Factors Shaping Student Readiness for Online Learning: Technology, Perception, and Lecturer Roles

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ABSTRACT

Aim. This study explores factors shaping student readiness for online learning, focusing on learner control, technology readiness, perception of online learning, and lecturer readiness.

Methods. The research employs Structural Equation Modeling (SEM) to analyse data collected from 573 electronics students at a university in Indonesia. SEM analysis examined the relationships between these dimensions and their impact on student readiness for online learning.

Results and Conclusion. The findings indicate that lecturer readiness significantly enhances student readiness, with technology readiness and perception of online learning also playing crucial roles. While learner control does not directly affect student readiness, it influences readiness by impacting perceptions of online learning. These results emphasise the importance of student autonomy and lecturer support in fostering motivation and engagement in online learning.

Research Restrictions. The study is limited to a single study programme and employs a quantitative approach, indicating a need for broader exploration in future research.

Practical Application. The findings suggest that educational institutions should invest in professional development for lecturers and technological access for students to optimise the online learning environment.

Cognitive Value. This study provides empirical insights into the interconnected factors affecting student readiness for online learning, highlighting the pivotal role of lecturer support and technology in shaping student success.

Keywords: Learner control, technology readiness, perceptions of online learning, readiness of lecturers in online learning, students' readiness for online learning

Introduction

In recent years, education has undergone significant changes driven by technological advancements and the evolving needs of the 21st century (Fadhilah

& Husin, 2023). Integrating digital tools and online platforms into traditional education is based on educational technology and constructivist theories, which suggest that technology can improve learning by making it more interactive and student-centred (Dada et al., 2023). These changes present new opportunities for improving education and introduce challenges for educators and students. As institutions adapt to these technological shifts, understanding the factors influencing student readiness for online learning becomes increasingly important. This study bases its conceptual framework on several established theories, including self-regulated learning theory (Theobald, 2021), diffusion of innovations theory (Menzli et al., 2022), expectancy-value theory (Shang et al., 2023; Wang & Xue, 2022), and pedagogical content knowledge theory (Ekiz-Kiran et al., 2021; Schiering et al., 2023). These theories help explain key factors affecting student readiness for online learning, such as learner control, technology readiness, perception of online learning, and lecturer readiness.

Each theory explains how the variables in this study relate. For example, self-regulated learning theory highlights learner autonomy, suggesting that students with more control over their learning tend to be more engaged and motivated. The diffusion of innovations theory focuses on how technology readiness affects students' willingness to use new digital tools. Expectancy-value theory suggests that students' perceptions of the value and effectiveness of online learning are crucial for their motivation and engagement. Finally, pedagogical content knowledge theory emphasises the importance of lecturer readiness for effective online teaching.

Learner control, rooted in self-regulated learning theory (Li & Lajoie, 2022), is a key aspect of online education, giving students the autonomy to manage their learning experience (Abuhassna et al., 2022). It includes controlling the pace, sequence, and amount of instructional content, which can positively affect engagement, motivation, and academic achievement (Bertram et al., 2021). This autonomy aims to create a more personalised and adaptable learning environment. However, researchers are still exploring the role of learner control in improving student readiness for online learning. Technology readiness, as described by the diffusion of innovations theory (Basarir-Ozel et al., 2023), is another important factor affecting online learning (Tang et al., 2020). It refers to the preparedness to embrace and use new technological tools effectively. With rapid technological change, students and educators must develop the necessary skills and attitudes to use digital tools in education (Núñez-Canal et al., 2022). As digital platforms become essential, understanding how technology readiness influences student engagement and readiness for online learning is crucial for improving educational outcomes.

Learner control and technology readiness influence students' perception of online learning (Alam et al., 2023). Students' perceptions of online learning's effec-

tiveness, convenience, and value significantly influence their willingness to engage (Cole et al., 2021). According to expectancy-value theory (Fielding et al., 2022), positive perceptions are associated with higher engagement, satisfaction, and motivation, while negative perceptions can hinder the adoption of online learning practices. Exploring how learner control and technology readiness shape perceptions of online learning provides insights into enhancing online education quality.

Lecturer readiness in online teaching is connected to pedagogical content knowledge theory (Scherer et al., 2023) and is vital in shaping the online learning environment (Scherer et al., 2021). Effective online teaching requires lecturers to adapt their methods for digital platforms, design engaging content, facilitate discussions, and provide timely feedback. Lecturer preparedness directly influences student readiness and learning outcomes (Pribudhiana et al., 2021). As more institutions adopt online instruction, assessing lecturer readiness is essential for ensuring quality online education.

Learner control, technology readiness, perception of online learning, readiness of lecturers in online teaching, and student readiness for online learning

Self-regulated learning theory (Theobald, 2021) suggests that students who manage their learning are better prepared for independent learning. In online learning, learner control refers to students' autonomy in navigating and engaging with the content (Shahzad et al., 2021). This control allows students to adjust the pace, sequence, and depth of their learning based on their needs and preferences (Reeve et al., 2019). By making decisions about how they learn, students can tailor their experience (Smale-Jacobse et al., 2019). Greater learner control improves engagement and motivation, increasing online learning readiness (Teng & Zhang, 2020). However, the link between learner control and online learning readiness is unclear. While many view autonomy as beneficial, some researchers argue that instructors providing control with proper support can enhance learning outcomes (Shahzad et al., 2021). Understanding how learner control interacts with other factors like instructional support and material complexity is important for its impact on readiness.

Technology readiness is another key factor in online learning. The diffusion of innovations theory (Menzli et al., 2022) emphasises that individuals' preparedness to adopt new technologies affects their engagement with digital learning platforms. Technology readiness includes technical skills and attitudes towards digital tools (Damerji & Salimi, 2021). Students need confidence in using technology to succeed in online learning, which involves digital literacy, troubleshooting skills, and a positive view of technology in education (Basarir-Ozel et al.,

2023). In the era of Industrial Revolution 4.0, technology readiness is even more important (Fadhilah & Husin, 2023). More tech-savvy students will likely engage more with online learning, improving their outcomes and readiness (Karatas & Arpaci, 2021). Conversely, students lacking tech confidence may struggle with online learning, affecting their motivation and results.

Perception of online learning is a key mediator in these dynamics. Perception refers to how students view their learning experiences, including the effectiveness and convenience of online education (Bingjie et al., 2019). Positive perceptions increase engagement, satisfaction, and academic success (Alawamleh et al., 2022). In today's globalised world, the Internet is integrated into education to enhance convenience and improve learning outcomes (Rojabi, 2020). Good learning outcomes indicate that students are well-prepared for online learning. Lecturer readiness for online teaching is crucial for effective online learning (Almazova et al., 2020). Lecturers' strategies and methods reflect their readiness (Muhamad et al., 2023). These strategies help prevent boredom and engage students, creating a supportive online environment. By improving student readiness and providing necessary resources, higher education institutions can ensure that they support students in their online learning journey.

Learner control, technology readiness, and perception of online learning

In online learning, students' perceptions of its effectiveness, convenience, and value depend on their level of control and technological readiness. Expectancy-value theory (Shang et al., 2023; Wang & Xue, 2022) suggests that individuals engage more in activities they find valuable and in which they believe they can succeed. Learner control reflects students' ability to take responsibility for their outcomes, as instructors support this process (Korkmaz & Toraman, 2020). It allows students to navigate content and adjust learning paths, improving their perception of quality and boosting motivation and engagement (L. X. Jensen et al., 2021; Wei & Chou, 2020). The flexibility provided by learner control enhances satisfaction, perceived competence, and willingness to participate (Rasmitadila et al., 2020). Technology readiness also influences perceptions of online learning (Damerji & Salimi, 2021). Students with higher technological proficiency interact better with platforms, increasing confidence and motivation (Suliman et al., 2020). Studies show a direct link between technological readiness and positive attitudes towards online learning (Hussein et al., 2020; Karatas & Arpaci, 2021). It shapes how easily students access resources and perceive the educational value of online platforms (Hussein et al., 2020).

Perception of online learning as mediator variable

Perception plays a key role in online learning by shaping students' experiences and ability to adapt to digital platforms. Lecturers' readiness to teach online also influences students' perceptions, as supported by the Pedagogical Content Knowledge (PCK) theory (Ekiz-Kiran et al., 2021; Schiering et al., 2023). Well-prepared instructors who adjust their teaching to digital media help improve student understanding and positively affect their perception of the learning experience (Scherer et al., 2021). According to this theory, instructors' ability to engage students with interactive and accessible content is essential for positive learning outcomes (Pribudhiana et al., 2021). When lecturers deliver content well online, students are more likely to view online learning as valuable and practical, reinforcing its effectiveness.

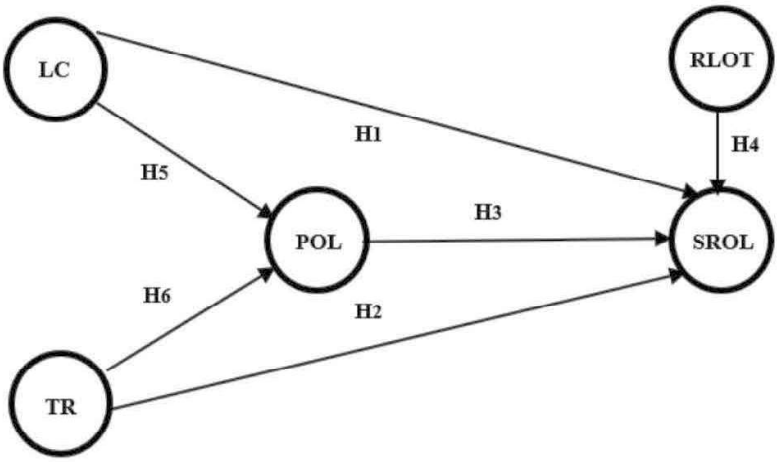
Perception is a complex cognitive process beyond just using technology. Hongxia Lin et al. (2019) explain that perception involves interpreting experiences and forming an understanding that influences students' readiness for learning. Marjorie Woollacott et al. (2021) argue that how students perceive the online learning environment impacts their engagement, motivation, and success. Students are more motivated and engaged when they positively perceive online learning—seeing the platform as effective, user-friendly, and beneficial. It aligns with Yuk Ming Tang et al. (2020), who found that higher learner control and technology readiness lead to more positive perceptions of online learning, improving student readiness. Based on this, perception mediates learner control, technology readiness, and student readiness for online learning. When students feel in control of their learning and have the right tools, their perception of online learning improves, boosting engagement and readiness (Tang et al., 2020). This mediating role of perception highlights the connection between these factors, suggesting that enhancing students' perceptions of online learning can improve their readiness for digital education.

Student readiness for online learning is a multifaceted concept involving learner control, technology readiness, perceptions of online education, and lecturers' readiness (Tang et al., 2021). Understanding how these factors interact is crucial for educational institutions to develop strategies that help students adapt to online learning environments. This study explores the relationships between these factors and their collective impact on student readiness for online learning. The research seeks to improve online education and student outcomes in the digital age through a detailed analysis. The study aims to provide evidence to guide best practices and policy decisions to create better online learning experiences for students and educators by addressing these factors.

Figure 1 presents the conceptual framework, showing the direct relationships between the independent variables—learner Control (LC), Technology Readiness (TR), and Readiness of Lecturers in Online Teaching (RLOT)—and the dependent variable, Student Readiness for Online Learning (SROL). The framework also includes the Perception of Online Learning (POL) as a mediating variable, highlighting the indirect effects of LC and TR on SROL.

Figure 1

Conceptual Framework of Student Readiness for Online Learning



Notes: LC, Learner control; TR, Technology readiness; POL, Perception of online learning; RLOT, Readiness of lecturers in online teaching; SROL, Student readiness for online learning.

Source. Own research.

Methodology

Data

This study gathered data through a questionnaire distributed to students in the Electronic Engineering Department, Faculty of Engineering, at a public university in Indonesia during the January-June 2024 term. A total of 621 respondents participated, with 573 complete responses included in the analysis. The demographic details of the participants, such as gender, study programme, and year of study, are shown in Table 1. The researchers mainly selected participants through snowball sampling, with the course lecturer facilitating the process via a WhatsApp group to reach a wide range of student groups. The data were processed using SmartPLS 3.0 software, chosen for its ability to handle complex models with many indicators and its lack of requirement for normal data distribution (Busu & Busu, 2021). Additionally, the researchers used SEM analysis to examine causal relationships with mediating variables (Sarstedt et al., 2020). Path analysis was applied to assess latent variables' direct and indirect effects and test the hypotheses.

Hypotheses development

This study uses several hypotheses to explore the relationships between key variables in online learning readiness. These hypotheses are drawn from previous research and theories, focusing on learner control's direct and indirect effects, technology readiness, perception of online learning, lecturer readiness, and student readiness. Direct Effects: H1: Learner Control (LC) positively influences Student Readiness for Online Learning (SROL). H2: Technology Readiness (TR) positively influences Student Readiness for Online Learning (SROL). H3: Perception of Online Learning (POL) positively influences Student Readiness for Online Learning (SROL). H4: Readiness of Lecturers in Online Teaching (RLOT) positively influences Student Readiness for Online Learning (SROL). H5: Learner Control (LC) positively influences the Perception of Online Learning (POL). H6: Technology Readiness (TR) positively influences the Perception of Online Learning (POL). Indirect Effects: H7: Perception of Online Learning (POL) mediates the relationship between Learner Control (LC) and Student Readiness for Online Learning (SROL). H8: Perception of Online Learning (POL) mediates the relationship between Technology Readiness (TR) and Student Readiness for Online Learning (SROL).

Data analysis

This research uses a questionnaire to examine the four main factors influencing student readiness for online learning: learner control, technology readiness, perception of online learning, and lecturer readiness. Confirmatory factor analysis and Cronbach's alpha testing established the validity and reliability of the questionnaire, with all scales showing adequate reliability (Cronbach's alpha > 0.70). The instrument items adapted scales from previous studies. SmartPLS validated the factors using measurement and structural models based on a predetermined hypothetical design. The measurement model assessed convergent validity (AVE, composite reliability, and factor loadings) and discriminant validity. The structural model tested the hypothesised relationships, including direct and indirect effects. A test of normality was conducted on the data from 573 respondents to ensure it met the assumptions for SEM. The Shapiro-Wilk test showed that the data was normally distributed (Sig Value > 0.05) (Souza et al., 2023), confirming its suitability for SEM analysis. The questionnaire included 28 items from 5 latent variables. These items were carefully selected based on previous research for each variable (see Appendix Table A1). The learner control variable consisted of seven items (Tang et al., 2020); technology readiness had seven items (Tang et al., 2020); perception of online learning had five items (Sarfraz et al., 2022); lecturer readiness in online teaching had four items (Sarfraz et al., 2022), and student readiness for online learning had five items (Suhandiah et al., 2022).

This study applies instruments from (Tang et al., 2020; Sarfraz et al., 2022; Suhandiah et al., 2022) with many studies actively adopting them to examine online learning readiness. The instruments were adapted to suit the local context, explicitly targeting electronic engineering students in Indonesia and reflecting the university's online learning conditions. The adaptation process ensured that the instruments remained relevant and appropriate for the study. First, the original instruments, written in English, were translated into Indonesian using a back-translation method (Phedy et al., 2021). This approach preserved the original meaning and intent of the items while ensuring linguistic accuracy and precision for Indonesian students. Second, certain items were modified to align with Indonesia's local context and educational practices. For example, the team adjusted technology-related items to reflect commonly used platforms and apps, such as local learning systems and communication tools. Specific references to 'the latest technologies' were replaced with examples relevant to students' experiences in Indonesia. Third, the Likert scale retained its original 5-point structure, but minor adjustments to the descriptors improved clarity and ease of understanding for respondents.

Before the primary survey, the adapted instrument was pilot-tested with 57 students from other departments. This test, conducted using SmartPLS, evaluated whether the questions were comprehensible and whether any language or technical issues arose. The analysis assessed validity through outer loading values of ≥ 0.7 and measured reliability using Cronbach's alpha values of ≥ 0.7 (Hair et al., 2019, 2021; Husin et al., 2024). The outer loading values ranged as follows: LC (0.734–0.842), TR (0.730–0.827), RLOT (0.737–0.911), POL (0.757–0.880), and SROL (0.748–0.893). Cronbach's alpha values were LC (0.910), TR (0.917), RLOT (0.889), POL (0.909), and SROL (0.908). These results indicated that respondents understood most of the questions well. The team made minor adjustments to simplify technical terms, ensuring the instrument's readiness for a larger sample.

Results

Table 1 shows the characteristics of the respondents who provided complete answers to the distributed questionnaires.

Table 1
Respondent Profile

Sample Characteristics		**Frequency**	**Percent**
Gender	Male	338	59%
	Female	235	41%
	Total	573	100%

Sample Characteristics		Frequency	Percent
Study Program	Electronic Engineering Education	111	20%
	Informatics Engineering Education	235	41%
	Informatics	71	12%
	Animation	62	11%
	Electronic Engineering	94	16%
	Total	573	100%
Student ID Number/ Entry Year	2023	229	40%
	2022	206	36%
	2021	138	24%
	Total	573	100%

Source. Own research.

Table 1 shows that most respondents were male, with 338 students (59%) identifying as male and 235 (41%) identifying as female. This gender distribution is important as it could influence the study's results. Regarding study programmes, most respondents were from Informatics Engineering Education (235 students, 41%), followed by Electronic Engineering Education (111 students, 20%), Electronic Engineering (94 students, 16%), Informatics (71 students, 12%), and Animation (62 students, 11%). In terms of year of entry, the majority of respondents were from the class of 2023 (229 students, 40%), followed by the class of 2022 (206 students, 36%), and the class of 2021 (138 students, 24%).

Measurement model

This model evaluates the effects on latent and manifest variables and calculates convergent and discriminant validity. The convergent validity criteria consist of outer loading ≥ 0.70, AVE ≥ 0.50, CR ≥ 0.70, and Cronbach's Alpha (α) ≥ 0.70 (Hair et al., 2019; 2021). Table 2 shows the results of this testing. The Standardized Root Mean Square Residual (SRMR) and Variance Inflation Factor (VIF) assessed the model's goodness of fit and multicollinearity. SRMR measures how well the theoretical model fits the data, with a value below 0.08 considered acceptable (Hair et al., 2019; 2021). This study's SRMR value was 0.078, indicating a good fit. The calculation of the VIf checked for multicollinearity among predictor variables. A VIf below five suggests no significant multicollinearity (Hair et al., 2019; 2021). In this model, VIf values ranged from 1.523 to 2.717, showing no multicollinearity issues.

All items in the manifest variables, which include learner control, technology readiness, perception of online learning, readiness of lecturers in online teaching, and student readiness for online learning, are detailed in the manifest variables (see Appendix

Table A2). The outer loading values for these variables are all 0.70 or higher, indicating their validity. The AVE values are as follows: LC = 0.553, TR = 0.549, POL = 0.578, RLOT = 0.681, and SROL = 0.670. Each of these values exceeds the threshold of 0.50, categorizing them as latent variables. Additionally, Cronbach's alpha values are LC = 0.867, TR = 0.863, POL = 0.819, RLOT = 0.844, and SROL = 0.877, all surpassing the minimum acceptable value of 0.70. The composite reliability scores are also robust: LC = 0.896, TR = 0.895, POL = 0.873, RLOT = 0.844, and SROL = 0.910, all exceeding 0.70. These findings confirm that the measurements for all items in the study are consistent and reliable. Appendix Table A3 shows that the discriminant validity HTMT (Standardised) < 0.9 (Hair et al., 2019; 2021), the Heterotrait-Monotrait Ratio (HTMT) calculation with discriminant validity through the confidence intervals bias corrected method, all constructs are declared valid.

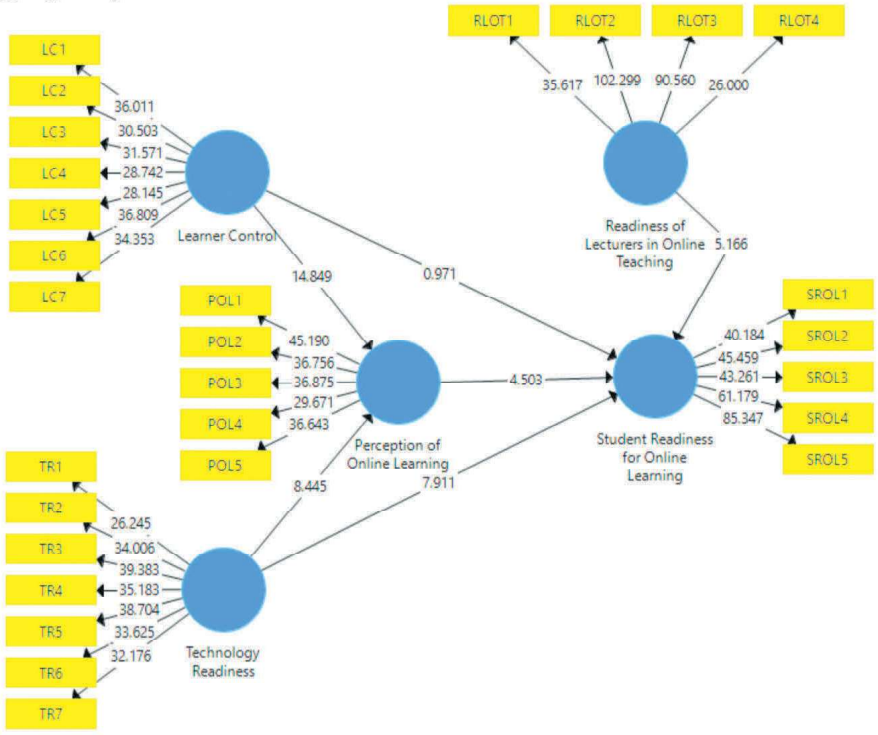
Structural model

Using a sophisticated structural model is instrumental in understanding the influence of latent variables. The R and Q square tests reveal that learner control and technology readiness significantly affect the perception of online learning by 52% (R2 = 0.520). Moreover, the combined effects of learner control, technology readiness, the readiness of lecturers in online teaching, and the mediation of perception of online learning by (learner control and technology readiness) contribute to student readiness for online learning by 50.3% (R2 = 0.503), as shown in Appendix Table A4. Joseph F. Hair et al. (2019; 2021) categorize the r square as > 0.25 (weak), 0.5 (moderate), and 0.75 (substantial). The predictive value of the relevance of Q square for the perception of online learning is 29.4% (0.294), and for student readiness for online education is 33.3% (0.333), as shown in Appendix Table A4. The criteria for Q square are> 0 (weak), 0.25 (moderate), and 0.5 (large) (Hair et al., 2019; 2021). Appendix Table A5 shows the effect size between latent variables, with effect size f2 > 0.02 (small), 0.15 (moderate), and 0.35 (large) (Hair et al., 2019; 2021). As seen in Table 5, learner control has a significant effect size (0.433), technology readiness has a moderate effect size (0.155), and the rest has a negligible effect size.

The standardised path coefficient, a critical component of our hypothesis test, is outlined in Figure 2 and Appendix Table A6. Most of these Coefficients are positive and statistically significant, providing a solid foundation for our research. However, the negative Standardised (β = -0.037; P value = 0.316) in hypothesis 1 is an important observation, while not statistically significant. We employ the bootstrap procedure to test the statistical significance of the path between latent variables, considering the T statistic and P value. If the T statistic is > 1.96 and the P value is < 0.05 (Hair et al., 2019; 2021), the research hypothesis is accepted, providing a clear and confident conclusion.

Figure 2

Bootstrapping Analysis



Source. Own research.

POL is a critical factor in mediating the effects of TR on SROL. It underscores the importance of your work in understanding SROL. The direct impact of LC on SROL may not be significant, but POL fully mediates the influence between LC and SROL. Moreover, POL mediates some of the effects between TR and SROL, further highlighting the significance of your research.

Discussion

The purpose of this research is to see the readiness of students for online learning associated with learner control, technology readiness, perception of online learning, and readiness of learning in online teaching. Significant changes have occurred in the world of education. Usually carried out conventionally (face-to-face), the learning process has shifted to digital forms, specifically online learning systems. This transformation raises questions about online learning systems' sustainability and future direction. Can these systems be effectively maintained, or will they face discontinuation? Ensuring

the continued success of online learning demands comprehensive readiness from higher education institutions, students, and lecturers..

Based on the findings in this study, the conclusion is that TR, POL, and RLOT significantly influence SROL. An average increase in TR, POL, and RLOT will also increase SROL. The average increase in TR, POL, and RLOT will also increase SROL. In addition, the average rise in LC and TR will also increase the average POL. However, an increase or decrease in LC will not directly affect SROL. Based on the mediation of the POL, LC and TR will broadly increase the average POL and indirectly increase the average SROL.

The Industrial Revolution 4.0 is a phenomenon of collaboration between automation technology and cyber technology (Tripathi et al., 2023). The concept focuses on automation by technology without human intervention in the application process (Shimaponda-Nawa & Nwaila, 2024). Today, lecturers and students are no longer just workers entering the workforce but can prepare for new jobs based on their creative ideas and technological capabilities (Song & Gao, 2020; Spurk & Straub, 2020). Education in the Industrial Revolution 4.0 is creative and intelligent education. Higher education aims to produce qualified graduates who can compete with the rapid development of technology. University learning facilities and lecturers' readiness to teach online enhance student involvement in online lectures. LC in online learning allows students to determine information related to the learning material from various sources (Festiyed et al., 2024; Husin et al., 2024). Minimising the use of classrooms in online learning will increase the flexibility of lecturers in teaching time. Students can participate in online learning at any time, and the creativity of lecturers in teaching is essential to avoid boredom (Rafique et al., 2021). The delivery of material must be designed as well as possible according to the concept of online learning.

SROL is the student's maturity level related to LC, TR, POL, and RLOT (Rafique et al., 2021). In online learning, learner control is handy. Giving control to students over their interactions can improve online learning and increase their readiness to participate in online learning. Of the 12 principles of multimedia learning (Castro-Alonso et al., 2021), learning at their own pace is said to help them learn well—a group of students exercising control in understanding a concept with animation obtained better results than other groups. Broadly speaking, how to learn and the extent to which students can choose what, when, and where are forms of learner control. With learner control, students can record and reflect on their learning. Online learning allows students to take responsibility for their learning speed, content, and sequence. Technological developments will change the concept of learner control (speed, content, sequence, context, incentives, and task difficulty) (Ananga, 2020).

The ability to adopt new technology is a form of technology readiness (Damerji & Salimi, 2021). Readiness in technology provides an advantage in gathering the latest developing information. The rapid development of technology must accompany the readiness of students to use it. It is a relatively complicated process of including technology in life; it requires readiness. It is one of the crucial factors in increasing SROL. The effect

of TR on the POL requires a thorough investigation of student readiness for online learning. Inconvenience and insecurity generally impede users' technology readiness, while optimism and innovation are indispensable in technology readiness. The Government's participation in providing free Internet network access will also provide technological readiness for students (Othman et al., 2023). Therefore, with the freedom of internet network access, students can increase their potential to search for appropriate literature materials quickly and precisely.

Online learning is a new paradigm in teaching and learning activities because it does not require students and lecturers in the classroom (Sofi-Karim et al., 2023). The teaching and learning process only requires an internet connection and can be done remotely. In this era of globalisation, human activity and mobility are very high, making an internet connection an essential part of life. Perception of online learning is a response based on feelings and experiences (Syauqi et al., 2020). Selection, interpretation, reaction, and positive and negative perceptions will occur. Perception of online learning must provide the perception that online learning activities have the same nuance or approach as face-to-face learning activities (L. Jensen et al., 2020). Online learning adapts the material to students' needs, with instructions crafted for easy comprehension. Student interaction also plays a vital role in online learning. Interacting will establish a good relationship between students and the lecturers concerned. In face-to-face learning, interaction can occur directly when a student has difficulty understanding material by asking the lecturer directly and immediately getting a response. During online learning, students and educators should interact through online discussions on e-learning platforms or messaging applications, with educators providing quick responses to ensure effective SROL.

The readiness of learning in online teaching also influences the achievement of SROL. Lecturers must maximise the use of applications in their teaching. Lecturers must maximise the use of applications in learning. The application allows educators to create a fun and interactive class. Lecturers can improve SROL and enhance learning outcomes by maximising their involvement in using learning applications. How a lecturer can design interactive learning will increase students' creativity and activeness in participating in online learning. The lecturers' ability to make learning evaluations is also essential in increasing student readiness to participate in online learning. An evaluation can be well designed because of the right way of delivering learning, especially in online learning systems.

SROL plays a role in higher education, Government, and lecturers who will teach online. From the results obtained, the readiness of students to take part in online learning has met good standards, but some improvements still must be made. Students' understanding of the material presented by the lecturer significantly affects the sustainability of students' readiness to learn online. A student is said to be able to learn if they are already ready to understand something (Ramos-Morcillo et al., 2020). Preparing in advance for learning is necessary to achieve the learning objectives properly. Students with

good learning readiness will have a sense of interest in the learning process they will do and then will arouse enthusiasm to improve their learning abilities. If their learning abilities are reasonable, their learning outcomes will also increase. So, learning readiness is a condition in which someone has prepared something to do learning activities. Related to this, students' readiness to participate in online learning must have good self-control (Karatas & Arpaci, 2021). Each individual's control will determine the speed of understanding the material. Proficiency in technology must also be good because, in online learning, students must be more active and independent in finding additional sources of information to support the information that the lecturer has conveyed.

Implications

The article's findings have theoretical and practical implications for higher education institutions and educators. Theoretically, the study highlights key factors — learner control, technology readiness, perception of online learning, and lecturer preparedness — that shape students' readiness for online education. These factors suggest the need for institutions to improve technological infrastructure and provide proper training for educators to use online teaching tools effectively. Practically, institutions can focus on fostering positive perceptions of online learning by creating interactive and engaging learning experiences. These efforts can support student engagement and improve learning outcomes in online environments.

Limitation and recommendations

This study has some limitations to consider. First, the team conducted the study in one department at a public university in Indonesia, limiting the findings' generalisability to other fields or institutions. However, this also suggests the need for broader participation in future research. The reliance on self-reported data may lead to bias, as respondents might provide socially desirable answers instead of accurate reflections of their experiences. Future research should aim for more diverse participation and use objective measures to improve the validity of results, ensuring a wider range of perspectives. The findings offer several recommendations to improve student readiness for online learning. Institutions should invest in comprehensive training programmes to equip students and educators with essential technological skills and digital literacy. Developing strategies to promote active learner engagement and control over their learning processes can also significantly improve student readiness. Further research into the role of learning styles in online learning readiness would also provide valuable insights to enhance educational practices in the digital age.

Conclusion

The study highlights the importance of several factors in shaping student readiness for online learning, especially with the rapid technological advancements and changing educational trends of the 21st century. The findings show that technology readiness, perception of online learning, and lecturer readiness in online teaching improve students' preparedness for online learning. While learner control does not directly affect student readiness, it influences readiness through students' perceptions of online learning. It emphasises the need to foster positive perceptions of online education to create a supportive learning environment. Integrating technology into education as part of the broader Industrial Revolution 4.0 requires students and educators to be well-prepared to adopt digital tools and platforms. This preparation includes technical skills, positive attitudes, and effective teaching strategies that can adapt to the digital learning environment. By enhancing learner control, ensuring technological readiness, and improving perceptions of online learning, educational institutions can offer more flexible, personalised, and effective online experiences. Future research should explore these factors and develop best practices for online education. As online education evolves, research and best practices must progress to ensure that students and educators succeed in the digital learning landscape. Such efforts will help higher education better meet the demands of the 21st century and produce graduates who are both technologically proficient and capable of lifelong learning in a rapidly changing world.

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Appendix

Table A1

Survey Items on Learner Control, Technology Readiness, Perceptions of Online Learning, and Readiness for Online Teaching

Item	Questions
Learner Control (LC) (Tang et al., 2020)	
LC1	I am able to acquire knowledge from the course easily
LC2	I am able to explore more information related to the course from other means of learning (e.g. videos, games, and discussion)
LC3	I am able to link the information learned from the course
LC4	The course provides the chance for me to reflect on what I learned
LC5	The course provides a clear guideline on learning
LC6	The tools or technologies used in the course facilitate learning and interaction
LC7	I am satisfied with the information delivery channels
Technology Readiness (TR) (Tang et al., 2020)	
TR1	I prefer to use the most advanced technology available
TR2	Technology gives me more freedom of mobility
TR3	I feel confident that machines will follow through with what you instructed them to do
TR4	In general, you are among the first in your circle of friends to acquire new technology when it appears
TR5	You enjoy the challenge of figuring out high-tech gadgets
TR6	There should be caution in replacing important people tasks with technology because new technology can breakdown or get disconnected
TR7	If you provide information to a machine or over the Internet, you can never be sure it really gets to the right place
Perception of Online Learning (POL) (Sarfraz et al., 2022)	
POL1	Online learning provides various multimedia learning resources
POL2	Online learning can encourage interaction between lecturers and students
POL3	Online learning overcomes time and places constraints
POL4	Online learning enables me to learn more about the knowledge that I desire to learn

Item	Questions
POL5	Online learning environments can effectively reduce the learning burden
Readiness of Lecturers in Online Teaching (RLOT) (Sarfraz et al., 2022)	
RLOT1	My lecturer designs learning activities that provide opportunities for students to interact (eg discussion forums, wikis)
RLOT2	Lecturers respond to student questions promptly (eg, 24 to 48 hours)
RLOT3	Lecturers use facilitation strategies to manage time spent in courses (eg, discussion board moderators, collective feedback, rating scales).
RLOT4	Lecturers share open educational resources (e.g., learning websites, Web resources, games, and simulations)
Student Readiness for Online Learning (SROL) (Suhandiah et al., 2022)	
SROL1	Ability to carry out study plans
SROL2	Ability to set study time
SROL3	Ability to direct learning progress
SROL4	Ability to manage other online activities
SROL5	Repeating online course material

Source. Adapted from Tang et al. (2020), Sarfraz et al. (2022), and Suhandiah et al. (2022).

Table A2

Outer Loading, Cronbach's Alpha, CR, and AVE

Latent Variable	Manifest	Normality Shapiro-Wilk Sig ≥ 0.05	Outer Loading ≥ 0.70	Cronbach's Alpha ≥ 0.70	CR ≥ 0.70	AVE ≥ 0.50	VIf < 5
Learner Control	LC1	0.071	0.784	0.867	0.896	0.553	2.155
	LC2	0.057	0.745				1.912
	LC3	0.102	0.728				1.820
	LC4	0.083	0.738				1.916
	LC5	0.214	0.742				1.888
	LC6	0.182	0.739				1.720
	LC7	0.065	0.727				1.695
Technology Readiness	TR1	0.055	0.702	0.863	0.895	0.549	1.564
	TR2	0.114	0.728				1.886
	TR3	0.084	0.771				2.008
	TR4	0.302	0.739				1.679
	TR5	0.118	0.771				1.850
	TR6	0.052	0.751				1.915
	TR7	0.068	0.720				1.816

Latent Variable	Manifest	Normality Shapiro-Wilk Sig ≥ 0.05	Outer Loading ≥ 0.70	Cronbach's Alpha ≥ 0.70	CR ≥ 0.70	AVE ≥ 0.50	VIf < 5
Perception of Online Learning	PLO1	0.130	0.793	0.819	0.873	0.578	1.656
	POL2	0.086	0.760				1.661
	POL3	0.070	0.760				1.630
	POL4	0.231	0.739				1.661
	POL5	0.062	0.749				1.523
Readiness of Lecturers in Online Teching	RLOT1	0.237	0.780	0.844	0.894	0.681	1.602
	RLOT2	0.052	0.892				2.557
	RLOT3	0.094	0.877				2.240
	RLOT4	0.118	0.742				1.755
Student Readiness for Online Learning	SROL1	0.083	0.791	0.877	0.910	0.670	1.862
	SROL2	0.221	0.800				1.835
	SROL3	0.084	0.807				2.044
	SROL4	0.075	0.822				2.072
	SROL5	0.095	0.872				2.717

Source. Own research.

Table A3

Discriminant Validity (HTMT)

Latent Variable	Standardized	Lower	Upper
POL → LC	0.764	0.704	0.828
RLOT → LC	0.449	0.351	0.527
RLOT → POL	0.460	0.373	0.541
SROL → LC	0.421	0.341	0.500
SROL → POL	0.564	0.495	0.633
SROL → RLOT	0.671	0.591	0.761
TR → LC	0.550	0.483	0.620
TR → POL	0.658	0.592	0.725
TR → RLOT	0.812	0.754	0.855
TR → SROL	0.773	0.705	0.843

Notes: LC, Learner control; TR, Technology readiness; POL, Perception of online learning; RLOT, Readiness of lecturers in online teaching; SROL, Student readiness for online learning.

Source. Own research.

Table A4

R Square and Q Square

Latent Variable	R2	Category	Q2	Category
Perception of Online Learning	0.520	Moderate	0.294	Moderate
Student Readiness for Online Learning	0.503	Moderate	0.333	Moderate

Source. Own research.

Table A5

f Square

Latent Variable	f^2	Category
LC → POL	0.433	Large
LC → SROL	0.001	Small
POL → SROL	0.031	Small
RLOT → SROL	0.065	Small
TR → POL	0.155	Moderate
TR → SROL	0.137	Small

Notes: LC, Learner control; TR, Technology readiness; POL, Perception of online learning; RLOT, Readiness of lecturers in online teaching; SROL, Student readiness for online learning.

Source. Own research.

Table A6

Bootstrapped Results

Path Analysis	Standardized β	T Statistic	P Values	Decision (α < 0.05)
LC → SROL	-0.037	0.971	0.332	H1 Not Supported
TR → SROL	0.411	7.911	0.000	H2 Supported
POL → SROL	0.180	4.503	0.000	H3 Supported
RLOT → SROL	0.255	5.166	0.000	H4 Supported
LC → POL	0.523	14.849	0.000	H5 Supported
TR → POL	0.302	8.445	0.000	H6 Supported
LC → POL → SROL	0.094	4.385	0.000	H7 Supported
TR → POL → SROL	0.054	3.695	0.000	H8 Supported

Notes: LC, Learner control; TR, Technology readiness; POL, Perception of online learning; RLOT, Readiness of lecturers in online teaching; SROL, Student readiness for online learning.

Source. Own research.