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Empowered Learners in a Digital Age: The Critical Nexus of Engagement, Agency, Interest, and Motivation

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Abstract

Integrating information and communication technology (ICT) into teaching and learning is critical to raising students' engagement. As engagement is vital for productive learning, understanding its relevant aspects is essential. Thus, it is crucial to understand how ICT integration can help improve students' engagement. This paper reports a study on ICT-integrated learning and how the integration improved student engagement of 122 university students enrolled in three courses. The study captured the students' digital e-learning activities, driven by their interest-related activities and study motivation. How they navigated their way in using technology to help with their course learning was examined. The connection between students' agency, interest, motivation and engagement was analyzed. The findings highlighted how technology strengthened the nexus between agency, interest, motivation and engagement. Students' interest in ICT uses and activity preferences motivated their learning and promoted their engagement. The students' agency helped control their effort and perseverance, enabling long-lasting engagement. Motivated learners with interest showed more developed agency. They exhibited determined goals, self-directed learning and resoluteness in responding to their surroundings, including access and knowledge of technology use, aligning with their preferred ways of learning and objectives. Pedagogic implementation recommends flexible ways to accommodate students' interests in ICT use to maintain their motivation, as both are important to their developed agency and engagement.

Keywords: *interest and motivation, agency and engagement, technology (ICT) integration*

Introduction

Learning is a long and complex process involving factors from individuals, the educational system, and the environment to succeed. It also involves multifaceted activities and approaches requiring an active agent from educators and learners. In today's rapidly changing world, technological advancements are reshaping nearly every aspect of our lives, including education. The increasing demand for the integration of information communication technologies into education has increased the number of platforms, applications (apps) and software that provide teachers with the required abilities to support students in their digital e-learning while still referring to the curriculum. Research has shown that when technology is effectively incorporated into the curriculum, it can significantly enhance student engagement by making learning more interactive, personalized and accessible (e.g., Haleem et al., 2022; Schindler et al., 2017).

Years of studies have proved that engagement is an essential factor for the successful learning of students across ages (e.g., Renninger & Bachrach, 2015; Renninger & Hidi, 2016, 2022). As research on personalized learning thrives, critical problems in education, such as how individual learning styles, preferences, values and goals are integrated into cognitive functioning are examined further (Duchesne et al., 2022). More research was subsequently conducted to conceptualize the affective domain of learning while considering students' well-being, individual requirements and preferences to develop a healthy learning environment (Arikpo & Domike, 2015). One of the most extensively researched subjects is interest and its impact on motivation and engagement (Renninger & Hidi, 2016; 2022). The study reported here tried to connect interest, motivation and students' agency concerning their engagement in digital e-learning activities to promote success in independent learning. It addressed Indonesian university students as adult learners who are supposed to be more independent and self-directed; thus, engagement is even more necessary for their long-lasting individual venture (Sutarni et al., 2021).

The change in learning principles causes teaching methods to evolve, adapting to the social shift and education transformation. The approaches develop as the paradigm changes from behaviourism—cognitivism—constructivism—humanism to the currently flourishing practices of connectivism. According to researchers, interaction is critical in human life to encourage learning, and they believe that continuous learning is based on

diversity of opinion and sustaining connections (Wang et al., 2014). Amidst the current technological advancement, connectivism is profound, reflecting on how it integrates internet technologies to give more access for students to various learning resources and activities, connecting to others (e.g., peers, teachers, mentors) and joining informative discussion forums (Siemens, 2019). Prominently, in the past years, during the lockdown due to the COVID-19 pandemic, technology integration helped a lot to maintain educational practices, which required students to engage in online learning and connect to others virtually.

As we have passed the critical times of the pandemic, we have come to see that the pandemic might have initially caused significant disruptions to education systems worldwide. However, it has also led to the widespread adoption of technology to facilitate remote learning. As the impacts of the pandemic diminish and schools are reopened, the education world witnesses a transition to a new standard practice in which technology integration is found as a crucial strategy to enhance teaching and learning and become a critical part of students' learning experience (Biletska et al., 2021; Haleem et al., 2022).

The rapid advancement of digital technologies has transformed education systems globally, with Indonesian universities also embracing digital platforms to enhance learning. However, the effectiveness of these technologies in fostering student empowerment remains inconsistent. Indonesian university students often face challenges in engaging deeply with digital learning environments, stemming from limited digital literacy, cultural attitudes towards technology, and varying motivation levels. This problem becomes more acute as digital learning increasingly demands higher self-direction, interest and engagement (Sutarni et al., 2021).

Despite the potential for digital tools to create more interactive and flexible learning environments, many students in Indonesia struggle to align their personal goals with academic demands in digital settings. The critical gap lies in understanding how learner agency, interest and motivation converge to affect engagement and how these interactions foster empowered, autonomous learners. Research shows engagement and agency are significant predictors of academic success, particularly in digital contexts. However, this is not fully explored for Indonesian university students with different interests, motivations and technological backgrounds (Kristiana et al., 2023; Rahman et al., 2023).

The research reported here aimed to explore how these four factors—engagement, personal agency, interest, and motivation—interact to either enhance or inhibit student empowerment. It examined how Indonesian university students adapt to digital learning environments, where increased autonomy, digital literacy and intrinsic motivation play a critical role in academic success. Understanding these dynamics would help educators and institutions develop more targeted strategies to support learners in becoming more autonomous, motivated and engaged in their digital education journey.

This problem is highly relevant in Indonesia, where rapid digitalization in education coincides with varying levels of digital readiness and student engagement. Exploring these factors can provide valuable insights into improving educational outcomes in the digital age. Three research questions guide the investigation, as follows:

1. What role does technology play in enhancing the interest and motivation of Indonesian university students in a digital e-learning context?
2. How can personal interest, motivation and agency be fostered among Indonesian university students to improve their engagement with digital tools and platforms?
3. How do the relationships between engagement, agency, interest, and motivation develop in the era of digital education?

Literature Review

A discussion of literature is presented here, reviewing studies about interest, motivation, learners' agency, engagement, and how they affect students' successful learning. A review of technology integration in education associated with students' learning preferences and interests is presented afterwards.

Interest, Motivation, Agency and Engagement

This study adopted an interest definition from prominent scholars Renninger and Hidi (2016; 2022), who have studied the conceptualization of interest and its roles in learning for decades. Those scholars have defined interest as a motivational variable essential to keeping students motivated and engaged. Motivation refers to a strong feeling or will to do something. It is the

process of stimulating people to act and accomplish their goals. Interest can be one of the triggering factors behind the actions. So, interest conceptually is more specific and a part of the motivation domain. In other words, motivation has a broader territory. It may cover interest, or it may not. For a simple illustration, motivated learners do not necessarily have to feel interested. Their motivation can come from other reasons, such as grade expectations and academic obligations (Loughlin-Presnal & Bierman, 2017).

Another difference distinguishing interest from motivation is that interest involves more positive emotion (Reeve et al., 2015) and enjoyment (Ainley & Hidi, 2014). Motivation is characterized by keen efforts, perseverance and determined goals in a more comprehensive rational concept of learners' reasoning (Krapp et al., 2014). The crucial aspect is that although motivation and interest are conceptually distinct, they are connected and co-exist in students' learning development. Another important aspect is that interested learners will also be motivated, further securing the role of interest in students' motivation, and thus their connection is profound. The studies above posited that interest and motivation are underlying reasons for students' attitudes and behaviours, which drive them to act, engage and learn (Krapp et al., 2014; Renninger & Hidi, 2016).

Interest also leads to engagement when there are opportunities for prolonged interaction. Like the existence of motivation without interest, engagement also does not always require interest. Students might need to engage with revisions because exams are approaching. However, their actions are not always due to their interest in the subject matter. However, engagement involving students' active participation can be more meaningful and productive when it involves interest resulting from their genuine effort (Renninger & Hidi, 2016). Thus, like the role of interest in motivation, interest also spurs engagement. Many studies have proved that interest, motivation and engagement are constructively connected to meaningful and active learning (e.g., Järvelä & Renninger, 2014; Renninger & Hidi, 2016). However, studies on how the connection works in an ICT-integrated learning environment are limited. This paper reports a study about students' interest in digital e-learning and how it helps boost their motivation, agency and engagement, which benefits educational practices and theories of learning in the digital age.

With the current flourishing research advocating autonomous learning and students' well-being, another aspect essential for students' independent

learning is their self-agency development. Learners' agency can be interpreted as the capacity of the learners to act in a given learning environment to achieve their goals. The agency is formed when they strive to make choices and decisions about their learning and purposes. As agents, students can reflect on their learning and act and project themselves into the necessary actions to succeed (Code, 2020). Learners' agency can be simultaneously exercised by providing opportunities for students to lead their learning, such as in group collaborative projects, presentations and independent tasks. They then can be directed to reflect on their learning by incorporating self-assessment practices to help them recognize their strengths and interests, identify areas for improvement, and decide which way they will go from their current level of learning (Hidi & Ainley, 2009; Sansone et al., 2010).

The agency offers opportunities for students to have choice and autonomy; it gives more space for their interests to grow. The research found that interest is crucially connected to agency aspects, such as the ability of students to self-regulate their learning (Sorić & Palekčić, 2009), their self-efficacy (Bong et al., 2015), effort and perseverance (Renninger & Hidi, 2016), and their ability to navigate their learning to achieve their goal (Roure & Kaestner, 2021). The interest provides ample opportunities for the students to explore exciting activities while exercising their agency. Cultivating students' interest, agency and independent learning is vital for developing lifelong learners who are motivated, self-directed and capable of adapting to new challenges. By creating an engaging, supportive and flexible learning environment, educators can empower students to take control of their education and thrive academically and personally (Code, 2020), aligning with education expectations in the digital age. The study reported here focused on the agency development of university students in ICT-integrated learning since, as adult learners, they are supposed to be independent and resourceful in utilizing their environment, including ICT, to enhance their learning.

Technology Integration in Education

Technology represents dynamism, and adapting to such a dynamic necessitates appropriate skills. Education is the only way to prepare for and adapt to technological changes. As a result, education must keep up with the digital transformation. Digital-based learning refers to learning activities using digital technologies, such as computers, CDs, DVDs and television programs.

However, with the Internet storm, the practice is expanding into digital e-learning, which depends on electronic materials and is virtually conducted, as it involves information and communication technology (ICT). Later, the advancement of machine learning in computerized systems developed *artificial intelligence* (AI), which is currently increasingly used, strengthening the practice of digital e-learning (Murtaza et al., 2022).

As discussed earlier, the sudden shift to remote learning during the COVID-19 pandemic initially posed several challenges for educators, students and parents. Limited access to technology and digital resources, disparities in internet connectivity, and the lack of digital literacy skills were among the main obstacles encountered during the pandemic. Moreover, maintaining student engagement and ensuring effective communication and collaboration in virtual classrooms posed significant challenges for educators (Basar et al., 2021). However, as time passed, society was found to adapt quickly. The pandemic was then revealed to strengthen the digitally immersed society's lifestyle with notable impacts on education and learning. Schools and educators promptly adapted to new technologies and digital platforms to deliver instruction remotely. The situation was improved by an exponential upsurge in online learning platforms and content innovations which resulted from learners who developed different needs and requirements as technology intensely weaved its way into their lives (Haleem et al., 2022).

Studies have claimed that digital and internet technologies significantly contribute to new avenues of learning (Biletska et al., 2021) and promote students' independent and autonomous learning (Haleem et al., 2022). Initially seen as a challenge, ICT use nowadays is critical as most students smartly adapt and evolve in line with technological advancements, as they are the tech-savvy generation. (Basar et al., 2021). Considering the benefits of technology use, the educational system should not be limited to the traditional classroom; instead, it should promote outside classrooms, which are still less studied. More studies need to be conducted following students' learning journey in and out of the classroom, particularly in independent learning where students can exercise their skills, including web sources-based knowledge harvesting, as investigated in the study reported here. The study tried to capture students' interests in digital e-learning activities and how they navigated their ways in ever-developing technologies and digital environments concerning their university course learning.

Method

The Participants

One hundred twenty-two university students aged 19 to 21 participated in the study. They were enrolled in three different courses taught in English (Philosophy of Education, Academic English and Scientific Paper Writing) at an Indonesian university. A consent form was obtained from the students beforehand, and they were informed about the study, their participation, confidential matters and their right to withdraw from their involvement at any time during the study. Pseudonyms were applied to ensure the participants' confidentiality and protect their identities.

Research Design

The study employed a case study conducted throughout one Indonesian academic semester (approx. six months). A case study method is particularly suited for in-depth exploration of complex phenomena in real-world contexts (Yin, 2018). For this study, a case study method supported a holistic analysis of the phenomenon, leveraging the naturalistic setting and multiple data sources to explore the complex dynamics of ICT-enhanced learning. It also provided an empirical foundation for understanding how technology could facilitate interest and agency among Indonesian university students.

Data was collected from repeated observation of classroom activities, open-ended questionnaires to all participants, and interviews with selected students for one academic semester. The triangulation was achieved from those multiple data sources and many participants to help improve the credibility of the data. The observation was done three times in each course, primarily when the students were assigned project or task-based and collaborative learning. Each observation lasted 90 minutes and, thus, 810 minutes for all observations (3 courses x 3 observations x 90). The focus of the observation was to evaluate students' use of ICT tools during the lessons, encompassing their interaction with digital resources, collaboration using technology, and their interest–related digital e-learning, which motivated them to stay engaged.

All student participants were administered an open-ended questionnaire at the semester's end. It covered three essential questions assessing their experience with their course learning with ICT help, their feelings, and their interest in using digital access. The questions were:

1) How do you feel about using ICT to help with your course learning and completing tasks/assignments? (e.g., constructive or deconstructive feelings such as enjoy, engaged, challenged, inspired, difficult to catch up, bored, struggling, etc.)
2) What makes you interested in using ICT? (e.g., accessible, interactive, engaging, staying updated, easy to collaborate, etc.)
3) In what aspect does ICT (technology) help you improve your course learning? And how?

The unstructured interview was developed from items of the open-ended questionnaire and carried out with nine students (three each represented for each course) at the end of the semester. The students were selected based on their learning performance in each course: three were from the top performing students; three were from the moderate level who represented the majority of the good students; and another three were from the average performing students (the students who just passed the required grades). Gender was not the factor examined; thus, the students were selected randomly in terms of gender, and the interviews ended up with five female students and four male students.

Through the conversational interview, students were again asked to reflect on their digital e-learning venture, how it helped their course learning, and how ICT tools helped their learning. Thematic analysis (TA) was employed to scrutinize the interviews' results. Thematic analysis is a qualitative method used to systematically identify, analyze and interpret patterns or themes within data. TA provides a structured approach to exploring participant responses in interviews by focusing on salient themes that reflect shared meanings (Braun & Clarke, 2006). TA was used to draw themes related to items of investigation and their connection (interest, motivation, engagement and agency). With the help of NVIVO, the salient themes were concluded, and the data was interpreted. TA helped to draw meaningful insights from the data, exploring how participants' views converged and differed on ICT-integrated learning. Themes should provide a robust framework for analyzing the qualitative data, which can be linked to theoretical constructs underpinning the study's research questions (Braun & Clarke, 2006).

Results

The Observation

The repeated observation in three investigated courses (Philosophy of Education, Academic English, and Scientific Paper Writing) revealed that students were assigned project-based learning (PBL) to do a case study and task-based learning (TBL) to do essay writing and group presentations. Table 1 below summarizes the details of the tasks observed:

Table 1. *Tasks and Projects Based on Assigned Observed Lessons*

Course	Observation
Philosophy of Education	1. TBL—Group collaborative task: Write a 1500-word essay to analyze and answer the question, how does philosophy help solve problems humans face in their personal, social, and environmental lives on this earth? Give an example in a case study and analyze it! 2. TBL—Individual task: Write a-1500-word essay about one of the prominent philosophers in the old days (e.g., John Locke, Plato, Aristoteles, Ibnu Sina, Imam Al-Ghazali, etc.), and how are their teachings still relevant and implemented in the current modern times! 3. PBL—Group collaborative project: Do a school observation on how the philosophy of education is exemplified at school and write a 2000-word report for the observation! Prepare for a group presentation highlighting what you learned from your school observation!
Academic English	1. TBL—Individual task: Write a 1000-word descriptive essay on the child-friendly city you conceptualize! 2. TBL—Individual task: Write a 1500-word analytical essay on the impact of social media on society and young people! 3. PBL—Group collaborative task: Write a 2000-word persuasive essay addressing a real issue in educational cases in Indonesia and present your case and argumentation with your group in front of your peers in front of the class!
Scientific Paper Writing	1. PBL—Group collaborative task: Write a research proposal for PKM—AI (National Student Creativity Program—Scientific Article) following the guidance from the PKM-AI National writing competition! 2. TBL—Individual task: Choose a research topic you are interested in, do problem identification and write in 1000 words! Give your strong reasoning for why you choose the topic and the significance of the problem to be addressed! 3. TBL—Group collaborative task: Prepare and do a group presentation on the structure and content of a research paper you choose from the University Library Database!

The observation revealed that the lecturers provided the primary sources for learning materials covering the course books or modules, lectures' presentation slides, relevant scholarly articles and tasks/assignments; all uploaded through the university LMS (*SPADA* and *Open Learning).* The lecturers also advised students to use the university library database, where they needed to self-navigate the library's accesses and services. Most students were shown to be adaptable in utilizing the LMS and Library services. Group (collaborative) work was instrumental since it provided plenty of opportunities for the students to learn the necessary skills and knowledge in IT skills and work together for course comprehension and task completion.

Further observation revealed how students navigated their way to using various e-digital sources. LMS provided them with sufficient materials to follow their classes. However, many students still frequently downloaded multiple academic and research materials such as e-books, scholarly articles, journals and multimedia content from the university library database to support their learning, mainly when completing tasks/assignments/projects. Older students ventured further to other databases such as Scopus, Academia, Google Scholar and various scientific journal web pages. Since the tasks involved a lot of writing and composing, most students also utilized educational software and apps, such as *Grammarly* and *Turnitin,* via university library access. *ChatGPT* and *QuillBot* were commonly used as AI applications*,* which mainly helped them with their essay composition. Other Google apps, such as *Google Docs* and *Google Drive,* were also popularly used by many students to store their files and share them with others. As for the presentation, *Google Slides* and *PowerPoint* were the most used, while some more experienced and creative students experimented with *Canva* and *Prezi*.

The students enjoyed experimenting with various ICT tools and learning platforms, significantly increasing their engagement. They also exhibited more focused attention on what they were doing. They independently and collaboratively navigated their way in harvesting the information e-sources, analyzing and synthesizing the collected data to help finish their projects/tasks. ICT also helped improve student participation and collaboration, as observed during the group work. Group activities using digital platforms allowed students to collaborate on projects, share insights and collectively solve problems.

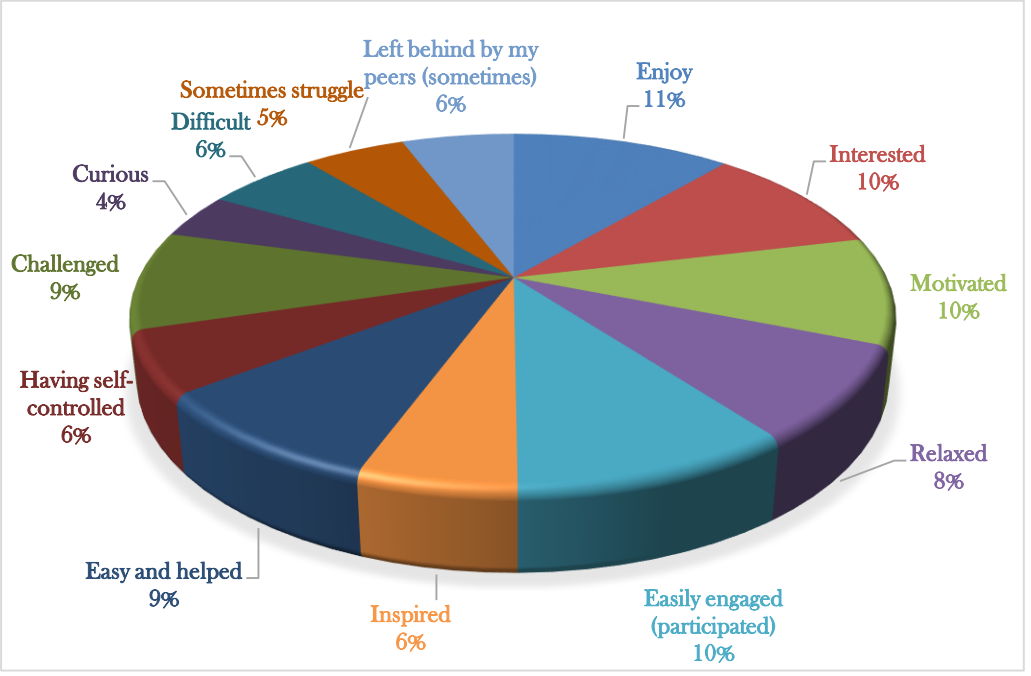
Despite the positive things students gained from the technology mentioned above, the students also showed various skill levels in using the

technology, which was prominently seen during the group work. In a few cases, the more skilled students would guide their less proficient peers. However, some students would just stick to the ways they were familiar with, and others worked through any innovation challenges on learning platforms and searching skills. Their creativity was shown when they prepared slides for their project presentation using various software they liked. The diligent work was seen when the students exerted their efforts on information harvesting through various research papers, scientific articles and lecture materials from the university library database and LMS, as well as other e-sources, to help them compose their essays.

The Open-Ended Questionnaire

The findings from the repeated observations above are supported by students' responses to the open-ended questionnaire. The first question was about their feelings (experiences) towards ICT use. The salient themes were drawn from the students' collected answers, as illustrated in Figure 1 below.

Figure 1. *The Students' Constructive–Deconstructive Experiences of ICT Use*



Following the clock movement, Figure 1 above illustrates the students' constructive and deconstructive experiences. The constructive ones presented by ten positive emotions of enjoy, interested, motivated, relaxed, easily engaged/participated, inspired, easy and helped, self-controlled, challenged, and curious represented 83 percent of students' answers. As for the deconstructive feelings, they were reflected by a much lower number of responses (17%) revealing the students' difficulty and struggle in catching up with the ever-changing technology which sometimes also left them behind their more adapted peers. The chart demonstrates that the students' positive experiences represented more than the negative ones, insinuating that ICT tools offered more benefits as it was enjoyable (11% cited), engaging (10% cited) and motivating (10% cited). The challenge of using ICT tools attracted at least 9% of students, as it was also helping (9 % cited) and relaxing (8% cited).

Interest, motivation and engagement were among the prominent themes discovered (together, 30% cited), directing to the next question, which asked students to recall their experience of interest and what made them interested in using ICT tools. Figure 2 below illustrates the various responses from the students representing rationale-related factors associated with their interests.

Figure 2. *Rationale-Related Factors of Interest in ICT Use*

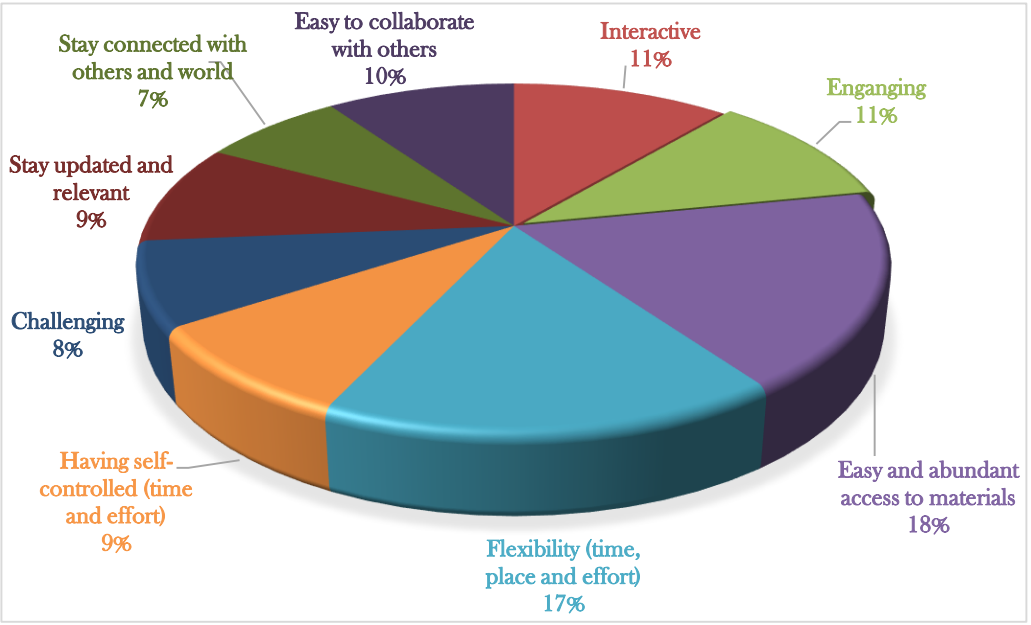


Figure 2 above shows that the easy and abundant access to materials and the flexibility in terms of time, place and effort were the most quoted from the students (18% and 17%), as it was observed that the students did a lot of information (materials) harvesting for their courses and assignments where they liked doing this in their own space and pace (flexibility). The following factors were interactive and engaging activities offered mainly by the digital e-learning platforms (11% cited each), which practically helped sustain their interest. Collaborative study again proved beneficial in ICT integration as ten percent of students disclosed it as their interest-related factor. The satisfaction over some control of their learning became the next factorial aspect of students' interest, on par with their value experience to stay updated and relevant with any changes (progress) in their course learning (9% cited each). As it was revealed (see Figure 1), 'challenged' was one of the constructive feelings, as the challenge of the ever-changing innovation and development of ICT application was what kept the students interested (8% cited). The last factor disclosed by the students was 'stay connected with others and the world' (7% cited), which made them feel socially included and belonging, enabled them to build connections and networks, and followed the constant changes in education and society.

The students' experience (feelings and interests) above was essentially summed up in their responses to the last questionnaire question, inquiring about the practical aspects of ICT use that helped improve their course learning, as summarized in Figure 3.

Figure 3. *Students Experience Feelings of Interest Associated with Their Digital and Online Learning*

Figure 3 demonstrates that the limitless access to information and learning materials was one of the most prominent examples of how ICT can help students with their course learning. The students explored various open and free educational resources besides accessing learning resources through the Digital Library and LMS. The experience was then strengthened by their excitement to learn new tools/software, which was challenging but also offered some fun.

The Interviews

As mentioned earlier, students' abilities to adapt and catch up with the latest technological interference were varied. For some students, it can be problematically challenging. However, for some others, the challenge to keep up with ever-changing innovation and abundant information was found to be also the triggering factor for their interest and motivation, as disclosed by a first-year participant, 'I need time to adapt as I am not that tech-savvy guy. But the challenges keep me interested and motivated and help my brain stay active' (Fuza, personal communication, 18 March 2024).

Interest was again found as a prominent theme, and the students repeatedly quoted it in their interviews. It was an underlying factor that made them stay motivated and engaged as well as to resort to navigate their learning independently, as shared by one of the second-year participants, 'I like learning independently based on my activity and topical interests, which help me enjoy and sustain my studies' (Nizar, personal communication, 15 March 2024).

Digital e-learning provides ample opportunities for students to learn not only based on their interests but also based on their paces and spaces. They can work from anywhere, at home, campus, park or even at the coffee shop, as a student from a second-year class delightedly shared:

> I like the current age of digital learning. The most positive experience, I think, is that I can study and learn at my own time and ability, be anywhere I please, and feel relaxed. I enjoy studying with friends while having coffee in the café with free WIFI. (Dan, personal communication, 15 March 2024).

Another student from the second year casually shared how Zoom offered financial and practical benefits.

> I like it when the university starts using Zoom in some of our classes. It is more flexible to fit into my timetable and less effort to attend my classes. It is also more economical—no more petrol to fill up my motorcycle (Rossie, personal communication, 8 March 2024).

Some students expressed how digital e-learning offered more opportunities to learn from others who were more skilled and experienced. For example, they can learn English directly from native or more fluent speakers through online forums and networking. Finding real-life role models might be more efficient for students in some cases. It also can be seen as an enrichment or practical experience beyond the classroom. One of the students from the Academic English class shared his English self-learning journey, which he felt was more efficient than his formal English classes.

> For Academic English, I prefer learning independently rather than in formal classes. Communicating in English is more effective with international audiences through online discussion forums and interactive learning platforms. I can also use AI to help with my essays and presentations (Zee, personal communication, June 4, 2024).

Additionally, Nina (personal interview, 7 June 2024), a student from the Scientific Paper Writing course, divulged her writing experience on how software and apps helped her immensely in developing ideas and writing structure as she said, 'I usually build up ideas by reading a lot of articles online and use ChatGPT to help me in structuring my writing'. She learnt from the writing model of the AI and developed ideas from other people's writings.

The students' responses above highlight that the growing number of innovations in learning platforms that offer interactive activities and plenty of materials is critical for students' engagement. The innovative platforms' variety, models and activities enable students' interests to grow due to choices, circumstances (situational factors) and chances, as expressed by a student, 'The

university LMS are pretty efficient since we can access lecture materials more efficiently. They are usually available all the time and keep updated' (Han, personal communication, May 15, 2024). Han highlighted the effectiveness of LMS as the materials could be accessed quickly, and he could follow the learning at any time.

The interactive space of discussion offered by the platforms also allowed the students to connect with peers and lecturers to discuss their problems and assignments, as disclosed by Susan (personal communication, May 13, 2024). Another student, Sofie (personal communication, May 13, 2024), highlighted that the same e-learning offered flexibility, allowing them to explore the materials and comprehend the contents at their own pace, which might be more time-restricted in classroom lecture-model learning. The students' experience highlighted that technology integration was not only helping them in their courses-related learning, but it also helped them develop essential digital literacy skills, which is crucial in the current era of digital education.

Discussion

The study highlights four critical aspects in promoting students' constructive learning experience. They are learner's interest, motivation, engagement and agency, which was found strengthened by technology integration. The critical activities related to integrated technology were when the students were given plenty of opportunities to learn and navigate their learning based on their interests in content-related matters and activities, further driving their motivation and promoting engagement. This finding was in concurrence with a previous study that advocated the critical role of digital e-learning in student engagement (Schindler et al., 2017). The study also suggested that developing students' navigation skills and their effort and perseverance in using technology to help with their course learning also helped promote their motivation and agency, aligned with studies of Code (2020) and Sansone et al. (2012).

Roles of Technology in Students' Interest and Motivation

As previously discussed, interest is a motivational variable essential to learning (Renninger & Hidi, 2022) and is crucial in keeping students engaged in the learning process. Renninger and Hidi (2016) emphasize that interest is more

specific than motivation and is often driven by positive emotions like enjoyment (Ainley & Hidi, 2014). This study discovered that students using ICT-based tools showed higher interest levels, as they disclosed that these tools offered interactive and engaging experiences, making the learning process more enjoyable. Most participating students shared stories that revealed the positive sides of using technology in their learning and the potential to optimize their activities from mere entertainment to educational purposes, which helped with their growing interest in the activities. Moreover, integrating ICT into education helped them improve their digital literacy skill, critical thinking, creativity, and problem-solving abilities, as well as to synthesize information from multiple sources. As the students' learning experience expands, their values also improve with improved skills and knowledge, as previously claimed by Harackiewicz et al. (2016).

The learning activities discovered primarily were the ones that give the students opportunities to explore, develop and exercise their interests, strengthening their motivation as they found value in their improved abilities to solve problems, face challenges, finish their tasks (assignments) and achieve more knowledge and skill. Concerning the principle of successful learning, the findings supported the previous claims on the relationship between developed interest with achieved goals and competence (Roure & Kaestner, 2021), students' experience of improved values (Harackiewicz & Hulleman, 2010), and their improved skills and knowledge from their effort and perseverance (Wahyuni, 2022; Wahyuni & Bee Tin, 2024).

Fostering Students' Interest, Motivation and Agency to Improve Engagement

This study revealed how technology promoted students' interest and motivation, which later helped develop their agency and independent learning, as previously claimed by Haleem et al. (2022). Agency, the ability of students to take control of their education, increased through ICT. The findings show that ICT gave students greater autonomy over their educational journey, allowing them to personalize their learning experiences and choose how they interacted with course content. In Indonesia, where traditional education often emphasizes teacher-centred approaches, ICT tools focus on student-centred learning, thus encouraging the development of learner agency (Ratnasari et al., 2022). Students learn to navigate digital tools, evaluate information critically

and communicate effectively in digital formats, preparing them for success in the digital age (Basar et al., 2021; Biletska et al., 2022).

Engagement is closely linked to interest and motivation, mainly when students are provided opportunities for active participation in the learning process. Renninger and Hidi (2016) noted that engagement is most meaningful when it involves students' genuine efforts driven by their interests. This study discovered that Indonesian university students demonstrated higher engagement in ICT-rich environments as digital tools promote collaboration, interaction and feedback, which were crucial for maintaining their interest and motivation and fostering engagement. Students were also found to be more adept at collaborating and working together in virtual environments, using tools such as *Zoom* to communicate and share ideas. Their participation in online group projects, collaborative research and peer-to-peer learning communities helps foster a culture of collaboration and knowledge sharing (Schindler et al., 2017) and strengthens social connections (Wang et al. (2014).

Another highlighted finding is the support ICT offers to different learning styles. Technology opens more opportunities for personalized learning experiences tailored to individual student needs, preferences and learning styles, as a study by Murtaza et al. (2022) emphasized its critical role in successful learning. Students can access many online resources, interactive tutorials and educational apps catering to their interests and abilities. Personalized learning helps educators track their students' progress and provide targeted interventions based on need analysis, which is highly advocated in the current Indonesian curriculum of the scientific approach to learning. The finding also supports a prior study by Shemshack and Spector (2020), who pointed out the need for personalized learning as technology changes and how learning can be effectively personalized to enable students to experience meaningful and valuable learning.

Relationships Between Engagement, Agency, Interest and Motivation

Pedagogically, the collected stories from the students highlight the connection between digital era integration with students' developed agency—self-directed (andragogy)—self-determined (heutagogy)—interest and motivation, as all connected in the cycle of effective teaching and learning. The connection is profound, emphasizing the need to keep exercising students' self-

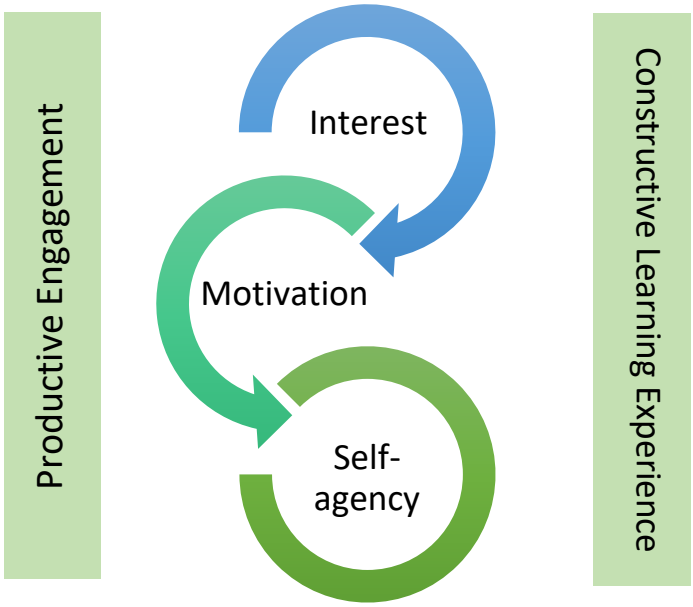
agency and motivation by accommodating their interest in association with various digital and online activities. Figure 4 below highlights how technology integration helped develop students' constructive learning experience, enabling their agency to grow and be established.

Figure 4. *Effect of ICT-Use on the Students' Agency, Interest and Motivation*

Figure 4 shows the relationship between the students' interests, motivation, agency and self-directed learning. The agency showed learners' capacity to act in each learning environment to achieve their goals. The agency was exhibited when they made choices and decisions about their learning targets and purposes. The agency helped control their effort and perseverance to invest their time and effort. The developed agency was promoted by prolonged engagement sustained by the students' interests and motivation. The students' interests (e.g., content development) and their preferred ways of learning (e.g., independent discovery) strengthened their motivation, realizing they could control their choices. Their stories also highlighted that learners who have developed interest will likely set goals, self-regulate, exert effort, and further develop their agency as they continue their learning venture. In short, agency (e.g., self-determined, self-directed), interest, and motivation are reciprocally connected in promoting productive engagement, which is critical

for positive experience and practical learning. The following Figure 5 helps to illustrate the relationship.

Figure 5. *Nexus Between Interest, Motivation, Agency and Engagement*



The study suggested the nexus thrives upon the students' growing interest in digital e-learning. In today's fast-paced world, the number of students who understand the importance of continuous learning and adaptation to stay relevant is growing. Most students are ready to embrace innovation, seek new opportunities for skill development, stay updated on the latest technological trends and advancements, and harness the power of technology to enhance their learning experiences, thus signifying their developed agency. Hence, it is essential for teachers to nurture, maintain and help establish their students' interests and motivate them to stay engaged, utilizing the current progressive innovation in ICT related to learning practices, as advocated by various studies (e.g., Keengwe & Bhargava, 2014; Wahyudi et al., 2023).

Conclusion

Technology advancement has accelerated technology adoption in education, profoundly transforming teaching and learning. The study provides evidence of the positive effects of technology use and unveils elaboratively constructive practices of young people. It aims to determine how the practices can be optimized to help alleviate the problems of technology imposed on the young generation and strengthen their agency. Notably, the study connects the four successful learning factors of interest, motivation, engagement and agency, the nexus of which was consolidated by the involvement of ICT in learning. The students demonstrated increased interest and participation in digital e-learning, as using ICT tools also facilitated improved digital literacy skills and accommodated their curiosity about technology innovation. The students exercised their agency and independent learning through their motivation to stay engaged with their interests in ICT use.

Considering the current tech-savvy generations who are more adapted and attracted to technology interference, the integration of technology will continue to play a central role in shaping the future of education. By leveraging technology effectively, teachers (educators) can create more engaging, inclusive and personalized learning that prepares their students for success in the digital age. Teachers must develop innovative teaching practices; thus, ICT integration empowers teachers to implement creative and student-centred practices. Teachers must also continue supporting and encouraging their students' growth by facilitating their needs and interests in digital e-learning and helping them cultivate adaptability to ever-changing innovation and technology.

As some students still struggle to adapt to the fast development of technology, it is necessary to address technical challenges and ensure that all students have sufficient support to use ICT tools effectively and wisely. It also highlights the need for differentiated instruction and ongoing digital literacy training. This integration can also be a professional growth opportunity for teachers to enhance their digital teaching skills and instructional strategies. Schools also need to ensure resource accessibility for their teachers, encompassing access to a wide range of digital resources and tools for lesson planning. The efforts must ensure equitable access to technology and digital resources for all students, regardless of socio-economic background or geographical location.

Despite the study's findings showing positive effects and constructive experiences on students' education, this study only focused on how the students leverage technologies in their learning without further examination of the students' mental well-being. The Internet is an excellent place to harvest helpful information, but it also poses dangers to students' mental well-being, including addictive behaviour unrelated to learning. Thus, further research is recommended to evaluate the impact of technology integration on students' mental well-being. This study also did not differentiate between female and male students (gender matter). Further studies involving genders are recommended to better understand the different attitudes and behaviors in digital e-learning activities between female and male students and how they affect the study outcomes, including the various influences on their mental well-being.

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