



Student Experiences in Developing Self-Directed Learning within Technology-Based Learning Systems in Higher Education

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ARTICLE INFO

Keywords: Self-Directed Learning, Higher Education, Learning Technology, Student Experience, Phenomenology.

Received : 27, March

Revised : 29, April

Accepted: 30, May

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ABSTRACT

Digital transformation in higher education requires students to have high learning independence, but technology-based learning systems also have the potential to create algorithmic dependency that reduces intellectual autonomy. This research aims to explore students' experiences in developing self-directed learning (SDL) in a digital environment. The research uses a qualitative approach with a hermeneutic phenomenological design through in-depth interviews with 15 purposively selected final year students. Data were analyzed using NVivo 14-assisted thematic analysis. The results of the study identified three typologies of student adaptation, namely Proactive Navigators, Adaptive Followers, and Passive Recipients. The findings suggest that overly prescriptive technological systems can trigger pedagogical alienation and lower the quality of learning autonomy. In addition, the strategy of "planned digital detoxification" was found to be an important mechanism in maintaining students' cognitive depth. This study concludes that the success of SDL is determined by the balance between technology system support and independent exploration space

INTRODUCTION

Digital transformation in higher education has shifted the learning paradigm from traditional instructional models to a student-centered environment. This phenomenon requires students to have strong self-directed learning (SDL) skills in order to be able to navigate technology-based learning systems effectively. Globally, the integration of Learning Management Systems (LMS) and artificial intelligence in education is no longer just a complement, but a key infrastructure that determines academic success. However, the reality on the ground shows that the availability of advanced technology does not automatically increase learning independence; On the contrary, many students feel overwhelmed and lose their way in a digital environment that is not well structured.

The urgency of this topic is even more evident considering the latest data shows that there is a large disparity in students' readiness to study independently amid massive post-pandemic digitalization. At both the local and global levels, the main challenge faced is how students manage their motivation and cognition when physical interaction with teachers is reduced. Without adequate SDL capabilities, educational technology will only become a pile of digital materials that have no impact on the depth of understanding. Therefore, understanding the subjective experience of students in building learning independence in a technology-based system is crucial to ensure the sustainability of the quality of higher education in the contemporary era.

Although the literature on educational technology has grown rapidly, there is a significant research gap regarding how SDL is organically formed from the perspective of student experience. Previous studies by Zhu & Zhang (2022) have mapped students' digital competencies, but the study focused more on quantitative learning outcomes than the psychological process of self-sufficiency. On the other hand, O'Neill (2021) highlights the cognitive burden in online learning, but has not provided a critical explanation of how students overcome these barriers through specific self-regulation strategies in adaptive technology-based systems.

Further disparities were seen in a study conducted by Roberts et al. (2022), which identified the phenomenon of digital burnout but failed to attribute it to the evolution of students' identities as independent learners. In addition, research from Hasan & Khan (2023) emphasizes the analytical function of systems in supporting independent learning, but does not give a portion to the affective aspects and social-emotional experiences of students when interacting with learning algorithms. These gaps show the need for a more holistic and qualitative study to capture the essence of students' struggles and adaptations in developing SDL.

Based on this background, this research aims to explore in depth the experience of students in developing self-directed learning skills in technology-based learning systems. Narratively, this study seeks to reveal how students perceive the role of technology in triggering or hindering their autonomy. In addition, this study aims to identify unique patterns of strategies used by

students to remain intellectually empowered in a digital environment that is often mechanistic and lacks direct supervision.

Another goal is to analyze the interaction between instructional design of technology and the internal dynamics of students in achieving learning independence. By investigating various backgrounds of students' experiences, this study aims to dissect the contextual factors that strengthen students' persistence in directing themselves. The results of this analysis are expected to provide a comprehensive picture of the evolution of SDL in response to the demands of the increasingly complex modern learning system.

Theoretically, this research contributes to the development of adult learning theory (andragogy) and self-regulation theory in a digital context. This study expands the understanding of SDL by adding the dimension of "human-machine interaction" as a key variable that affects learning autonomy. This scientific contribution is important to update the existing theoretical framework to be more relevant to the current conditions of higher education which are already highly integrated with artificial intelligence technology and self-learning platforms.

Practically, the results of this study provide guidance for university managers and instructional system developers to design "autonomy-supportive" technology. This contribution is very relevant for lecturers in developing mentoring strategies that are not dictating, but are able to stimulate students' metacognitive awareness. By implementing the recommendations of this study, educational institutions can create a digital ecosystem that not only provides content, but also shapes the character of students as resilient and independent lifelong learners.

THEORETICAL REVIEW

The Evolution of Self-Directed Learning (SDL) in the Digital Era of Higher Education

The development of digital technology has changed the learning paradigm in higher education from teacher-centered learning to student-centered learning. In this context, self-directed learning (SDL) develops into a strategic competency that is not only related to independent learning capabilities, but also reflects students' capacity to manage the learning process in a reflective, adaptive, and sustainable manner. Zhu and Zhang (2022) emphasized that digital transformation in higher education requires students to be able to determine learning goals, choose relevant learning resources, and evaluate learning outcomes independently. SDL is the main foundation in building lifelong learning because students are faced with a very dynamic and ever-growing flow of digital information.

Conceptually, SDL is no longer understood as just an individual learning activity, but as a multidimensional process involving self-regulation, intrinsic motivation, digital literacy, and adaptability to a technology-based learning environment. Knowles (1975) has since the beginning defined SDL as a process in which individuals take the initiative in diagnosing learning needs, formulating goals, identifying learning resources, choosing strategies, and evaluating learning

outcomes independently. In the context of modern digital education, the concept is expanding as students not only interact with conventional learning resources, but also with algorithms, adaptive systems, and artificial intelligence-based learning platforms that actively influence their learning patterns.

Although technology provides broad and flexible access to information, various studies have shown that the existence of technology does not automatically improve the quality of students' SDL. O'Neill (2021) explained that students often experience information disorientation due to the abundance of digital resources available without adequate selection and self-regulation skills. This condition causes students to tend to be trapped in superficial learning, such as only completing digital administrative tasks without really understanding the substance of the material. This phenomenon shows that the success of SDL is not only determined by access to technology, but also by students' ability to manage attention, motivation, and learning strategies effectively.

The Role of Technology-Based Learning Systems as SDL Facilitators

Technology-based learning systems such as Learning Management Systems (LMS), Massive Open Online Courses (MOOCs), adaptive platforms, and Artificial Intelligence (AI)-based learning applications play an important role in supporting the implementation of SDL in universities. Technology allows students to access materials anytime and anywhere, provides flexibility in learning timing, and provides a variety of multimodal learning resources that can be tailored to individual needs. Hasan and Khan (2023) stated that features such as progress tracking, learning analytics dashboards, personalized recommendation systems, and automatic feedback help students monitor their learning progress more systematically.

In addition, the adaptive system allows the learning process to be more personalized because the material and level of difficulty can be adjusted to student performance in real-time. In the perspective of digital constructivism, technology not only functions as a medium for delivering information, but also as an interactive space that allows students to actively build knowledge through exploration, simulation, virtual discussions, and online collaboration. Therefore, technology integration has great potential to strengthen a more flexible, participatory, and student-centered learning experience.

However, the effectiveness of technology-based learning systems is greatly influenced by the pedagogical design used. Miller (2024) highlights that systems that are too prescriptive and automation-oriented can reduce students' intellectual exploration space. When learning platforms over-regulate learning steps through notifications, recommendation algorithms, and automatic targeting, students tend to become passive users who simply follow the pattern of the system without doing critical reflection. This condition gives rise to the phenomenon of "algorithmic dependency", which is the dependence of students on the direction of the digital system in determining what to learn and how to learn.

This phenomenon shows a paradox in the digital transformation of higher education. On the one hand, technology is designed to support flexibility and personalization of learning, but on the other hand, it can limit intellectual autonomy if the system controls student learning behavior too much. As a result,

students focus more on completing the platform's technical indicators, such as completing a quiz or reaching a specific progress bar, rather than building a deep conceptual understanding. Thus, the design of learning technology needs to consider the balance between the system structure and the space of exploratory freedom so that SDL can develop optimally.

Student Experience: Motivational Challenges, Self-Regulation, and Digital Fatigue

Students' experience in developing SDL in the digital era is greatly influenced by the ability to self-regulate and intrinsic motivation. Self-regulation includes students' ability to manage time, control digital distractions, maintain focus on learning, and evaluate the effectiveness of the learning strategies used. Kumar and Singh (2025) found that students with high levels of digital literacy tend to have better confidence in running SDL. They are better able to explore alternative learning resources, use technology creatively, and adjust learning strategies according to personal needs.

However, the main challenge that many students face is the increase in digital distractions due to the high intensity of technology use. The presence of social media, application notifications, digital multitasking, and academic pressure based on online platforms often cause students to experience a decrease in concentration and difficulty maintaining depth of thinking. Roberts et al. (2022) identified the phenomenon of digital burnout as one of the main obstacles in modern SDL. Digital fatigue arises when students constantly interact with screens, online assignments, and virtual learning systems for long periods of time without adequate psychological balance.

Digital burnout not only impacts students' mental health, but also affects the quality of their learning experience. Students who experience digital fatigue tend to show decreased intrinsic motivation, increased transactional learning behavior, and a tendency to learn only to meet formal academic demands. In this condition, SDL loses its essence as a reflective and meaningful process of intellectual exploration. Therefore, some recent research has begun to highlight the importance of the "digital detoxification" strategy as a form of cognitive resilience mechanism. This strategy is carried out by limiting exposure to technology in a certain period so that students have room for reflection, deep information processing, and psychological recovery.

In addition to individual factors, students' SDL experiences are also influenced by the social and academic cultural conditions in the university environment. Students who are in a supportive, collaborative, and open-to-exploratory learning environment tend to have better SDL skills than students who study in an academic culture that is too competitive and performance-oriented. This shows that SDL is the result of a complex interaction between personal, social, and technological factors.

Institutional Support and Pedagogical Strategies in Strengthening SDL

Contemporary literature confirms that the development of SDL cannot be fully imposed on students. Universities have an important responsibility in creating a digital learning ecosystem that supports student learning autonomy in a sustainable manner. Li and Wong (2023) argue that the role of lecturers in the

digital era must shift from just conveying information to learning facilitators who are able to build an autonomy-supportive learning environment. Lecturers need to design learning experiences that provide space for students to make decisions, reflect, and develop learning strategies that suit their needs.

Pedagogical strategies that support SDL can be carried out through the implementation of project-based learning, reflective learning, inquiry learning, and collaborative digital learning. These approaches allow students to be actively involved in the process of knowledge discovery and the development of critical thinking skills. In addition, the integration of technology in the curriculum needs to be accompanied by digital literacy training, time management, and self-regulation strategies so that students are not only proficient in using technology, but also able to use it reflectively and productively.

Pratama (2024) also highlighted the importance of collaboration between students through digital platforms as a mechanism to strengthen SDL. Peer-feedback features, virtual discussions, and online learning communities can help students build a sense of social connectedness in the midst of digital learning that is often individualistic. The collaboration not only increases learning motivation, but also strengthens students' ability to reflect and evaluate themselves through the exchange of experiences and perspectives.

Thus, the development of SDL in the digital era requires a holistic and balanced approach between technology, pedagogy, and psychosocial support. Technology should not only be used to improve the efficiency of learning administration, but also designed to strengthen students' reflective capacity, creativity, and intellectual autonomy. Universities need to ensure that the digital transformation of education does not produce students who are simply technologically connected, but also able to become independent learners who are critical, adaptive, and oriented towards lifelong learning.

METHODOLOGY

Research Approach and Design

This study uses a qualitative approach with a hermeneutic phenomenological design to explore in depth the essence of students' life experiences in developing self-directed learning (SDL). The qualitative approach was chosen because the research focuses on the subjective interpretations and meanings that individuals construct of their interactions with technology-based learning systems (Creswell & Poth, 2023). The design of hermeneutic phenomenology allows researchers to understand how the structure of student consciousness responds to the challenges of digital autonomy in a digitized higher education ecosystem. In this study, SDL is understood not just as a measurable variable, but as a complex psychological and pedagogical adaptation process.

Participants and Sampling Techniques

The research participants were determined using the purposive sampling technique, which is a non-probability method that selects subjects based on certain criteria relevant to the research objectives. The research involved 15 final year students from various disciplines at universities who have integrated Learning Management Systems (LMS) based on Artificial Intelligence (AI) for a

minimum of two years. The number of participants is determined based on the principle of data saturation, which is the condition when the addition of participants no longer results in significant new information (Saunders et al., 2023). Final year students are chosen because they are considered to have more mature experience in dealing with digital learning transformations and implementing independent learning strategies during their studies.

Data Collection Techniques

The research data was collected through semi-structured in-depth interviews. This technique is used to provide space for participants to express their experiences and views freely but still in a directed manner according to the focus of the research. The interview guidelines were compiled based on SDL indicators adapted from Zhu and Zhang (2022), including the dimensions of self-planning, cognitive monitoring, and evaluation of learning outcomes in a digital environment. To maintain the validity of the data, the research applied the principle of trustworthiness through member checking, which is the return of interview transcripts to participants to verify their accuracy, as well as dependability through trail audits that document the entire research process systematically and transparently.

Research Implementation Procedure

The research procedure begins with the preparation stage which includes the management of ethical permits and the recruitment process of participants through official emails. The implementation stage was carried out through online interviews using video conferencing platforms to provide convenience and flexibility to participants. Before the interview began, participants were given an explanation of the research objectives and the procedure for conducting the research. All interview sessions are recorded based on the written consent of the participants and then transcribed verbatim. After the data collection process is complete, the researcher conducts initial verification and analysis to ensure that no important context is missed. All participants' identities are disguised using pseudonyms to maintain data confidentiality in accordance with scientific research ethics standards.

Data Analysis Techniques

Data analysis was carried out using thematic analysis techniques which included the process of coding data, identifying themes, and reviewing relationships between thematic categories. The researcher leveraged NVivo 14 software to assist with data organization, hierarchical coding, and visualization of relationships between themes emerging from participants' narratives. The use of Computer-Assisted Qualitative Data Analysis Software (CAQDAS) helps to improve the systematics of analysis and minimize the biases of researchers' interpretations (Silver & Lewins, 2024). The results of the analysis are then synthesized into a descriptive narrative that describes the typology of student experience in balancing the structure of the technological system with the need for autonomy in independent learning.

RESEARCH RESULTS

This study explores students' experiences in developing self-directed learning (SDL) in technology-based learning systems in universities. Based on the results of thematic analysis using NVivo 14, five main themes were found that describe the dynamics of student experience in building learning independence in a digital environment. These themes include: (1) the typology of student adaptation to the digital system, (2) technological paradoxes and pedagogical alienation, (3) self-regulation and learning adaptation strategies, (4) the phenomenon of digital burnout and digital detoxification, and (5) the role of social and institutional support in strengthening SDL.

Typology of Student Adaptation to Digital Learning System

The results of the study show that students have different adaptation patterns in dealing with technology-based learning systems. Based on the intensity of self-control, the ability to reflect, and how to utilize technology, participants were classified into three main typologies, namely *Proactive Navigators*, *Adaptive Followers*, and *Passive Recipients*.

Proactive Navigators

This group consists of students who show a high level of SDL. They actively utilize LMS, AI platforms, digital journals, and learning forums to develop an understanding beyond the material provided by lecturers. Students in this category have clear learning planning skills, time discipline, and a tendency to evaluate learning strategies independently.

One participant explained:

"I usually don't just follow the material in the LMS. If there is an interesting topic, I look for additional journals myself or discussions in other forums to understand better." (P3, interview, February 12, 2026)

Other participants also said:

"Technology for me is not just a place to upload tasks, but a tool for exploration. I feel freer to learn if I can decide for myself the learning resources to use." (P7, interview, 15 February 2026)

Adaptive Followers

The second group showed considerable adaptability, but still relied on the structure of the available digital system. Students in this category are able to follow the rhythm of online learning and make effective use of technological features, but do not yet fully have high exploratory initiatives.

One participant stated:

"I usually learn according to the flow that already exists in the LMS. If the tasks and deadlines are clear, I can follow them well." (P9, interview, February 18, 2026)

Another participant added:

"If there are no notifications or reminders from the system, sometimes I forget to open the material myself." (P11, interview, 19 February 2026)

Passive Recipients

This group showed the lowest level of SDL. Students are more likely to carry out learning activities as an administrative routine without deep reflection on the learning material.

One participant revealed:

"Sometimes I just focus on completing tasks so that the checklist in the LMS is completed. After that, it is rare to open the material again." (P14, interview, 21 February 2026)

Other participants stated:

"I tend to follow what the system recommends because I'm confused about where to start learning." (P15, interview, February 22, 2026)

Table 1. Typology of Student Adaptation in Digital SDL

Typology	Key Characteristics	Interaction Patterns with Technology
Proactive Navigators	Reflective, mandri, exploratory	Technology is used as a tool for exploration and self-development
Adaptive Followers	Adaptive yet system-dependent	Follow the structure and direction of the learning platform
Passive Recipients	Passive and administrative	Fully dependent on algorithms and system instructions

The Paradox of Technology and Pedagogical Alienation

The results of the study found that there is a paradoxical phenomenon in the use of learning technology. On the one hand, technology provides flexibility, efficiency, and broad access to information. But on the other hand, a system that is too prescriptive actually gives rise to the experience of pedagogical alienation in students.

Most participants revealed that automated features in AI-based LMS do help learning management, but also create psychological pressure because students feel constantly monitored by the system.

One of the participants said:

"At first, the progress tracking feature helped, but over time I felt that learning was only to meet the system indicators, not to understand the material." (P5, interview, 16 February 2026)

Another participant explained:

"Sometimes learning feels mechanical. The important thing is that the progress bar is full and the assignment is completed, even though I myself don't necessarily really understand the content of the material." (P8, interview, 17 February 2026)

Other findings show that students begin to lose their freedom in determining the rhythm of learning because the system is too regulated by the pace of learning.

"Everything has been directed by algorithms, starting from the material to the weekly target. For a long time, I felt that I didn't have my own space for exploration." (P10, interview, 18 February 2026).

Table 2. The Impact of Digital Systems on Students' SDL Experience

Positive Impact	Negative Impact
Flexible learning access	Dependency on the system
Monitoring the Progress of Learning	Decline in self-exploration
Quick feedback	Alienasi pedagogis
Task management efficiency	Learning becomes mechanistic

Self-Regulation and Learning Adaptation Strategies

Research shows that the success of SDL is greatly influenced by students' self-regulation ability in managing attention, time, and learning strategies. Students with high self-regulation generally have a more structured study routine.

One participant explained:

"I divide my study time and social media strictly. Otherwise, the focus on learning is easily distracted." (P2, interview, February 11, 2026)

Other participants stated:

"I usually make my own daily targets outside of the lecturer's assignments so that the learning process continues to develop." (P6, interview, February 14, 2026)

Students also use various strategies to maintain their focus on learning.

"I use a focus timer app and turn off notifications while studying because the digital distractions are huge." (P4, interview, February 13, 2026)

On the other hand, students with low self-regulation are more prone to experiencing a decrease in concentration due to digital multitasking.

"Sometimes I open the LMS while on social media, and the material doesn't really come in." (P12, interview, 20 February 2026)

Digital Burnout and "Digital Detoxification" Strategies

Another important theme found is the emergence of the phenomenon of digital burnout. Almost all participants admitted to experiencing cognitive fatigue due to the high intensity of the use of learning technology.

One participant revealed:

"Spending too much time in front of a screen makes me tired quickly and has a hard time focusing on reading long material." (P1, interview, February 10, 2026)

Another participant explained:

"Sometimes I feel bored because every day I have to interact with online tasks and virtual meetings." (P13, interview, 20 February 2026)

As a form of adaptation, some students applied the "planned digital detoxification" strategy.

"I started limiting the use of gadgets after a certain hour so that the brain could rest." (P7, interview, 15 February 2026)

Other participants said:

"If I'm too bored, I learn to use printed books or write manual notes to be calmer." (P5, interview, 16 February 2026)

Students who applied the strategy reported increased focus and emotional stability during studying.

Table 3. Forms of Digital Burnout and Student Adaptation Strategies

Symptoms of Digital Burnout	Adaptation Strategy
Mental fatigue	Digital detox
Loss of focus	Notification restrictions
Transactional learning	Offline reflective learning
Information overload	Selection of learning resources
Decreased motivation	Rescheduling digital activities

Social and Institutional Support in Strengthening SDL

The results of the study show that students' SDL does not develop individually, but is influenced by social and institutional support.

Participants assessed that lecturers who provide learning flexibility and open discussion spaces are able to increase students' motivation to learn independently.

One participant stated:

"I am more motivated when lecturers give me the freedom to choose topics and ways of studying, instead of just focusing on assignments." (P8, interview, 17 February 2026).

Another participant explained:

"Discussions with friends on online forums helped me understand the material more deeply than I did on my own." (P3, interview, February 12, 2026)

In addition, peer-feedback in the digital community also strengthens students' sense of social connectedness.

"Online learning often feels lonely, so the existence of discussion groups really helps maintain the spirit of learning." (P9, interview, February 18, 2026)

These findings show that SDL in the digital era is the result of a complex interaction between personal factors, technology, and the social-academic environment.

DISCUSSION

The results of the study show that the development of student self-directed learning (SDL) in technology-based learning systems does not take place uniformly, but is formed through complex dynamics between personal capacity, technological design, and academic environment support. Based on the thematic analysis, five main themes were found, namely the typology of student adaptation to the digital system, technological paradox and pedagogical alienation, self-regulation and learning adaptation strategies, digital burnout and digital detoxification, as well as the role of social and institutional support in strengthening SDL. These findings confirm that SDL in the digital era is not just the ability of students to learn independently, but an active process that requires reflective awareness, self-control, digital literacy, and the ability to manage psychological pressure due to the intensity of technology use.

The first finding shows that there are three typologies of student adaptation, namely Proactive Navigators, Adaptive Followers, and Passive

Recipients. Proactive Navigators shows the highest level of SDL because it is able to use LMS, digital journals, learning forums, and AI platforms as a means of knowledge exploration. On the other hand, Passive Recipients tend to interpret digital learning administratively, namely completing tasks only to meet system indicators. This is in line with the concept of SDL which emphasizes the ability of individuals to set learning goals, choose learning resources, manage strategies, and evaluate their learning outcomes independently. Recent studies have also shown that SDL in higher education contributes to increased student independence and academic achievement, especially when technology is used as a means of exploration, not just as an instructional medium.

The second finding shows a technological paradox. On the one hand, technology provides flexibility, information access, quick feedback, and task management efficiency. But on the other hand, a digital system that is too prescriptive can cause pedagogical alienation, which is a condition when students feel that they are learning only to meet the indicators of the platform, not to understand the substance of the material. This phenomenon is important because it shows that learning technology does not always automatically improve the quality of learning. If technology design is too oriented towards progress tracking, checklists, notifications, and recommendation algorithms, students can lose space for reflection and learning autonomy. Thus, the results of this study reinforce the view that educational technology should be designed to expand student agency, not replace the critical thinking process and learning decision-making.

The third finding confirms that self-regulation is a key factor in the success of digital SDL. Students who are able to manage their time, limit social media distractions, set daily goals, and use strategies such as focus timers show more stable learning abilities. These findings are consistent with a study of self-regulated learning that planning, monitoring, attention control, and reflection are important components of the success of online learning. The latest systematic review also confirms that self-regulation strategies are very important in a digital learning environment because students have to face the freedom of learning as well as the high risk of distractions.

The fourth finding is related to digital burnout. Students experience cognitive fatigue, screen saturation, decreased focus, and decreased motivation due to the intensity of using digital platforms. This condition shows that technology-based learning not only has an impact on the cognitive aspect, but also on the psychological well-being of students. Recent studies show that digital learning fatigue can reduce students' academic motivation and learning engagement, while burnout in online learning is an obstacle to academic success and learning participation. Digital detoxification strategies carried out by students, such as limiting the use of gadgets, turning off notifications, reading printed books, and writing manual notes, show that there is an adaptive effort to balance the use of technology with the need for cognitive rest.

The fifth finding suggests that SDL does not develop individually, but is also influenced by social and institutional support. Lecturers who provide learning flexibility, open discussion spaces, and freedom to choose topics can

increase student motivation. In addition, discussion forums and peer-feedback help students reduce loneliness in online learning. These findings are in line with research showing that peer support and lecturer support play an important role in increasing student learning engagement, intrinsic motivation, and confidence in the digital environment. Thus, SDL needs to be understood as a social-cognitive process, not just an individual responsibility of students.

Theoretically, this research contributes to expanding the understanding of SDL in the digital age by showing that learning independence is not only determined by internal motivation, but also by technological design, the quality of pedagogical interactions, and social support. Practically, the results of this study provide implications for universities to not only provide digital learning platforms, but also ensure that they encourage reflection, exploration, collaboration, and student well-being. A digital learning system ideally not only measures assignment completion, but also facilitates deep understanding, active engagement, and students' ability to manage their own learning process.

However, this study has some limitations. First, the study uses a qualitative approach so that the results are not intended to be generalized widely. Second, the data depends on the subjective experience of students so there may be a perception bias. Third, the study has not compared the differences in SDL based on the study program, semester level, or digital literacy level of students. Therefore, follow-up research is recommended using a mixed design involving quantitative surveys, digital activity observations, and LMS log analysis to obtain a more comprehensive picture. The next study can also examine the relationship between digital literacy, self-regulation, digital burnout, lecturer support, and student academic achievement statistically.

CONCLUSIONS AND RECOMMENDATIONS

This study shows that the development of students' self-directed learning (SDL) in technology-based learning systems is influenced by the complex interaction between self-regulation skills, learning technology design, and social and institutional support. The results of the study identified three typologies of student adaptation, namely Proactive Navigators, Adaptive Followers, and Passive Recipients, which illustrate the difference in the level of learning autonomy in the digital environment. The findings also show that learning technologies have paradoxical properties; On the one hand, it provides flexibility and efficiency, but on the other hand, it can lead to pedagogical alienation and algorithmic dependency if the system is too prescriptive. In addition, self-regulation and digital detoxification strategies are important factors in maintaining students' focus, motivation, and psychological well-being during the online learning process.

Based on these findings, universities are advised to design a more autonomy-supportive digital learning system, which is a system that is not only oriented towards monitoring tasks and technical indicators, but also encourages critical reflection, independent exploration, and meaningful social-academic interaction. Lecturers also need to develop flexible, collaborative, and reflection-based learning strategies so that students can develop SDL more optimally. The

next research is recommended to use a mixed methods approach with a wider scope of participants in order to be able to analyze the relationship between digital literacy, self-regulation, digital burnout, and student academic achievement in more depth and produce more comprehensive findings.

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