning process? As digital devices become embedded in students' everyday lives, understanding their role in shaping learning experiences becomes crucial. Central to this discourse is the role of educators, who not only manage digital technology in the classroom but also shape students' learning behaviors and academic outcomes through their pedagogical approaches. This study focuses on the influence of smartphone use (SPU) on SAE among Generation-Z students and the pivotal role of educators' democratic behavior towards knowledge acquisition (EDBTKA) in this relationship.

The educational sector is undergoing a digital transformation, with an increasing shift from traditional, static learning tools toward dynamic, mobile technologies. Smartphones now serve as powerful, portable gateways to educational content, offering students access to learning management systems (Turnbull et al., 2020), digital libraries (Pokorná et al., 2020), collaboration platforms (Liu & Shi, 2018), and virtual classrooms (Pratama et al., 2020). These resources facilitate both synchronous and asynchronous learning, allowing students to tailor their educational experiences to their individual needs and preferences. Unlike desktop computers, smartphones are highly portable, customizable, and user-friendly, making them particularly attractive to Generation-Z learners who are accustomed to using digital tools in their daily routines. Their versatility and accessibility have contributed to their widespread integration into both formal and informal learning settings (Trelease, 2008; Nedungadi & Raman, 2012).

A growing body of research recognizes the importance of DC in navigating these technology-rich environments. DC refers to the ability to use digital tools effectively for communication, collaboration, and learning (Erstad et al., 2021). Current educational reforms increasingly emphasize the development of DC as a core competency for students and teachers alike. In pre-service and in-service training, educators are being encouraged to foster digital literacy among learners while also developing their own DC (Røkenes & Krumsvik, 2014; Tudor, 2016). This dual emphasis aims to prepare both teachers and students for the demands of 21st-century education. However, while smartphones offer potential benefits for improving engagement and academic performance, concerns remain about their misuse, particularly when students use them for non-academic purposes during class.

Previous research on the impact of SPU on academic outcomes presents mixed findings. Some studies suggest that smartphone integration supports active learning and improves student outcomes by increasing access to resources, enabling collaboration, and facilitating real-time feedback (Kim et al., 2020; Saqr et al., 2023). Others, however, caution that excessive or unregulated use can result in cognitive overload, distraction, and disengagement (Anshari et al., 2017; Sahlström et al., 2019). These contradictory results indicate that the impact of SPU on SAE may depend on a range of contextual and behavioral factors, including the student's level of DC and the role of educators in guiding technology use. Singh and Samah (2018) emphasize that the absence of digital guidance from educators may increase students' vulnerability to online distractions, reducing their academic focus and performance.

Given these complexities, the educator's role becomes increasingly central. Pettersson (2018) argues that the success of technology integration in education often hinges on educators' digital competence and their ability to manage learning environments effectively. In particular, educators'

democratic behavior (EDBTKA)—defined by open communication, participatory decision-making, and collaborative learning practices—has been shown to positively influence students’ motivation and engagement (Hauk & Gröschner, 2022; Rainer & Guyton, 1999). Democratic educators create inclusive classrooms where students feel valued and heard, which in turn supports active learning and responsible SPU. Such environments may also empower students to co-create learning experiences, using smartphones not merely for consumption but as tools for research, problem-solving, and collaboration.

In addition to formal instruction, the proliferation of mobile devices has led to an increase in digital informal learning (DIL)—learning that occurs outside the structured classroom environment through digital channels. Students often turn to educational apps, forums, social media, and open-source content to supplement their learning, develop new skills, or explore topics of personal interest (Mehrvarz et al., 2021). Smartphones play a vital role in facilitating DIL by offering flexibility and personalized access to a wide array of digital resources. Sari et al. (2020) note that DIL allows students to exercise autonomy over what, when, and how they learn, often enhancing motivation and academic engagement in the process. However, DIL also presents challenges, such as the need for self-regulation and critical thinking to evaluate the credibility and relevance of online information.

Considering these factors, this study seeks to investigate the nuanced relationships among SPU, SAE, DC, DIL, and EDBTKA. Specifically, it examines (1) the direct effect of SPU on SAE; (2) the mediating roles of DC and DIL; and (3) the moderating role of educators’ democratic behavior in these relationships. By situating the research within the theoretical frameworks of Social Cognitive Learning Theory (SCLT) and Self-Determination Theory (SDT), the study explores both the social-environmental and motivational dimensions of smartphone-mediated learning. SCLT emphasizes learning through observation, modeling, and social interactions (Bandura, 1986), while SDT highlights autonomy, competence, and relatedness as key drivers of engagement and learning outcomes (Deci & Ryan, 1985).

This study contributes to the ongoing discourse on mobile learning by providing empirical evidence on how SPU, when supported by digital competence and democratic pedagogy, can enhance academic engagement among Generation-Z students. The findings are expected to inform educators, curriculum designers, and policymakers on how to effectively integrate mobile technology into academic settings. In doing so, this research advances both theoretical understanding and practical strategies for optimizing the use of smartphones in higher education, particularly in developing countries such as Bangladesh.

1.1. Operational Definitions of the Variables

Smartphone Use: Smartphone use (SPU) refers to the frequency and manner in which individuals utilize smartphones for various activities, including communication, information retrieval, and entertainment.

Educators’ Democratic Behavior Towards Knowledge Acquisition: Educators’ democratic behavior towards knowledge acquisition refers to the extent to which educators facilitate participatory and collaborative learning environments, empowering students to actively engage in the acquisition of knowledge through open discussions, shared decision-making, and interactive teaching methods.

Digital Competency: Digital competency refers to the ability of individuals, particularly educators and students, to effectively utilize digital technologies for learning, including skills in discerning credible information, using educational apps, and collaborating on digital platforms.

Digital Informal Learning: Digital informal learning refers to self-directed and flexible learning experiences facilitated by smartphones outside of traditional classroom settings, enabling students to access educational apps, participate in online forums, and engage with a wide range of digital resources.

Students' Academic Engagement: Students' academic engagement refers to the active participation and involvement in educational activities, encompassing interaction with the learning process, effort, resilience, and commitment to achieving learning outcomes.

Generation-Z Students: Generation-Z students, born from the mid-1990s to early 2010s, are characterized by their digital nativism, valuing technology, diversity, inclusivity, social justice activism, and prioritizing work-life balance. They are adaptable, entrepreneurial, and seek authentic, personalized learning experiences.

1.2. Underpinning Theories of the Study

The present study is grounded in two significant theories in the field of learning: 1) Social Cognitive Learning Theory (SCLT) and 2) Deci and Ryan's Self-Determination Theory (SDT). The SCLT underscores the reciprocal interaction between personal, behavioral, and environmental factors, elucidating how individuals learn within their social contexts. In contrast, SDT offers insights into human motivation and behaviors within learning environments.

1.2.1. Social Cognitive Learning Theory (SCLT)

SCLT elucidating how individuals learn within their social contexts. According to Bandura, learning occurs through observation, modeling, and cognition, influencing individuals to imitate learned behaviors. In the context of this study, students may observe and emulate the way smartphones are used for accessing materials, conducting research, or collaborating on projects by teachers and peers. When students are attentive in using smartphones for specific learning activities and use this technology accordingly, SPU can be extended to problem-solving activities and higher-order thinking skills. Furthermore, the manner in which students use smartphones for learning activities is also influenced by self-efficacy and motivation, leading to efficient SPU. For example, students who are confident in their technological skills in education may seek to use smartphones more than those who are not. However, SPU is also subject to environmental factors affecting learning and behavior, such as social norms, school policies, and stigma. Therefore, SCLT in this study can be linked to four components: 1) observation and modeling, 2) cognitive processes, 3) self-efficacy and motivation, and 4) environmental factors. Current findings also highlight SAE through SPU, with observed behavior manifesting in both positive and negative ways. For instance, a study on SPU during face-to-face instruction was evaluated as socially negative and perceived as hindering conversation recognition tasks (Johnson et al., 2019). Conversely, as cited in Youn (2019), SPU in non-learning environments was perceived as enjoyable, entertaining, and relaxing. Youn also discovered, in light of SCLT, that various social and emotional factors influenced SPU. Other studies recognize the cognitive dimension in SCLT in online knowledge-sharing behavior (Chiu et al., 2006), while the social dimension in SCLT underscores the social influences learned through social media (Counts & Fisher, 2010). These prior studies affirm the SCLT theories, emphasizing that social influences play a crucial role in shaping individual experiences and behaviors, even within digital settings.

1.2.2. Self-Determination Theory (SDT)

Introduced by Deci and Ryan in 1985, SDT offers a valuable framework for examining the psychological factors affecting individual behavior across various contexts. SDT is based on three intrinsic psychological needs: autonomy, competence, and relatedness, which are fundamental to motivation. This theory has been widely employed to investigate SPU and its associations with

addictive behaviors and anxiety, as noted by Morales Rodríguez et al. (2020). These three pivotal factors—autonomy, competence, and relatedness—can be examined across various scenarios. For instance, in the classroom setting where smartphones are used, autonomy is crucial. Students should have the freedom to choose educational apps and conduct research with their smartphones. However, overly prescriptive guidelines from teachers can limit this autonomy. Competence is felt when students experience a sense of achievement using smartphones to complete assignments, collaborate with peers, or access information, fostering intrinsic motivation to repeat such behaviors. Meanwhile, relatedness emphasizes the importance of social connections and a sense of belonging. Encouraging collaborative smartphone activities can nurture a supportive classroom environment and enhance student motivation.

The interplay of these two theories provides a solid foundation for this research. In this study, the SCLT is applied to understand how individuals' digital competencies, acquired through informal observation and experience, influence SPU and subsequently affect academic engagement. Meanwhile, the SDT focuses on the role of emotion and motivation in exploring students' engagement with learning. This engagement, fostered by their digital competencies and supported by educators' behavior, is related to their SAE facilitated by SPU.

2. Literature Review and Hypotheses Development

In the following section, we delve into the existing literature to establish the theoretical foundation and develop hypotheses exploring the relationships between smartphone use, digital competency, digital informal learning, educators' democratic behavior, and students' academic engagement.

2.1. Smartphone Use (SPU) and Students' Academic Engagement (SAE)

SAE encompasses their active involvement in educational processes, reflecting a multidimensional construct that includes cognitive, metacognitive, affective, social, task management, and communicative components (Coates, 2007; Trowler, 2010; Schaufeli et al., 2002). It captures the time, effort, and psychological investment students devote to learning activities, which are essential for achieving meaningful and high-quality academic outcomes (Krause & Coates, 2008). As digital learning environments become increasingly prevalent, understanding how SPU impacts SAE has gained prominence in educational research. Smartphones provide immediate access to learning materials, facilitate communication with peers and instructors, and support flexible, self-directed learning. However, their effect on academic engagement is not universally positive and remains a subject of scholarly debate. Theoretically, Social Cognitive Learning Theory (SCLT) posits that learners acquire behaviors through observation, modeling, and interactions with their environment (Bandura, 1986). In the context of SPU, students may model effective or ineffective smartphone habits based on peer and instructor behavior. Their level of DC—often developed informally—may shape how purposefully and responsibly they use smartphones for academic tasks, which in turn influences engagement. Simultaneously, Self-Determination Theory (SDT) provides insight into the motivational aspects of student engagement. SDT emphasizes the fulfillment of three psychological needs—autonomy, competence, and relatedness—as essential for fostering intrinsic motivation and engagement (Deci & Ryan, 1985). Smartphones, when used meaningfully, can support these needs by enabling students to control how and when they learn (autonomy), accomplish learning tasks through apps and resources (competence), and remain socially connected with peers and educators (relatedness). However, if SPU is poorly guided or unregulated, it may lead to dependency, distraction, or reduced motivation, counteracting these benefits. Empirical findings on the SPU–SAE relationship remain mixed. On one hand, studies have shown that SPU enhances learning engagement, access to information, and collaborative opportunities, particularly among digitally fluent students (Kim et al., 2020; Saqr et al.,

2023). On the other hand, excessive or unstructured SPU has been associated with addiction-like behaviors, impaired cognitive functioning, and academic underperformance (Sunday et al., 2021; Lin et al., 2021; Morales Rodríguez et al., 2020). These divergent outcomes suggest that the nature and context of SPU are critical in determining its educational impact. To address these challenges, scholars and institutions emphasize the integration of digital literacy and competency into the curriculum. Strengthening DC among students can help mitigate the risks associated with SPU and promote more purposeful use of smartphones in academic contexts (Nascimbeni & Vosloo, 2019; UNESCO, 2018). Educators play a pivotal role in this process by modeling appropriate digital behavior, establishing usage guidelines, and creating learning environments that support engaged, technology-enhanced learning. Informed by the frameworks of SCLT and SDT, and supported by existing empirical evidence, this study posits that when used appropriately, SPU can enhance students' academic engagement by supporting both their learning behaviors and motivational drivers.

H1: SPU has a significant positive effect on SAE.

2.2. Digital Competency (DC), Smartphone Use (SPU), and Students' Academic Engagement (SAE)

In today's digitally enriched learning environments, smartphones are increasingly recognized for their ability to promote critical thinking, collaboration, and engagement among students (Kim et al., 2020). However, the academic benefits of SPU are not automatic; they depend significantly on the user's level of DC—the skills and knowledge required to effectively navigate, evaluate, and apply digital tools in educational contexts. The importance of DC became particularly pronounced during the COVID-19 pandemic, when remote learning forced both educators and students to rely heavily on digital platforms. In this context, DC emerged as a vital enabler of meaningful SAE, influencing how learners accessed content, communicated with peers, and participated in virtual classrooms (Falloon, 2020; Aldhaen, 2024). Numerous studies have emphasized that students equipped with higher DC are more capable of using smartphones to support cognitive, emotional, and behavioral dimensions of engagement (UNESCO, 2018; Heidari et al., 2021; Chaw & Tang, 2023). Research also suggests that DC enhances students' self-regulated learning capabilities, allowing them to independently locate, process, and apply information in alignment with their academic goals. For example, Bergdahl et al. (2020) found that while high levels of DC significantly promote engagement, the absence of DC does not necessarily equate to high disengagement, indicating the presence of additional moderating and mediating factors in this relationship. From a theoretical standpoint, Social Cognitive Learning Theory (SCLT) positions DC as a learned behavior developed through observation, experience, and modeling in digital environments. Through exposure to competent digital role models—be it educators or peers—students can internalize effective SPU strategies that enhance learning outcomes. Similarly, Self-Determination Theory (SDT) suggests that DC supports the basic psychological needs of autonomy and competence, both of which are essential for intrinsic motivation and sustained academic engagement. When students possess the digital skills necessary to interact with learning content and platforms, they are more likely to feel empowered and confident in their academic pursuits, thereby increasing their engagement. Given this theoretical grounding and empirical support, it is reasonable to assume that DC mediates the relationship between SPU and SAE. That is, while smartphones provide the tools for learning, DC determines whether and how effectively these tools are used for academic purposes.

H2: DC has a significant mediating effect on the relationship between SPU and SAE.

2.3. Digital Informal Learning (DIL), Smartphone Use (SPU), and Students' Academic Engagement (SAE)

SAE has long been a focal point in educational research, often linked to desirable outcomes such as academic achievement, satisfaction, persistence, and collaborative learning. It is commonly analyzed through indicators like class participation, time on task, peer collaboration, interaction with instructors, and the use of active learning strategies (Zhu, 2012; Saqr et al., 2023; Talan & Gulsecen, 2019). While most research emphasizes formal classroom settings, an increasing number of scholars now highlight the role of informal, technology-mediated learning in shaping students' academic engagement. In particular, the rise of DIL—learning that occurs outside the structured boundaries of formal education—has expanded the understanding of SAE. DIL environments are typically self-directed, flexible, and less constrained by formal curricula, allowing students greater autonomy in choosing learning content, pace, tools, and evaluation methods. Mehrvarz et al. (2021) argue that informal learning has evolved into a digitally enabled learning modality, significantly supported by advances in mobile and internet technology. In this context, smartphones serve as a primary medium through which students engage in informal learning activities. Due to their portability, accessibility, and internet connectivity, smartphones facilitate continuous learning beyond the traditional classroom (Sari et al., 2020). Students can use them to browse educational content, access open-source resources, watch instructional videos, use learning apps, or engage in online discussions. This autonomy enables learners to tailor their educational experiences to their preferences, schedules, and learning styles, aligning closely with the Self-Determination Theory (SDT), which identifies autonomy as a key driver of intrinsic motivation and engagement (Deci & Ryan, 1985). Moreover, Social Cognitive Learning Theory (SCLT) also provides a useful lens for understanding DIL. According to SCLT, learning is not confined to formal settings but occurs through observation, modeling, and social interaction within digital environments. Online forums, peer-shared content, and social media communities contribute to learning behaviors that can ultimately influence students' academic mindset and performance. Empirical evidence supports the value of DIL in enhancing SAE. For instance, Şad et al. (2022) found that smartphone-facilitated informal learning makes a significant contribution to language acquisition and skill development. Baidoo-Annu and Owusu Ansah (2023) further illustrate how generative artificial intelligence tools accessed via smartphones are increasingly being used for academic tasks, such as content creation, research, and idea generation. However, not all findings are uniformly positive. Some studies report that SPU in informal contexts can lead to distraction, reduced focus, or even the misuse of digital tools for non-academic purposes (Şad et al., 2022), raising questions about self-regulation and digital boundaries in DIL environments. Given the diverse and evolving nature of informal digital learning, scholars caution against oversimplifying or generalizing its effects. Lin et al. (2021) emphasize that SAE in DIL environments should not be measured solely through structured indicators, as this may obscure the complexity of self-directed learning. Additionally, the success of DIL initiatives depends heavily on learners' digital literacy and self-regulatory skills. As Mehrvarz et al. (2021) suggest, educators and curriculum designers must consider their own digital competencies and pedagogical approaches when integrating DIL opportunities into educational frameworks. Theoretically and empirically, DIL emerges as a critical mechanism through which smartphone use can influence students' academic engagement. As such, this study positions DIL as a mediating variable, shaping the pathway from SPU to SAE.

H3: DIL has a significant mediating effect on the relationship between SPU and SAE.

2.4. Moderating Role of Educators' Democratic Behavior Towards Knowledge Acquisition (EDBTKA)

As digital technologies become deeply embedded in education, institutions are increasingly recognizing the pivotal role that educators play in guiding students' use of smartphones for meaningful learning. While many schools and universities adopt policies to regulate SPU, the practical effectiveness of such policies often depends on how educators implement them within the classroom environment. Educators act as intermediaries—not only enforcing institutional frameworks but also shaping students' digital behaviors and learning experiences through their own teaching styles and attitudes (Franklin & Harrington, 2019). One particularly influential aspect of teaching practice is EDBTKA. This behavior encompasses open dialogue, shared decision-making, student empowerment, and the creation of participatory learning environments. Democratic educators foster trust, encourage active engagement, and support students' autonomy and voice in the learning process (Özcan, 2016). By promoting critical thinking and inclusivity (Turabik & Gün, 2016), they create a supportive atmosphere where students feel encouraged to use smartphones and other digital tools purposefully, rather than as passive consumers or distracted users. In this context, EDBTKA becomes particularly relevant for enhancing DC among students. When educators adopt a democratic approach, they are more likely to guide students in selecting credible online resources, evaluating digital content, and utilizing educational technologies to support learning objectives. Rather than merely imposing restrictions, they enable learners to make informed decisions and take responsibility for their digital behaviors. As such, educators' democratic behavior functions as a contextual enabler of students' digital skill development. From a theoretical perspective, Social Cognitive Learning Theory (SCLT) underscores the importance of observational learning and the modeling of behaviors. When students observe educators demonstrating democratic practices and responsible SPU, they are more likely to emulate those behaviors, thereby improving their own DC. Similarly, Self-Determination Theory (SDT) emphasizes the value of autonomy and relatedness in fostering intrinsic motivation. Democratic educators satisfy these psychological needs by valuing student voice and promoting collaborative decision-making, which can enhance learners' confidence and engagement with digital tools. Given this conceptual foundation, this study posits that EDBTKA not only influences learning outcomes directly but also moderates the relationship between SPU and DC. In classrooms characterized by strong democratic behavior, the positive effects of smartphone use on digital competency are likely to be amplified. In contrast, in more authoritarian or non-participatory environments, this relationship may be weakened or even counterproductive.

H4: EDBTKA has a significant moderating effect on the relationship between SPU and DC.

The integration of smartphones in educational settings has sparked considerable debate, particularly concerning their dual potential as both learning tools and sources of distraction. While smartphones offer flexibility, accessibility, and interactivity, their effectiveness largely depends on how they are used—and more importantly, how their use is guided within the classroom context. Educators, as key stakeholders in the learning process, play a central role in shaping the academic outcomes associated with SPU. Recent studies emphasize that EDBTKA has a significant influence on how students interact with digital technologies. Democratic educators foster inclusive and participatory classroom environments where students are encouraged to contribute ideas, collaborate with peers, and actively engage with learning materials (Morales Rodríguez et al., 2020; Huang, 2021). Such environments empower students to use smartphones constructively and align their use with academic goals, thereby mitigating the risks of misuse or distraction. Moreover, educators who demonstrate democratic practices play a vital role in promoting digital responsibility. By modeling ethical and effective digital behavior and by explicitly teaching students how to evaluate credible information, use educational applications, and collaborate through digital

platforms, educators can equip students with the skills necessary for responsible SPU (Fu et al., 2021). This guidance enhances the educational utility of smartphones and ensures that their use contributes meaningfully to SAE. The connection between EDBTKA and SAE is supported by both theory and empirical evidence. Self-Determination Theory (SDT) underscores the importance of autonomy, competence, and relatedness as foundational psychological needs for engagement. When educators create environments that respect student voice and encourage co-construction of learning, students are more likely to experience these needs being met, resulting in deeper engagement. Likewise, Social Cognitive Learning Theory (SCLT) highlights the role of modeled behavior and social context in shaping learning outcomes. Observing and interacting with democratic educators may inspire students to engage more actively with course content and participate more confidently in academic tasks. When students perceive their instructors as approachable, inclusive, and supportive, they are more likely to feel motivated, connected, and empowered in their learning journeys (Cook-Sather, 2020; Ferguson-Patrick, 2022; Puneet, 2020; Trowler, 2010). These positive perceptions directly influence their willingness to participate and persist in academic activities—key dimensions of SAE. Thus, in classroom contexts where EDBTKA is high, SPU is more likely to be leveraged for academic growth rather than personal distraction. Based on these theoretical and empirical foundations, this study hypothesizes that EDBTKA moderates the relationship between SPU and SAE. Specifically, the presence of strong democratic behavior among educators is expected to strengthen the positive effect of smartphone use on students' academic engagement.

H5: EDBTKA has a significant moderating effect on the relationship between SPU and SAE.

The integration of smartphones into educational environments has expanded the scope of learning beyond traditional classroom boundaries, placing increased emphasis on students' engagement in DIL. In this expanded learning landscape, the role of educators has also evolved, extending beyond the facilitation of formal academic instruction to include guidance in self-directed, informal learning activities. This shift has sparked debate regarding the capacity of educators to influence informal learning effectively, particularly through the lens of democratic teaching practices. Advocates suggest that EDBTKA can foster student agency by encouraging autonomy, critical reflection, and responsible decision-making in how students utilize smartphones for learning. Democratic educators empower learners to explore topics of personal interest, develop digital literacy, and navigate learning materials beyond prescribed curricula (Hung et al., 2012). By promoting shared decision-making and valuing student voice, these educators enhance students' capacity to make informed choices about SPU in informal learning contexts. Research supports this view by highlighting how democratic educators foster skills such as critical thinking and resource evaluation—key competencies for productive DIL. For instance, Kim et al. (2020) emphasized the importance of fostering analytical thinking in digital environments, while Sari et al. (2020) pointed to the significance of tailoring learning to individual preferences and styles. Through structured yet flexible guidance, educators can help students engage in meaningful learning experiences using smartphones, even outside formal class time. However, concerns persist regarding the limits of educators' influence in informal learning domains. Critics argue that democratic teaching practices, if not clearly bounded, may inadvertently encourage smartphone use for non-academic purposes, such as entertainment or social media engagement. Moreover, there is the risk that promoting autonomy without sufficient digital scaffolding may widen digital divides, particularly among students with limited access to resources or weaker self-regulation skills (Hung et al., 2012). These concerns underscore the need for a balanced approach, where democratic behavior is accompanied by digital literacy education and contextual boundaries. From a theoretical standpoint, both Self-Determination Theory (SDT) and Social Cognitive Learning Theory (SCLT) provide support for exploring EDBTKA as a moderator in the SPU–DIL relationship.

SDT emphasizes that autonomy-supportive environments enhance motivation and engagement in self-directed learning. In parallel, SCLT posits that behaviors modeled by educators influence students' attitudes and actions, including how they engage in informal learning. Therefore, when educators exhibit democratic behaviors, students are more likely to model responsible smartphone usage and pursue meaningful DIL opportunities. In light of this, the present study posits that EDBTKA can strengthen or weaken the influence of smartphone use on students' engagement in informal learning. In classrooms where democratic behavior is high, students may be more inclined to use smartphones for self-directed, educational purposes. Conversely, in settings where such support is limited, the educational potential of SPU in informal contexts may not be fully realized.

H6: EDBTKA has a significant moderating effect on the relationship between SPU and DIL.

2.5. Conceptual Framework

Grounded in Social Cognitive Learning Theory, Self-Determination Theory and above empirical evidence, this study presents a conceptual framework wherein SPU positively impacts SAE, with DC and DIL serving as mediators. EDBTKA is proposed to moderate the links between SPU and DC, DIL, and SAE. The framework, illustrated in Figure 1 below, is informed by empirically supported hypotheses and captures the learning dynamics of Generation-Z students in digitally enhanced academic settings.

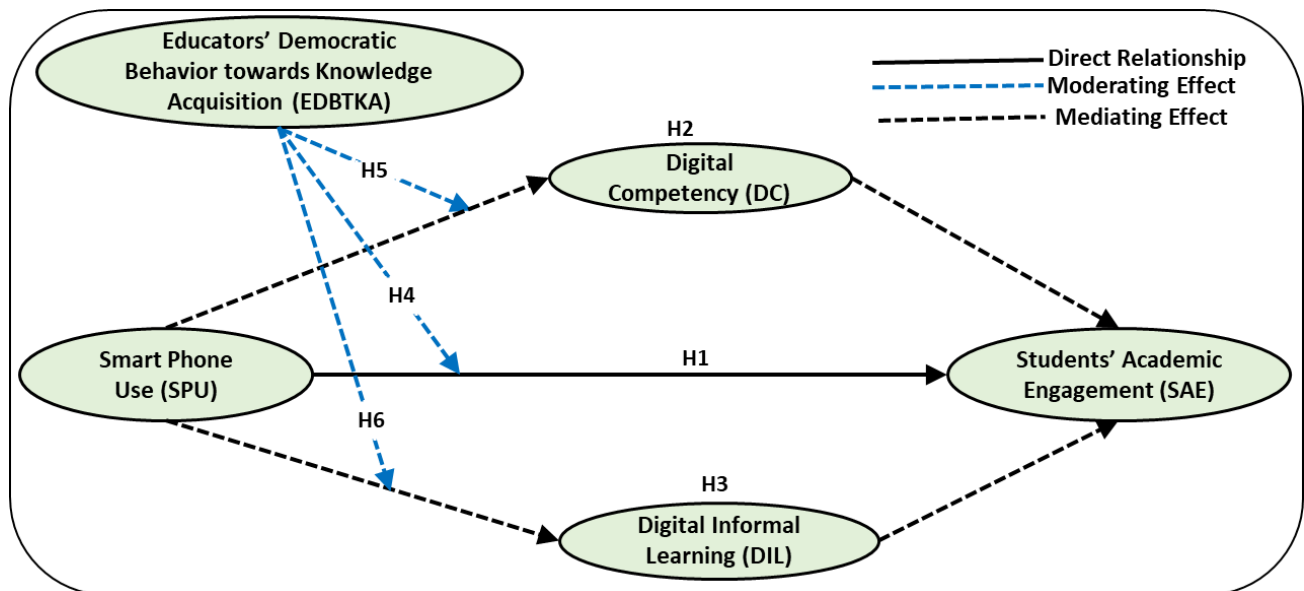


Figure 1. The Proposed Model for the Study

3. Methodology

This study adopted an explanatory research design aimed at uncovering the relationships among SPU, DC, DIL, SAE, and educators' democratic behavior (EDBTKA). The design was selected to systematically explore and clarify how these variables interact within the context of higher education institutions in Bangladesh. Emphasizing a positivist paradigm and a deductive approach, the research employed a structured survey questionnaire to collect quantitative data from university students. Bangladesh is home to a robust higher education system, consisting of 53 public universities, 107 private universities, and 3 international universities, which collectively serve approximately one million students across undergraduate, graduate, and doctoral levels. For this study, the target population was narrowed to undergraduate and master's students from 20 universities, selected based on top national rankings. The study excluded Ph.D. candidates to maintain focus on students more likely to engage in smartphone-mediated learning environments commonly observed at the undergraduate and master's levels. A sample size of 384 participants

was determined using the sample size estimation table developed by Krejcie and Morgan (1970), which is widely used for determining adequate sample sizes in social science research. The participants were recruited using a non-probability convenience sampling technique due to logistical constraints and the geographically dispersed nature of the student population. While this approach enabled efficient data collection, it inherently limits the generalizability of the findings to the broader student population. This limitation is acknowledged, and future studies are encouraged to employ stratified or random sampling methods to enhance external validity. Data collection was conducted over a four-week period using Google Forms. The survey link was distributed through institutional contacts, student groups, and academic networks, primarily via email and social media platforms such as WhatsApp and Facebook. To ensure ethical compliance and encourage honest responses, participation was strictly voluntary, and all participants were informed of the purpose of the study before beginning the questionnaire. No personal or identifying information was collected, thereby preserving the anonymity and confidentiality of respondents. The final dataset consisted of 384 fully completed responses, which were deemed adequate for the statistical techniques employed. The collected data were subsequently coded and analyzed using SPSS (version 26) for descriptive statistics and demographic profiling, and SmartPLS 4.0 for structural equation modeling and hypothesis testing.

3.1. Measurements

We implemented various measurement scales to assess different constructs within our study. Firstly, we utilized a six-item SPU scale, adapted from the work of Kör, Erbay, Engin, & Dündar (2017). Additionally, a six-item DC scale, derived from Oberländer, Beinicke, & Bipp (2020), was employed. To evaluate DIL, a six-item scale adapted from Heidari, Mehrvarz, Marzooghi, and Stoyanov (2021) was used. Moreover, we employed a six-item scale from Snijders, Wijnia, Rikers, & Loyens (2020) to measure SAE. Lastly, to gauge EDBTKA, we utilized a six-item scale adapted from the research of Almog & Shechtman (2007). All items were rated on a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly agree".

4. Data Analysis and Findings

We opted for Smart-PLS 4.0 over CB-SEM due to the non-parametric nature of our data. CB-SEM relies on the assumption of normality in the data and struggles with complex models. Our model comprises two independent variables, one dependent variable, one mediator, and one moderator, necessitating an alternative approach to analysis. Therefore, we chose PLS-SEM. Using PLS-SEM offers numerous advantages. Firstly, it provides flexibility, accommodating complex models with latent and observed variables, which is particularly beneficial when dealing with non-normal data or small sample sizes. Secondly, PLS-SEM emphasizes predictive power, making it well-suited for predictive modeling and hypothesis testing, particularly in fields such as marketing and management, where predictive accuracy is crucial. Lastly, PLS-SEM is computationally efficient, requiring smaller sample sizes and being less demanding, particularly advantageous for large or complex datasets. SPSS v23 was utilized to report participant demographic characteristics, while SmartPLS 4.0 facilitated model assessment and hypothesis testing.

4.1. Pre-Test and Pilot-Test

Before beginning the research, an initial evaluation was conducted with the assistance of 13 participants, whose insights were crucial for enhancing the clarity of the questionnaires and minimizing potential ambiguities. Following their feedback, minor revisions were applied to the questionnaires. To evaluate the internal consistency of the items, data from 15 individuals participating in a pilot study were collected, and Cronbach's alpha was calculated. The constructs all showed a level of reliability that exceeded the 0.70, meeting the reliability criteria established by Sekaran in 2003.

4.2. Common Method Bias (CMB)

The study thoroughly investigated the presence of common method bias (CMB) by analyzing the HTMT (heterotrait-monotrait) and inner VIF (variance inflation factor) values. According to Nitzl (2016), CMB is present when the primary constructs exhibit significant correlations ($r > 0.90$). However, upon examining the correlation values among the constructs (refer to the HTMT table), all correlations were found to be below 0.90. In fact, the highest correlation value observed was 0.585, indicating the absence of a correlation between the two variables. Another method to assess CMB is by examining the inner VIF values, whereby a VIF greater than 3.30 suggests the potential contamination of the model by CMB. In the present study, the highest VIF value observed was 1.538 (refer to the structural model assessment table), which is well below the threshold value of 3.30 as suggested by Kock (2015). This confirms that there is no issue of CMB in our analysis.

4.3. Inter-Correlations of the Study Variables

The constructs' descriptive statistics and inter-correlations listed in Table 1 demonstrate that all of the variables substantially correlate with SAE. The mean value of DC had the highest mean value (4.376), while the SPU had the lowest mean value 3.977.

Table 1. Means, SD, Correlations, and Reliabilities of the Study Variables

Variables	Gender	Depart.	Study Year	Study Prog.	SPU	DC	DIL	SAE	EDBTKA	Mean	SD
Gender	1									1.417	0.494
Department	-.379**	1								2.583	1.078
Study Year	0.000	.727**	1							2.500	1.119
S. Program	.567**	-.180**	-0.038	1						1.375	0.485
SPU	-.151**	0.054	-0.036	-0.020	1					3.977	0.816
DC	.109*	-.117*	-0.032	0.069	.267**	1				4.376	0.719
DIL	.126*	-0.007	0.092	0.094	.323**	.526**	1			4.109	0.782
SAE	0.027	0.046	0.094	0.057	.429**	.364**	.422**	1		4.249	0.748
EDBTKA	-0.037	.132**	.149**	0.025	.411**	.179**	.233**	.443**	1	4.215	0.773

Note: **. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

4.4. Demographic Profile of the Respondents

The table presents data on gender, department, study year, and study program, detailing both frequency and percentage distributions. In terms of gender, males constitute 58.33% (224 individuals) of the sample, while females make up 41.67% (160 individuals). Moving on to department distribution, the study reveals that the Arts department has the highest frequency at 112 individuals, accounting for 29.17% of the total, closely followed by Engineering with 96 individuals (25.00%), Business with 80 individuals (20.83%), and Science with 96 individuals (25.00%). Concerning study year, each year group (First, Second, Third, and Fourth) comprises an equal frequency of 96 individuals, translating to 25.00% each. Finally, in terms of study program, the Graduate program has a higher frequency of 240 individuals (62.50%), while the Post-graduate program consists of 144 individuals (37.50%). This data provides a comprehensive insight into the distribution of demographics and academic characteristics within the sampled population, offering valuable insights for further analysis and decision-making.

4.5. Evaluation of Measurement Model (Outer Model)

In order to evaluate the internal consistency reliability of our variables, we utilized two well-established measures: composite reliability (CR) and Cronbach's alpha (CA). As indicated in Table 2, all variables exhibited favorable internal consistency, surpassing the threshold of 0.7 for both CR and CA values. These results indicate strong reliability across the constructs, as suggested by Hair et al. (2021). Additionally, all items displayed factor loadings (FL) that exceeded the threshold of 0.60, providing further evidence of their substantial association with their respective constructs. Convergent validity was confirmed by the Average Variance Extracted (AVE) scores, which exceeded 0.5 for each construct, in line with the recommendations of Chin (1998) and supported by Hair et al. (2021). These findings serve to validate the robustness of our measurement model.

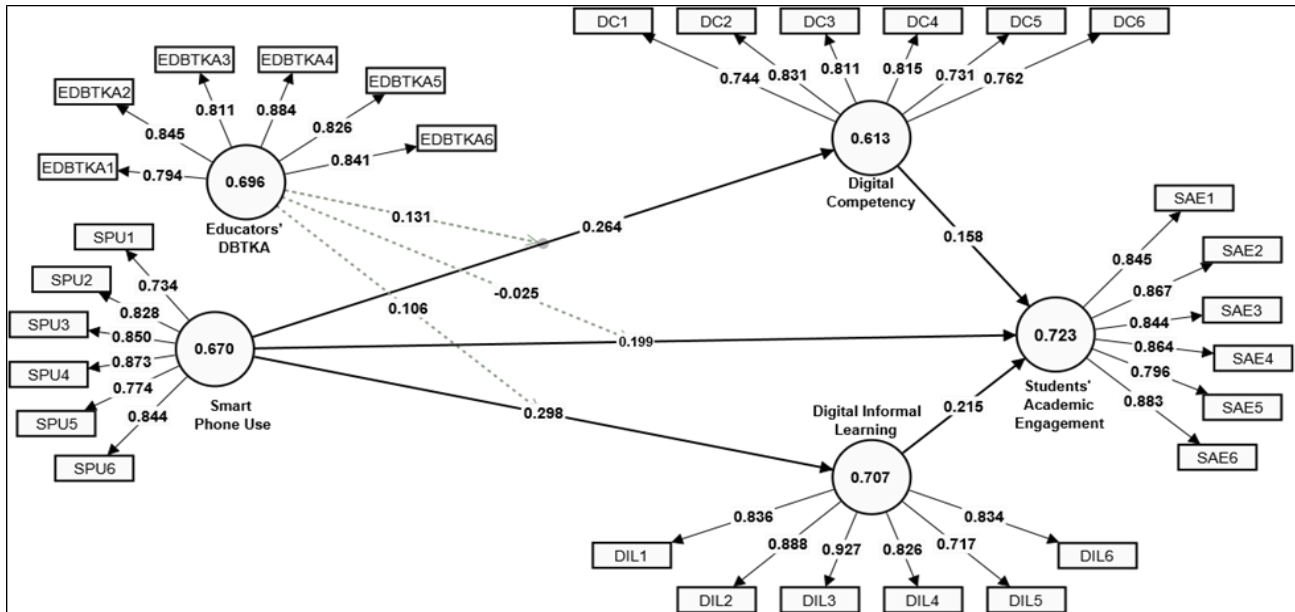


Figure 2. Measurement Model with Outer Loadings and AVE Values from PLS-Algorithm

Table 2. Constructs Validity and Reliability

Constructs	Items	F.L	CA	CR	AVE
DC	DC1	0.744	0.874	0.883	0.613
	DC2	0.831			
	DC3	0.811			
	DC4	0.815			
	DC5	0.731			
	DC6	0.762			
DIL	DIL1	0.836	0.916	0.920	0.707
	DIL2	0.888			
	DIL3	0.927			
	DIL4	0.826			
	DIL5	0.717			

	DIL6	0.834			
EDBTKA	EDBTKA1	0.794	0.913	0.918	0.696
	EDBTKA2	0.845			
	EDBTKA3	0.811			
	EDBTKA4	0.884			
	EDBTKA5	0.826			
	EDBTKA6	0.841			
SAE	SAE1	0.845	0.923	0.924	0.723
	SAE2	0.867			
	SAE3	0.844			
	SAE4	0.864			
	SAE5	0.796			
	SAE6	0.883			
SPU	SPU1	0.734	0.901	0.905	0.670
	SPU2	0.828			
	SPU3	0.850			
	SPU4	0.873			
	SPU5	0.774			
	SPU6	0.844			

Notes: CR: Composite Reliability; AVE: Average Variance Extracted; CA: Cronbach's Alpha

Once we had met the required threshold values for factor loadings, Average Variance Extracted (AVE), Cronbach's alpha (CA), and composite reliability (CR), we proceeded to evaluate the discriminant validity of the constructs using two well-established methods: the Fornell Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT). In Table 3, the diagonal cells present the square root of AVE values, while the correlations are shown below. In accordance with the Fornell Larcker criterion (Fornell & Larcker, 1981), we compared the square root of AVE values with the corresponding correlations. It is important to note that the diagonal values, representing the square root of AVE, consistently exceeded the correlations beneath them. This finding provides robust evidence that discriminant validity has been successfully established, in line with the requirements of the Fornell Larcker criterion. Furthermore, we evaluated the discriminant validity of the constructs utilizing the Heterotrait-Monotrait Ratio (HTMT) criterion, as suggested by Henseler et al. (2015). Our analysis demonstrated that all correlation values among the constructs were below 0.9, indicating satisfactory levels of discriminant validity. This outcome aligns with the recommended threshold proposed by Henseler et al. (2015). Specifically, in Table 3, the highest observed HTMT value was 0.585, providing additional confirmation that no significant concerns regarding discriminant validity were identified.

Table 3. Discriminant Validity- Fornell Larcker

Constructs	HTMT					Fornell Larcker				
	DC	DIL	EDBTKA	SAE	SPU	DC	DIL	EDBTKA	SAE	SPU
DC						0.783				
DIL	0.585					0.527	0.841			
EDBTKA	0.193	0.253				0.180	0.245	0.834		
SAE	0.407	0.458	0.480			0.369	0.428	0.443	0.850	
SPU	0.296	0.355	0.450	0.471		0.269	0.329	0.412	0.432	0.819

The off-diagonal values are the correlations between latent variables, and the diagonal is the square root of AVE.

4.6. Assessment of Structural (Inner) Model

Following the successful validation of the measurement model, the structural (inner) model was assessed using several key indicators presented in Table 4, including R^2 (coefficient of determination), f^2 (effect size), inner VIF (collinearity), and model fit indices. This evaluation provides insight into the model's explanatory power, the strength of relationships between constructs, and the overall adequacy of model fit. The R^2 values for the endogenous constructs indicate the amount of variance explained by the exogenous variables. The results show that SAE has an R^2 of 0.361, suggesting moderate to substantial explanatory power, while DIL (0.149) and DC (0.119) demonstrate moderate and weak explanatory power, respectively. These findings are interpreted in light of Cohen's (1989) criteria, where 0.26 is considered substantial, 0.13 moderate, and 0.02 weak. The adjusted R^2 values, which account for model complexity, are slightly lower but follow the same trend—supporting the model's predictive capacity. With regard to effect size (f^2), which measures the individual impact of each exogenous construct on the endogenous variables, several patterns emerged. SPU demonstrated weak but consistent effects on DC (0.065), DIL (0.085), and SAE (0.046). Similarly, EDBTKA exhibited weak effects on all three dependent constructs—DC (0.027), DIL (0.037), and SAE (0.068). The contributions of DC (0.027) and DIL (0.049) to SAE were also weak. According to Cohen (1989), values of 0.35, 0.15, and 0.02 correspond to substantial, medium, and weak effects, respectively. Despite the small effect sizes, they are meaningful within the context of multivariate relationships in educational behavior research. The assessment of collinearity (inner VIF) showed that all exogenous constructs fall well below the acceptable threshold of 5.0 recommended by Hair et al. (2017), confirming the absence of multicollinearity. Specifically, VIF values for SPU (ranging from 1.226 to 1.353), EDBTKA (1.472–1.538), DC (1.435), and DIL (1.486) are well within acceptable limits, ensuring the reliability of path coefficient estimates. Model fit was evaluated using the Standardized Root Mean Square Residual (SRMR), Chi-square, and Normed Fit Index (NFI). The SRMR values for the saturated model (0.061) and estimated model (0.076) are both below the threshold of 0.08, indicating a good model fit. However, the NFI values—0.662 for the saturated model and 0.659 for the estimated model—fall below the recommended minimum of 0.90, suggesting a need for refinement to improve comparative model fit. The Chi-square values (5536.594 and 5591.512) are presented for reference, though they are not primary evaluation criteria in PLS-SEM. In summary, the structural model demonstrates acceptable predictive power, minimal multicollinearity, and adequate model fit, providing a sound basis for interpreting the hypothesized relationships and supporting the theoretical framework applied in this study.

Table 4. Assessment of the Structural Model

R-Square	Endogenous Variables	R Square		R Square Adjusted	0.26: Substantial, 0.13: Moderate, 0.02: Weak (Cohen, 1989)
	DC	0.119		0.112	
	DIL	0.149		0.142	
	SAE	0.361		0.352	
Effect Size (F-Square)	Exogenous Variables	DC	DIL	SAE	0.35: Substantial, 0.15: Medium effect, 0.02: Weak effect (Cohen, 1989)
	DC			0.027	
	DIL			0.049	
	EDBTKA	0.027	0.037	0.068	
	SPU	0.065	0.085	0.046	
Collinearity (Inner VIF)	Exogenous Variables	DC	DIL	SAE	VIF <= 5.0 (Hair et al., 2017)
	DC			1.435	
	DIL			1.486	
	EDBTKA	1.472	1.472	1.538	
	SPU	1.226	1.226	1.353	
Model Fit	Criteria	Saturated model	Estimated model	Threshold	
	SRMR	0.061	0.076	SRMR < 0.08	
	Chi-square	5536.594	5591.512		
	NFI	0.662	0.659	NFI > 0.9	

4.7. Hypotheses Testing Results

Table 5 displays the outcomes of the proposed hypotheses achieved through bootstrapping with 5000 resampling iterations. The findings suggest that the examination of Hypothesis 1 (H1), which investigates the direct connection between SPU and SAE, produced statistically significant results. The p-value (0.001), below the conventional threshold of 0.05, indicates the existence of a significant relationship. Furthermore, the t-value (3.193) surpasses the critical threshold of 1.96, providing further confirmation of the relationship's significance. The positive beta value (0.199) signifies that SPU has a significant positive impact on SAE. The second hypothesis examined the role of DC as a mediator in the connection between SPU and SAE. The results provided evidence in support of this hypothesis, as evident from the p-value (0.041) falling below the significance threshold of 0.05. Furthermore, the t-value (2.691) surpassed the critical threshold of 1.96, confirming a significant mediating effect. The positive values of LL (0.006) and UL (0.101) indicate the absence of zero in between, further substantiating the presence of a mediating effect. It is important to note that the observed mediation is partial, as the direct relationship between SPU and SAE remains significant even with the inclusion of DC as a mediating factor. Similarly, the third hypothesis (H3) investigated the mediating effect of DIL in the association between SPU and SAE. The results also provided support for this hypothesis, with a p-value (0.037) below the significance threshold of 0.05. The t-value (2.088) exceeded 1.96, confirming a significant mediating effect. The positive values of LL (0.021) and UL (0.143) indicate the absence of zero in between, further

validating the mediating effect. Similar to the previous hypothesis, the mediation observed is partial, as the direct relationship between SPU and SAE remains significant despite the presence of DIL as a mediating factor. These findings suggest that DIL partially and significantly mediates the relationship between SPU and SAE, exerting a positive influence. Hypothesis 4 (H4) investigated the role of EDBTKA as a moderator in the connection between SPU and SAE. The results indicated the absence of a significant moderating effect, as demonstrated by the p-value (0.593) surpassing the significance threshold of 0.05. Additionally, the t-value (0.535) less than the critical threshold of 1.96 further confirmed no significant moderation. In summary, EDBTKA exhibits no significant moderation on the relationship between SPU and SAE. On the other hand, the second moderating hypothesis (H5) examined the impact of EDBTKA on the association between SPU and DC. The findings revealed a significant moderating effect, as evident from the p-value (0.010) less than the significance threshold of 0.05. Furthermore, the t-value (2.597) higher than the critical threshold of 1.96, further confirming a significant moderating effect. However, the hypothesis 6 (H6) investigated the role of EDBTKA as a moderator in the connection between SPU and DIL. The results indicated the a significant moderating effect, as demonstrated by the p-value (0.037) less than the significance threshold of 0.05. Additionally, the t-value (2.089) higher than the critical threshold of 1.96 further confirmed a significant moderating effect. In summary, EDBTKA exhibits a significant moderating influence on the relationship between SPU and DIL.

Table 6. Hypotheses Testing Result

Hypotheses	OS/Beta	SD	95% Bias Corrected Confidence Interval		T	P	Decision	Mediation
			LL	UL				
H1: SPU -> SAE	0.199	0.062	0.082	0.317	3.193	0.001	Supported	
H2: SPU -> DC -> SAE	0.042	0.025	0.006	0.101	2.691	0.041	Supported	Partial
H3: SPU -> DIL -> SAE	0.064	0.031	0.021	0.143	2.088	0.037	Supported	Partial
H4: EDBTKA x SPU -> SAE	-0.025	0.047	-0.103	0.075	0.535	0.593	Not Supported	
H5: EDBTKA x SPU -> DC	0.131	0.050	0.020	0.219	2.597	0.010	Supported	
H6: EDBTKA x SPU -> DIL	0.106	0.051	0.001	0.193	2.089	0.037	Supported	

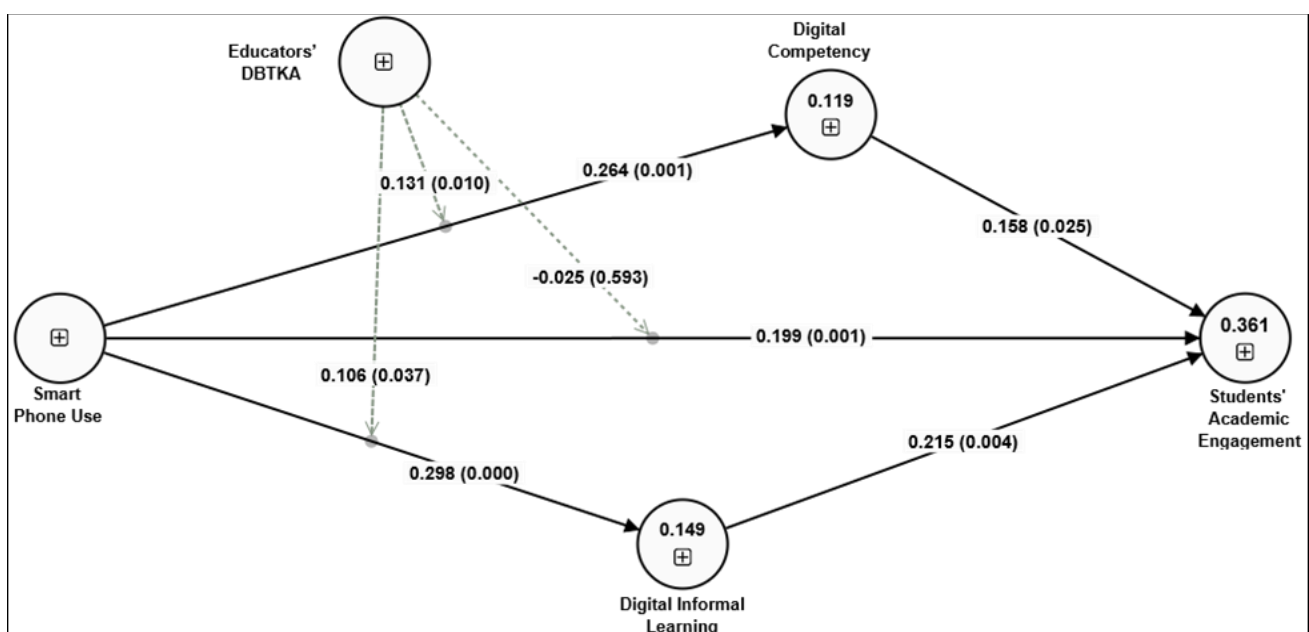


Figure 3. Structural Model with Beta and P-Values

Figure 4 presents a graph that offers additional insights into the moderating impact of EDBTKA. It illustrates the interaction between EDBTKA and the relationship between SPU and DC. The findings demonstrate that when EDBTKA is at a high level, the effect of SPU on DC is more prominent, indicating a stronger relationship. Conversely, when EDBTKA is at a low level, the effect of SPU on DC is weaker, indicating a diminished relationship. To further explore this interaction, we conducted separate path analyses for both high (i.e., 1 standard deviation above the mean) and low (i.e., 1 standard deviation below the mean) levels of EDBTKA. These analyses enabled us to examine the distinct paths for SPU and DC under each EDBTKA condition, providing a comprehensive understanding of the relationships involved.

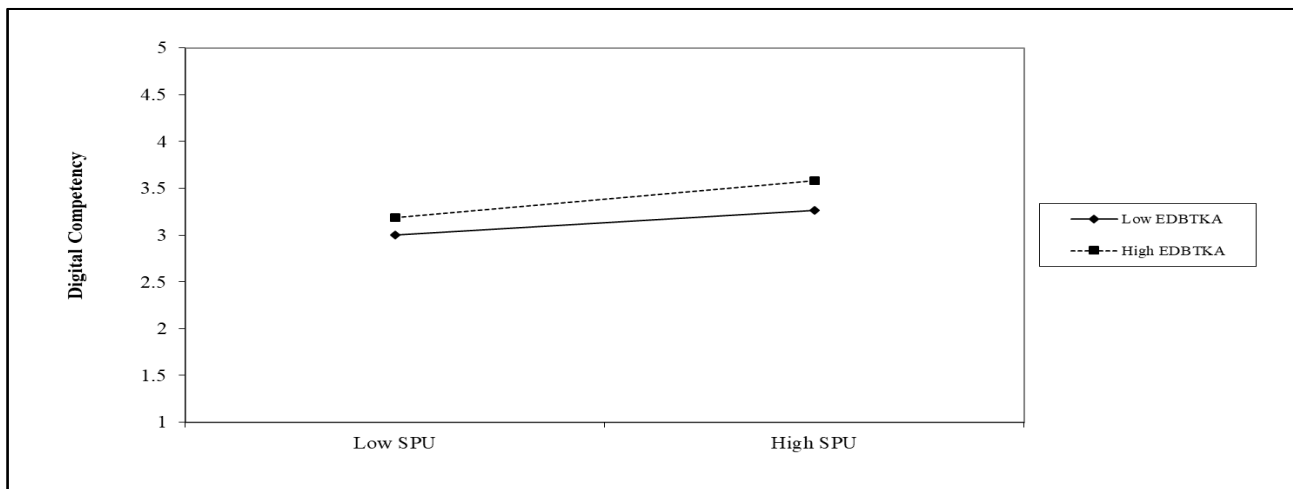


Figure 4. Interactive Effect of EDBTKA in Between SPU and DC

Figure 5 presents a graph that offers additional insights into the moderating impact of EDBTKA. It illustrates the interaction between EDBTKA and the relationship between SPU and DIL. The findings demonstrate that when EDBTKA is at a high level, the effect of SPU on DIL is more prominent, indicating a stronger relationship. Conversely, when EDBTKA is at a low level, the effect of SPU on DIL is weaker, indicating a diminished relationship. To further explore this interaction, we conducted separate path analyses for both high (i.e., 1 standard deviation above the mean) and low (i.e., 1 standard deviation below the mean) levels of EDBTKA. These analyses enabled us to examine the distinct paths for SPU and DIL under each EDBTKA condition, providing a comprehensive understanding of the relationships involved.

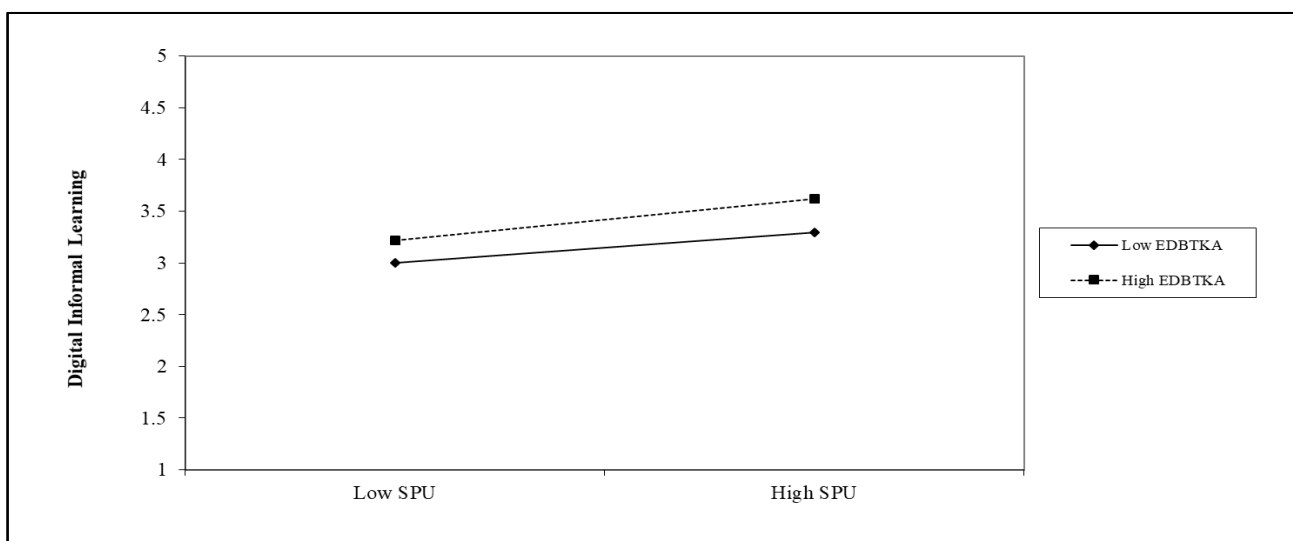


Figure 5. Interactive Effect of EDBTKA in between SPU and DIL

5. Discussion

This study aimed to investigate the relationship between SPU and SAE as a direct relationship for undergraduate university students in Bangladesh. The study also examined the mediating roles of DC and DIL in the relationship between SPU and SAE. Additionally, EDBTKA was assessed for its moderating effects between SPU and SAE, SPU and DC, and SPU and DIL. The first hypothesis (H1) findings supported the study, indicating that SPU has a significant positive effect on Generation-Z SAE. This aligns with previous empirical studies that have highlighted the positive impact of digital technology, including smartphones, on student engagement (Kim et al., 2020; Saqr et al., 2023). The SCLT and SDT provide a theoretical framework to understand this relationship. According to SCLT, individuals learn through observing, modeling, and cognitive processes, which can be facilitated by smartphones that provide immediate access to information and collaborative platforms (Bandura, 1963). This can enhance students' engagement by allowing them to actively participate in the learning process and collaborate with peers, which is particularly relevant for Generation-Z students who are digital natives and value interactive and collaborative learning environments (Prensky, 2001).

Similarly, SDT underscores the significance of self-determination, proficiency, and connection in motivating individuals' behaviors (Deci & Ryan, 1985). The use of smartphones can enhance students' autonomy by allowing them to choose when, where, and how they engage with educational content, thereby fostering a sense of ownership and responsibility in their learning process. Moreover, the use of smartphones to access educational apps, digital resources, and online forums can contribute to students' feelings of competence and relatedness, further enhancing their academic engagement (Fu et al., 2021). The findings of this study underscore the positive impact of SPU on Generation-Z SAE and are consistent with the theoretical frameworks of SCLT and SDT. Therefore, educators and policymakers should recognize the potential benefits of integrating smartphones into educational settings to enhance student engagement and learning outcomes.

The findings of the second hypothesis (H2) revealed that DC plays a significant mediating role in the relationship between SPU and SAE among undergraduate university students. This aligns with prior research indicating the importance of DC in influencing student engagement and learning outcomes (Heidari et al., 2021; Chaw & Tang, 2023). The SCLT provides a lens to understand how DC mediates this relationship. According to SCLT, individuals learn through observation, modeling, and cognitive processes (Bandura, 1963). In the context of digital learning environments, DC enables students to effectively navigate and utilize digital tools, such as smartphones, for learning purposes. This enhances their engagement by allowing them to actively participate in the learning process and collaborate with peers, which is particularly relevant for Generation-Z students who are digital natives and value interactive and collaborative learning environments (Prensky, 2001). DC can enhance students' feelings of competence by equipping them with the necessary skills to use digital tools effectively, thereby fostering a sense of ownership and responsibility in their learning process. Moreover, the use of digital tools to access educational resources and collaborate with peers can contribute to students' feelings of relatedness, further enhancing their academic engagement (Fu et al., 2021). The findings of the second hypothesis (H2) highlight the significant mediating role of DC in the relationship between SPU and SAE among undergraduate university students. Therefore, educators and policymakers should focus on developing students' DC to maximize the potential benefits of integrating smartphones and other digital tools into educational settings.

The results of the third hypothesis (H3) affirm that DIL plays a pivotal mediating role between SPU and SAE among undergraduate university students. This finding is in line with previous research emphasizing the integral role of informal learning environments in fostering student engagement

and academic success (Mehrvaz et al., 2021; Şad et al., 2022). In the context of Generation-Z students, who are digital natives, smartphones offer a convenient and accessible platform for informal learning experiences. As suggested by the SCLT, learning is a dynamic process influenced by observation, modeling, and cognitive processes (Bandura, 1963). Smartphones facilitate continuous, self-directed learning by providing instant access to a vast array of information, educational apps, and online forums, enabling students to choose and engage with content that aligns with their individual learning preferences and styles (Sari et al., 2020). This autonomy in learning enhances SAE, as they are empowered to take control of their learning experiences. Additionally, SDT underscores the value of independence, capability, and interpersonal connection in motivating individuals' behaviors (Deci & Ryan, 1985). DIL promotes students' autonomy by allowing them to self-direct their learning, competence by enabling them to effectively access and utilize educational resources, and relatedness by facilitating collaborative learning experiences with peers (Sari et al., 2020; Baidoo-Annu & Owusu Ansah, 2023). The findings of the third hypothesis (H3) highlight the significant mediating role of DIL in the relationship between SPU and SAE among undergraduate university students. Therefore, it is imperative for educators and curriculum designers to enhance DIL opportunities to effectively promote SAE.

The fourth hypothesis (H4) proposed that EDBTKA would significantly moderate the relationship between SPU and SAE among undergraduate university students. However, the findings did not support this hypothesis, indicating that EDBTKA does not exert a significant moderating influence on the SPU–SAE relationship. This result diverges from prior research, which has consistently emphasized the positive role of democratic educator behavior in fostering student motivation, participation, and learning outcomes (Morales Rodríguez et al., 2020; Huang, 2021). One possible explanation is that in the context of smartphone-mediated learning, other factors—such as students' DC, self-regulation skills, and engagement in DIL—may play a more direct and influential role in shaping academic engagement than the perceived behavior of educators. This finding challenges expectations grounded in Social Cognitive Learning Theory (SCLT) and Self-Determination Theory (SDT). While SCLT emphasizes learning through observation and modeled behavior (Bandura, 1963), and SDT highlights the importance of autonomy, competence, and relatedness (Deci & Ryan, 1985), it appears that for Generation-Z learners—who are inherently digital natives—these needs may be met more effectively through technology-enabled autonomy than through educator facilitation. The absence of a moderating effect by EDBTKA may signal a shift in the student-educator dynamic in digital learning environments, where the educator's traditional role as a transmitter of knowledge is being reshaped. Generation-Z students may rely more heavily on peer networks, digital content, and self-directed strategies than on teacher-led instruction, particularly when engaging with mobile technologies. Future research should explore which specific dimensions of educator behavior—such as digital scaffolding, motivational support, or instructional feedback—might still exert influence in smartphone-supported learning. While EDBTKA remains pedagogically valuable, its moderating effect on SPU and SAE appears to be limited in this context, especially among digitally fluent students in Bangladesh's higher education system.

The fifth hypothesis (H5) of our study posited that EDBTKA would significantly moderate the relationship between SPU and DC among undergraduate university students in Bangladesh. Our findings supported this hypothesis, indicating that EDBTKA does have a significant moderating effect on the relationship between SPU and DC. This result aligns with previous research suggesting that educators play a crucial role in fostering students' DC and SAE (Aldhaen, 2024; Heidari et al., 2021). Educators' democratic behavior has been shown to positively influence students' engagement, critical thinking, and responsible use of digital tools (Özcan, 2016; Turabik & Gün, 2016), which are fundamental aspects of DC. The significant moderating effect of EDBTKA on the relationship between SPU and DC supports the SCLT and SDT. SCLT stresses the interplay among

individual, behavioral, and environmental elements in learning (Bandura, 1986), whereas SDT highlights autonomy, proficiency, and interpersonal bonds in motivating behaviors (Deci & Ryan, 1985). In our study, the democratic behavior of educators appears to enhance students' autonomy and competence in using smartphones for learning, thus fostering their DC. In the context of Generation-Z university students in Bangladesh, who are navigating an increasingly digitalized educational landscape, the role of educators in promoting DC is paramount. Our findings suggest that fostering a democratic learning environment can empower students to use smartphones more effectively for academic purposes, enhancing their DC. The fifth hypothesis provides valuable insights into the role of educators' democratic behavior in shaping students' DC in the context of smartphone-enabled learning environments.

The sixth hypothesis (H6) of our study posited that EDBTKA would significantly moderate the relationship between SPU (SPU) and DIL among undergraduate university students in Bangladesh. Our findings supported this hypothesis, indicating that EDBTKA has a significant moderating effect on the relationship between SPU and DIL. This result resonates with previous research that underscores the role of educators in guiding students' informal digital learning activities (Mehrotra, 2020; Şad et al., 2022). Educators' democratic behavior fosters an environment that encourages students to engage in self-directed, informal learning activities using smartphones, such as enhancing language skills and utilizing search engines for cognitive knowledge (Şad et al., 2022; Baidoo-Annu & Owusu Ansah, 2023). The significant moderating effect of EDBTKA on the relationship between SPU and DIL is consistent with the SCLT and SDT. In our study, the democratic behavior of educators appears to enhance students' autonomy and competence in using smartphones for informal learning, thus fostering their DIL. In the context of Generation-Z students in Bangladesh, who are navigating an increasingly digitalized educational landscape, the role of educators in promoting DIL is crucial. Our findings suggest that fostering a democratic learning environment can empower students to use smartphones more effectively for informal learning purposes, enhancing their DIL. The sixth hypothesis provides valuable insights into the role of educators' democratic behavior in shaping students' DIL in the context of smartphone-enabled learning environments.

5.1. Theoretical Implications

The findings of this study hold significant theoretical implications for understanding the intricate dynamics between SPU, DC, DIL, educators' democratic behavior, and undergraduate university SAE. Firstly, the study reaffirms the pivotal role of smartphones in influencing SAE, aligning with previous empirical studies that suggest a positive relationship between SPU and SAE (Kim et al., 2020). This supports the notion that smartphones serve as valuable tools for learning and can foster active participation, critical thinking, and self-directed learning among Generation-Z students (Sari et al., 2020; Şad et al., 2022). The beneficial effect of SPU on SAE aligns with SCLT, which underscores the interplay among individual, behavioral, and environmental elements in learning (Bandura, 1986). Secondly, the study introduces DC as a significant mediating factor in the relationship between SPU and academic engagement. This finding is in line with previous research that highlights the importance of DC for effective participation in digital learning environments (Heidari et al., 2021; Chaw & Tang, 2023). It underscores the need for students to develop digital skills to navigate and utilize educational apps and online platforms effectively. This mediating effect of DC aligns with both SCLT and SDT, which emphasizes the role of competence and autonomy in motivating individuals' behaviors (Deci & Ryan, 1985). Thirdly, the study identifies DIL as another significant mediating factor in the relationship between SPU and academic engagement. This finding is consistent with the evolving nature of learning in the digital age, where informal learning experiences are increasingly facilitated by smartphones (Mehrotra, 2020; Baidoo-Annu & Owusu Ansah, 2023). It suggests that smartphones enable students to engage in self-directed, continuous

learning outside of traditional classroom settings. This mediating effect of DIL is also in alignment with SCLT, which emphasizes the importance of observational learning and the influence of environmental factors on learning outcomes (Bandura, 1986). Fourthly, the study explores the moderating role of EDBTKA in the relationship between SPU and DIL, and between SPU and DC. The finding that educators' democratic behavior significantly moderates the relationship between SPU and DIL is consistent with previous research emphasizing the role of educators in guiding students' informal digital learning activities (Mehrotra, 2020; Şad et al., 2022). However, the study did not find a significant moderating effect of educators' democratic behavior on the relationship between SPU and DC. This unexpected finding suggests that while educators may play a crucial role in fostering informal learning environments, their influence on students' DC may be more indirect or complex than previously assumed. Overall, the theoretical implications of this study contribute to the growing body of literature on digital learning and SAE among undergraduate university students. The findings underscore the multifaceted roles of smartphones and educators in shaping students' digital learning experiences. They highlight the importance of fostering DC and providing opportunities for DIL, while also emphasizing the need for educators to adopt democratic teaching practices that encourage active participation and self-directed learning. The study provides valuable insights for educational policymakers, curriculum designers, and educators in understanding how to harness the potential of smartphones to enhance SAE and digital learning outcomes.

5.2. Practical Implication

The practical implications drawn from this study offer valuable insights for educational institutions, policymakers, curriculum designers, and educators in fostering an environment conducive to enhancing undergraduate university SAE through SPU, DC, DIL, and educators' democratic behavior. First and foremost, educational institutions and policymakers should recognize the significant positive impact of SPU on SAE. Given the ubiquity of smartphones among Generation-Z students, institutions should leverage this technology to create innovative learning opportunities both inside and outside the classroom. Implementing policies that encourage the responsible and purposeful use of smartphones for educational purposes can help harness the potential of these devices to enhance SAE. This includes integrating educational apps, digital libraries, and online forums that align with the curriculum and foster active learning (Turnbull et al., 2020; Pokorná et al., 2020). Secondly, the findings underscore the importance of promoting DC among students. Educational institutions should prioritize integrating digital literacy and digital skills development into the curriculum to prepare students for effective participation in digital learning environments. This includes providing training and resources to help students evaluate digital resources, discern credible information, and utilize educational apps and online platforms effectively (Nascimbeni & Vosloo, 2019; UNESCO, 2018). Collaborative efforts between educational institutions and technology providers can facilitate the development of DC and ensure that students are equipped with the necessary skills to navigate and utilize digital resources for academic purposes. Thirdly, the study highlights the crucial role of DIL in enhancing SAE. Educators should recognize and support the value of informal learning experiences facilitated by smartphones, which enable students to engage in self-directed, continuous learning outside of traditional classroom settings. Encouraging students to explore topics of interest, access educational apps, and participate in online forums can foster a sense of autonomy and promote active learning (Sari et al., 2020; Şad et al., 2022). Providing students with opportunities to share and discuss their informal learning experiences can also enhance collaboration and peer learning, further contributing to their academic engagement. Fourthly, the study emphasizes the moderating role of educators' democratic behavior in shaping students' DIL experiences. Educators should adopt democratic teaching practices that encourage active participation, critical thinking, and self-directed learning. Creating a supportive and inclusive learning environment where students feel valued, heard, and

actively involved in the learning process can enhance their academic engagement and facilitate the integration of smartphones and digital technology into their learning experiences (Cook-Sather, 2020; Ferguson-Patrick, 2022; Puneet, 2020; Trowler, 2010). Lastly, the study's findings also point to the need for further research and development of guidelines and best practices for integrating smartphones and digital technology into educational settings. Educational institutions and policymakers should collaborate with researchers and technology providers to develop comprehensive guidelines and strategies for promoting the responsible and effective use of smartphones for educational purposes. This includes addressing concerns related to digital distractions, misuse of technology, and widening digital divides to ensure equitable access and opportunities for all students (Franklin & Harrington, 2019; Hung et al., 2012). The practical implications of this study provide a roadmap for educational institutions and educators to harness the potential of smartphones and digital technology to enhance undergraduate university SAE. By promoting DC, supporting DIL, and adopting democratic teaching practices, educational institutions can create a more inclusive and engaging learning environment that leverages the benefits of SPU for academic success and lifelong learning.

5.3. Limitations and Future Research Directives

The study has limitations that warrant consideration. Firstly, its cross-sectional design restricts the ability to determine causal relationships among SPU, DC, DIL, and academic engagement. Employing a longitudinal or experimental design could offer more conclusive insights. Secondly, the study focused solely on undergraduate students in Bangladesh, potentially limiting the generalizability of the findings to other contexts. Future research should replicate the study across diverse cultural and institutional settings to validate the findings. Lastly, the reliance on self-reported measures may introduce response biases. Future studies should incorporate objective measures and mixed-methods approaches to enhance the accuracy and depth of the findings.

6. Conclusion

This study explored into the intricate dynamics between SPU, DC, DIL, and SAE among undergraduate students in Bangladesh. Consistent with the SCLT and SDT, the findings revealed a significant positive effect of SPU on SAE, supporting our first hypothesis. Furthermore, the second and third hypotheses were substantiated as DC and DIL were found to significantly mediate the relationship between SPU and academic engagement. Interestingly, EDBTKA was found to have a significant moderating effect on the relationship between SPU and DC (H5) but not on the relationship between SPU and SAE (H4). However, the study did not fully support the hypotheses based on the theoretical frameworks of SCLT and SDT. The theoretical implications underscore the evolving role of digital technology and educators in shaping the learning environment and the academic engagement of Generation-Z students. Practically, the study accentuates the need for educational institutions to incorporate digital literacy training and foster a democratic learning environment to optimize the positive impact of SPU on academic engagement. Nevertheless, the study is not without limitations. The cross-sectional design restricts causal interpretations, the sample is confined to undergraduate students in Bangladesh, and reliance on self-reported measures may introduce response biases. Future research should adopt longitudinal or experimental designs, include diverse cultural settings, and employ mixed-methods approaches to further elucidate these relationships and enhance the generalizability and validity of the findings.

Declarations

Author Contributions: M.N.A. conceived the study's main idea, designed the framework, and conducted data collection and analysis. Z.M. contributed to methodology and questionnaire development, while S.H.A. wrote the discussion and conclusion. M.A.I.G. handled the introduction,

supervision, visualization and editing and H.S.A. conducted the literature review. F.H. ensured language accuracy and final editing. A.B.B. contributed conceptualization, validation and editing. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: There is no conflict of interest among the authors.

Funding: This research was supported by the self-funding of the authors.

Ethical Approval: The study was based on a survey questionnaire; therefore, ethical approval was obtained from the concerned organizations, and informed consent was secured before the collection of data from the respondents.

Data Availability Statement: Data will be provided upon request.

Acknowledgements. During the preparation of this work, the authors used ChatGPT in order to improve the language and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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