E-Learning Achievement of Higher Education Students: Role of Students' Learning Readiness, Grit and Characteristics

Marcela Fang, Kijung Choi*
William Angliss Institute, 555 La Trobe Street, Melbourne, VIC 3000, Australia.

* Corresponding author. Tel.: +61 3 9606 2502; email: kijung.choi@angliss.edu.au
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Abstract: In response to the rapid and forced transition to e-learning due to the COVID-19 pandemic, this study aims to explore the factors underlying students' e-learning achievement. This study proposes a theoretical framework based on literature to assess the role of students' e-learning readiness, grit, and characteristics in explaining their perceived e-learning achievement. The empirical data of 196 higher education students were collected via an online survey. Using structural equation modeling and a multigroup analysis, the findings indicated that students' self-directed learning, learner control, motivation for learning, and online communication self-efficacy from the e-learning readiness scale, as well as the perseverance of effort from grit scale, have significantly impacted their perception on e-learning achievement. The results also highlighted significant differences between first year and higher year students in a continued effort to achieve learning, and learner control to achieve learning success. The implications of the findings and educational practice are discussed.

Key words: E-learning, e-learning readiness, learning achievement, grit, students' characteristics, higher education.

1. Introduction

The COVID-19 pandemic caused a sudden and forced transition for the traditional face-to-face higher education providers to pivot to the e-learning environment to continue and support student learning. Students in higher education have experienced difficulties managing increased workloads while handling the online material and the new forms of IT software [1]. The sudden changes had also forced students to overcome the challenges, having the means to complete an online course during such a highly uncertain and ambiguous time can potentially signify successful student e-learning achievement. However, although students have similar learning skills, abilities, and preparations, their learning outcomes differ depending on the individual nature of their personal qualities [2]–[4]. This suggests that not only the cognitive academic skills but also personal characteristics play an important role in students' accomplished e-learning outcomes in higher education. Therefore, this study suggests that students' noncognitive skills would affect the achievement of students' perceived e-learning success.

Noncognitive skills refer to a set of attitudes, skills, and behaviors [5], like "*e-learning readiness*" (e.g., motivation, self-efficacy, self-control, self-directed learning) and "*personality traits*", and are increasingly investigated by educational researchers as they underpin educational achievements in online education

[6]–[8]. Based on the self-determination theory (SDT) [9], [10], students who have assessed their personal situation and ability to take their existing skills to the e-learning space have unearthed their motivational drive through their conscious choice, thus, opted to study fully online. On the other hand, insufficient motivational drive in some students could have resulted in lower e-learning uptake or possibly lower level of e-learning achievement [8], [11], [12]. Therefore, it is vital to explore how students perceived their e-learning readiness during this highly uncertain time, thereby helping current and future students strengthen their e-learning achievement through suitable support and intervention strategies in the noncognitive skills domain.

In addition, how different personality traits such as grit play in students' e-learning achievement seems necessary, especially in the highly uncertain, ambiguous, and high-stake situation [13]. Grit refers to perseverance and passion for long-term goals [14], which has been associated with a high predictive power of successful learning outcomes [14], [15], including students' e-learning satisfaction [6]. As the extant e-learning readiness research and grit research investigated subjects in highly predictable environments and stable times, this study aims to advance the current understanding of the constructs' relationships with students' perceived e-learning achievement during the COVID-19 pandemic.

This study attempts to identify students' perceptions toward e-learning readiness and the role of personality traits like grit that affected their e-learning achievement. This study first established the impact of five e-learning readiness facets (i.e., computer/ Internet self-efficacy, self-directed learning, learner control, motivation, and online communication self-efficacy) and two grit aspects (i.e., perseverance of effort and consistency of interest) in students' e-learning achievement. This study also examined whether the strength of associations between students' e-learning readiness and personal grit trait was influenced by students' characteristics to achieve their e-learning goals.

2. Literature Review and Hypotheses

2.1. E-Learning Readiness

E-learning readiness is suggested to investigate three aspects: namely, students' preference for online instruction; student confidence in using a computer and the Internet for instruction; and ability to pursue autonomous learning [16]. According to [8] Hung, Chou, Chen and Own (2010), the online learning readiness framework was expanded with technical computer-use skills, Internet navigation skills, and learner control over the sequence and selection of materials scales. The extant research established that e-learning readiness contributes to learning achievement [17], [18], and low levels contribute to drop-out risks [19]. Research has also suggested that online learning readiness should be a multifaceted concept [20]. Thus, this research builds on the e-learning readiness framework proposed by [8] Hung, Chou, Chen and Own (2010) in the context of the COVID-19 pandemic, an event that forced students from face-to-face learning to e-learning. A discussion of each of the e-learning readiness factors - computer/ Internet self-efficacy, self-directed learning, learning control, motivation for learning, and online communication efficacy is followed.

2.2. Computer / Internet Self-efficacy

Assessing students' perceptions and their ability to use technology would be the key aspects to consider in the e-learning context [8]. A strong and positive relationship was found between students' self-efficacy in technology use and students' achievement of their learning goals [21], [22]. Recent research also uncovered that students' computer/Internet self-efficacy had a strong effect on online discussion scores and online course satisfaction [20]. In terms of e-learning success, students' perceptions of technology-mediated learning experiences are essential to inform the effectiveness of the e-learning instruction and achievement of learning outcomes [23]. Therefore, the following is hypothesized:

Hypothesis 1. Students' computer/ Internet self-efficacy has a positive effect on their e-learning achievement.

2.3. Self-directed Learning

Self-directed learning refers to learning strategies that support learners' ability to control their learning, which requires students to identify their learning needs, goals, strategies, and evaluation measures autonomously to attain the set learning goals [2], [24]. This noncognitive facet involves students in the e-learning environment to have high expectations for their learning performance, capacity to set up their learning goals, effectively carry their study plan, manage their time, and seek assistance when facing learning problems [8]. A positive relationship has been established between self-directed learning and students' academic achievements in previous e-learning studies [20], [25], [26]. Therefore, the hypothesis is proposed as follows:

Hypothesis 2. Students' self-directed learning has a positive effect on their e-learning achievement.

2.4. Learner Control

Self-control is defined as the ability to override or change one's inner responses, as well as to interrupt undesired behavioral tendencies (such as impulses) and refrain from acting on them [20]. In the e-learning context, self-control or, more specifically, learner control refers to the control over the individual learning process [20], that is one of the psychological predictors of success, including academic success [7]. In the e-learning process, it is an ability to direct own learning focus and manage distractions, which may include instant messaging or Internet surfing during the learning process [8]. As students are presented with learning flexibility, students need to decide what to learn and when in the e-learning environment. Learner control can also lead to learning sequence of steps, enabling students to achieve their learning goals [27]–[30]. Therefore, the following is hypothesized:

Hypothesis 3. Students' control on learning has a positive effect on their e-learning achievement.

2.5. Motivation for Learning

Motivation is a multidimensional inner process, highlighting that a mixture of different motivations (e.g., motivations openness to new ideas, motivation to learn, willingness to learn from own mistakes, and confidence to share ideas with others) often drives students' e-learning achievement [8], [20], [31]. A relationship between motivation and academic outcomes has been widely examined in e-learning and showed that motivation acts as the key requirement to achieve e-learning success [11], [12], [31], [32]. Especially, during the continually changing learning context, understanding students' motivation for learning toward e-learning is essential to facilitate their efforts to be compatible with the students' own desires and to enhance their learning achievement. Therefore, the hypothesis is proposed as follows:

Hypothesis 4. Students' motivation for learning has a positive effect on their e-learning achievement.

2.6. Online Communication Self-efficacy

Providing opportunities for interactions and communications between students and instructors using online discussions has been indicated as one of the key factors affecting students' success in e-learning [33]. The aspects of online communication self-efficacy include confidence in using online tools, such as email, chat, and discussion options to effectively communicate with others during the learning process, confidence in expressing the self through text, and confidence in posting questions in online discussions [8]. Higher education students juggle their thoughts connected with social stigma when communicating with others in the e-learning process and the lack of communication engagement led to lower e-learning achievement [34]. Therefore, the following is hypothesized:

Hypothesis 5. Students' online communication self-efficacy has a positive effect on their e-learning achievement.

Although the above online learning readiness factors indicate an important role in e-learning success, researchers' efforts to explore the relationships between the factors and students' e-learning achievements remain limited, considering the changed learning context inflicted by the COVID-19 pandemic – that drove forcefully new student segments to e-learning. This changed situation requires continuing studies to inform the development of e-learning strategies, raising the online readiness levels for the increasingly diverse higher education student segments.

2.7. Grit

Grit has received widespread attention as a noncognitive variable due to its predictive power of academic achievement and success [35]. Previous research suggested that grit is a two-factor construct, including perseverance of effort and consistency of interest. Perseverance of effort refers to an ability to push through despite obstacles and setbacks, whereas the consistency of interest refers to an orientation towards accomplishing long-term goals [7], [14]. Particularity, in educational settings, grit has been linked to a sustained effort and interest to complete a months-long project or a program [15]. Grit in students' perseverance and consistency of interest is closely associated with student academic success in an online setting. Gritty learners tend to work harder and are more determined to enhance performance or success despite the potential obstacles caused using e-learning platforms [7].

However, interestingly, meta-analysis of grit uncovered that grit's predictive power is not as powerful as previously acclaimed in the literature related to academic performance [13] and a study also found that grit adds little predictive power to predicting academic outcomes [36]. Although some have shown grit to have little effect on academic performance and outcomes, the strong evidence in the direct effect of grit on learning achievement should be considered. In particular, grit positively augmented positive emotions [37], which would expect to affect better learning achievement during the unexpected shift from face-to-face learning to e-learning. It is also suggested that grit researchers should investigate different domains or settings, a larger range of difficulty, and various task types, which could help ascertain the boundary of grit conditions [13]. This led to the following two hypotheses:

Hypothesis 6. Students' perseverance of effort has a positive effect on their e-learning achievement.

Hypothesis 7. Students' consistency of interest has a positive effect on their e-learning achievement.

2.8. Students' Characteristics

To examine the relationship between e-learning readiness and student learning achievement, it is important to control for student characteristics, such as program level (e.g., first year, second and third year) and student status (e.g., international, domestic students). Regarding the program level differences, the first-year undergraduate students have been found to experience more academic stress due to their higher levels of expectations placed on better academic results/ learning success [38], [39], than second- and third-year students. More interestingly, research also found that self-control and grit are stronger predictors of learning motivation and achieved learning outcomes in first year undergraduate students [40], [41]. Empirical research points to the growing maturity and time spent in the university [8] and further research have been suggested to survey broader groups of students (e.g., from different course disciplines, geographies) [34].

In addition, prior research uncovered that student learning achievement varies by their status. For instance, long term goals related to future career and family were strongly associated with the academic achievement of international students who came to Australia to study [42] and international students experience difficulties adapting to living and studying overseas, which leads to worse learning outcomes

[43]. Furthermore, a recent study emphasized that international students' grit had a central role in reducing their academic stress during the pandemic [44], which suggests that students' status on studying in their home country or overseas would affect the relationships among readiness, grit and learning achievement differently. Therefore, the hypothesis is proposed as follows:

Hypothesis 8. Students' characteristics (year levels and student status) moderate the proposed set of relationships in e-learning achievement.

2.9. Perceived e-Learning Achievement

Students' academic success can be measured by their perceived e-learning achievement [45]. Students' perceived e-learning achievement can be defined as perceptions of how much students thought that they learned from their e-learning experience [46]. Perceived learning achievement is widely cited as a measure of e-learning success and used in research to compare between learners' perceived achievement derived from the e-learning versus a prior face-to-face learning experience [45]–[47].

Based on the preceding literature review, this study investigated the relationships among the five e-learning readiness factors (computer/Internet self-efficacy, self-directed learning, learner control, motivation for learning and online communication self-efficacy), two students' grit factors (perseverance of effort and consistency of interest), two moderating factors of students' characteristics, and their perceived e-learning achievement; in the context of the COVID-19 pandemic. Thus, Figure 1 shows the research framework of the study and hypotheses.

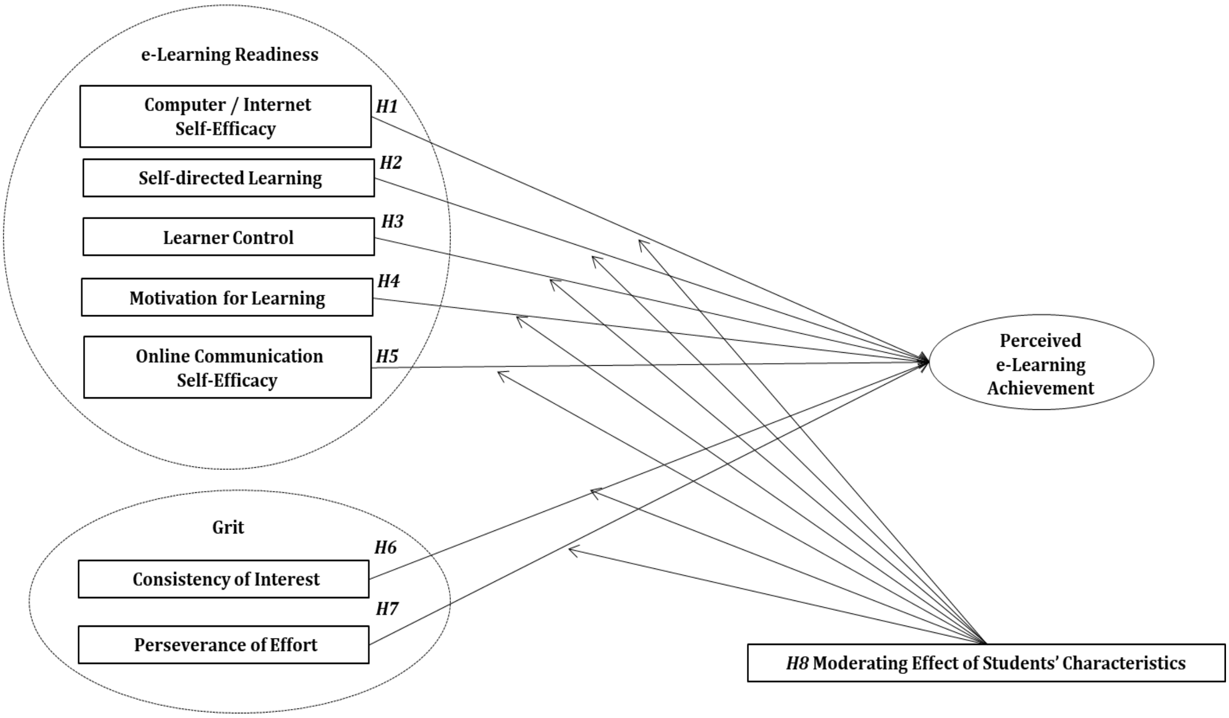

Fig. 1. Research framework.

3. Methodology

3.1. Data Collection Procedure and Participants

The questionnaires were disseminated via Google form between October and November 2020. A forced-response option was used for the online questionnaire to prevent missing values of the collected answers. Of the 288 undergraduate students enrolled in online management programs in an Australian higher education institution, 196 usable responses were collected, for a response rate of 68%. There were more female respondents (*N*=140, 71.4%) than male respondents (*N*=56, 28.6%). Regarding their course level, 116 participants (59.2%) were in their first year of undergraduate study, whereas 80 (40.8%) were in their second or third year. The sample is split between domestic (*N*=115, 58.67%) and international students (*N*=81, 41.33%), with the latter group comprising mainly Asian students, especially those from Southeast and South Asia such as Indonesia and Sri Lanka.

3.2. Measurement

All of the study items were drawn from existing studies. In terms of the e-learning readiness constructs, three items were used to measure computer/Internet self-efficacy and learner control, and four items were used to measure self-directed learning, motivation for learning and online communication self-efficacy, and all of these scales were adapted from [8]. Respondents were asked to indicate their online learning readiness on a 5-point, Likert-type scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*. To assess the consistency of interest and perseverance, we adapted three items for each construct from [15], using a 5-point, Likert-type scale (1 = *not like me at all*, 5 = *very much like me*). Finally, four items from [45], [46] capture perceived learning achievement. The items were also assessed on a 5-point Likert scale with endpoints of 1 = *strongly disagree* to 5 = *strongly agree*. A pilot test of the questionnaire was conducted with four higher education faculty members to assure content validity before collecting data. As a result of the pilot test, item wording was slightly modified to reflect the study's context, and a final set of questions was generated for the survey.

3.3. Data Analysis

A descriptive statistical analysis was conducted using SPSS 24 to explore the sample characteristics and distribution. Normality examination showed that all skewness and kurtosis values fell between -2 and +2 [48], indicating normally distributed data. To assess the sampling and data's suitability for factor analysis, Kaiser-Meyer-Olkin (KMO) coefficient and Barlett's test of sphericity were tested. The KMO measure of sampling adequacy test value was 0.89 for the online learning readiness scale and 0.77 for grit scale, above the recommended value of 0.60, and Bartlett's test of Sphericity was significant (p < 0.001). Based upon these results, questionnaire factor analysis was seen appropriate.

Confirmatory factor analysis (CFA) and structural equation modelling (SEM) were performed in AMOS 24, according to [49] Byrne (2016), to evaluate the internal validity of the constructs and test the estimation of the structural model and hypotheses. The hypothesized moderating effects of students' characteristics was assessed by conducting multigroup analyses, where the difference between the chi-square statistics was computed to examine whether the structural model was invariant between groups [49]. For fit indices, the following thresholds in the literature were used as recommended: chi-square (χ^2/df) less than 3, comparative fit index (CFI) = > 0.90, Tucker-Lewis index (TLI) = > 0.95, root mean square error of approximation (RMSEA) = < 0.08, and standardized root mean square error residual (SRMR) = < 0.08 [48]–[50].

4. Results

4.1. Measurement Model

To confirm the suitability of modeling and its validity, CFA was conducted. Factor loadings were above 0.65 [50], and the average variance extracted (AVE) scores of the seven dimensions exceeded 0.50, providing support for convergent validity [48]. The composite reliabilities and Cronbach's α coefficients were above 0.70, indicating good evidence of construct reliability [48]. Discriminant validity was established as the square root of the AVE for each of the factors was greater than the correlation between the constructs [50], as presented in Table 1. The results of the CFA indicated a good model fit for the sample data, with χ^2 = 612.206, *df* =278, χ^2/df = 2.202, *p* < 0.00, CFI = 0.93, TLI = 0.91, RMSEA = 0.079, SRMR = 0.058.

Table 1. Results of Validity Analysis

Construct	Mean (SD)	CR	AVE	CIS	SDL	LC	ML	OCS	CI	PE
CIS	4.396 (0.744)	0.890	0.715	**0.845**						
SDL	3.191 (1.104)	0.944	0.773	0.312	**0.879**					
LC	3.451 (1.249)	0.897	0.743	0.295	0.533	**0.862**				
ML	4.233 (0.795)	0.859	0.670	0.643	0.548	0.450	**0.819**			
OCS	3.816 (1.042)	0.890	0.731	0.321	0.629	0.591	0.526	**0.855**		
CI	3.068 (0.872)	0.885	0.659	0.256	0.601	0.555	0.459	0.256	**0.812**	
PE	3.413 (1.079)	0.939	0.795	0.175	0.802	0.591	0.352	0.626	0.603	**0.891**

Note. The bold diagonal elements are the square root of the variance shared between the constructs and their measures. Off-diagonal elements are the correlations between constructs. CR = composite reliability; AVE = average variance extracted. CIS = Computer/Internet self-efficacy; SDL = Self-directed learning; LC = Learner control; ML = Motivation for learning; OCS = Online communication self-efficacy; CI = Consistency of interest; PE = Perseverance of effort.

4.2. Structural Model

Table 2 presents the hypotheses test results. The overall structural model has a tolerable goodness-of-fit with χ^2= 733.108, *df* = 349, χ^2/df = 2.101, *p* < 0.00, CFI = 0.913, TLI = 0.899, RMSEA = 0.075, and SRMR = 0.061. The structural path coefficients suggest that five paths were supported, but two paths (i.e., computer/Internet self-efficacy → learning achievement and consistency of interest → learning achievement) were not supported. The proposed model accounts for 73.7% of the variance in students' perceived online learning achievement.

Table 2. Results of Hypothesis Testing

Hypothesis	Path	Standardized path coefficients	Result
H1	CIS → LA	-0.031(0.634)	Not supported
H2	SDL → LA	0.620^{***}	Supported
H3	LC→ LA	0.153^{*}	Supported
H4	ML → LA	0.208^{*}	Supported
H5	OCS → LA	0.187^{*}	Supported
H6	CI → LA	0.063(.221)	Not supported
H7	PE → LA	0.172^{*}	Supported

Note. CIS = Computer/Internet self-efficacy; SDL = Self-directed learning; LC = Learner control; ML = Motivation for learning; OCS = Online communication self-efficacy; CI = Consistency of interest; PE = Perseverance of effort; LA = Learning achievement.
* *p* <0 .05. *** *p* < 0.001.

4.3. Moderating Effects of Students' Characteristics

To test the moderation effects of students' characteristics (i.e., year levels of program, student status) on the proposed relationships from online learning readiness and grit constructs to learning achievement, multigroup analysis was conducted. The analysis indicated no difference in status between international and domestic students. However, the proposed relationships were partially moderated by students' year levels of study, as shown in Table 3.

Testing for differences between the two groups (First year *N*=118 vs. Second- and Third-year *N*=78) was achieved through pairwise comparison of the coefficients, using the critical ratios for differences after confirming that the measurement model yielded equivalent representation in both groups by assessing measurement invariance. The resulting z scores with associated *p* values for parameter differences indicated that the effects of the first-year students' perseverance of effort on perceived learning achievement (difference = 0.181, $p < 0.001$) were stronger than the higher year students. On the contrary, the effects of higher year students' learning control on achievement (difference = 0.221, $p < 0.05$) were stronger than for the first-year students.

Table 3. Moderating Effect of Student Study Year

Path	First year		Second and Third year		Group differences	
	Path coefficient	*t*-value	Path coefficient	*t*-value	z score for path comparison	*p*-value
PE → LA	0.445	3.937***	0.264	1.798***	3.268	< 0.001
LC → LA	0.156	1.637*	0.377	3.474***	2.289	<0 .05

Note. Only statistically significant results are presented. PE = Perseverance of effort; LC = Learner control; LA = Learning achievement.
* p <0 .05. *** $p < 0.001$.

5. Discussion

Through the lens of the SDT, we contended that students' ability to do well in the novel e-learning environment during the COVID-19 pandemic could be determined through the e-learning readiness factors [8] and the grit constructs [14], [15]. The findings suggest that students' perceptions of their learning skills and abilities in self-directed learning, learner control, motivation for learning, online communication self-efficacy, and grit's perseverance of effort trait characteristic act as strong indicators of student perceived online learning success during the highly uncertain and ambiguous times. Results confirm that e-learning readiness is a multifaceted concept, however, contrary to other research findings, the computer/ Internet self-efficacy construct of e-learning readiness model [8] failed to produce an effect on students' perceived e-learning achievement. This finding is similar to previous studies [51], [52], in which the technology skill factors did not significantly predict students' learning performance and success. Despite the insignificant finding, students reported relatively high confidence using a computer and the Internet in terms of the construct's measures that assessed confidence in performing basic Microsoft Office functions, managing software for e-learning and using the Internet to gather information for learning. We could explain this aberration from the fact that many current higher education students in Australia would have developed these skills and capabilities in secondary education, thus, showing mastery in computer and Internet use, and from this perspective, showing learning readiness in higher education e-learning.

The findings are also in agreement with recent studies in education that posit grit should not be used as a composite measure when assessing students' achievement outcomes [13], [53]. Various studies demonstrated that perseverance of effort, not consistency of interest nor the composite grit score, correlates more strongly with achievement in education [13], [35], [54]. In addition, our findings indicate that there were significant differences in the underpinning mechanisms between the first year and higher year students. The study shows that first-year students relied on their effort to persevere to achieve e-learning success in the uncertain learning context – to transition to the higher education course level and e-learning. As grit's perseverance is linked to long-term goals [14], [15], the students' aspirations of succeeding in their chosen fields had reinforced the students' motivation to adapt to the changed learning conditions despite the life obstacles.

The study further shows that higher year students used learner control strategies to achieve their learning. This is consistent with the findings from [8] that more mature students can better use self-control in education. Whereas their argument emphasized maturity, we believe that it is also the students' learning experience gained in the higher education learning process that contributes to the difference. Thus, as students become familiar with their learning style in higher education, they use different learning strategies to achieve their learning goals. As they strengthen their learning skills and abilities during the course of their undergraduate studies, students become more competent to use their learner control effectively and use it in the more routine tasks, such as completion of course assessments. These control actions, in turn, support the accomplishment of the students' long-term goals. In light of the SDT [9], [10], this suggests that students who believed they could transfer their existing abilities (perseverance in first-year students and learner control in higher year students) to the new and uncertain context of learning, could achieve their learning goals.

Furthermore, e-learning readiness skills, such as motivation for learning, learner control, self-directed learning, and online communication self-efficacy, could be developed and/or strengthened through suitable learning strategies while meeting the needs of different students across the course levels. Online learning teachers can provide targeted support to students in their first year of higher education e-learning to help broaden their learning confidence repertoire. Focusing on students' perceived weaknesses in any of the online learning readiness domains, instructors could introduce strategies to model the way, enable practice, and self-evaluate and reflect on learning to help students develop good e-learning habits and behaviors. Throughout the course of the students' studies, instructors should continue to reinforce the importance of effective online communication, learner control and self-directed learning, the three areas that scored relatively lower in this study, to help students develop mastery in these harder to develop domains. Overall, institutions play an important role in supporting students' diverse e-learning needs. Pre-admission or pre-course testing could be used to assess students' e-learning needs through a skills-gap analysis [55]. The findings could help prioritize the training intervention strategies and the proposal of scaffolded program initiatives or teaching and e-learning strategies embedded in various subjects of a given higher education course. We argue that all students should have the opportunity to develop good e-learning habits and practices to become more effective and independent life-long learners.

6. Future Research

The study's results showed a more expanded view of students' noncognitive abilities and traits that can guide the evaluation of e-learning achievement and the development of student-centered e-learning strategies for higher education students. The limitation of this study is the collection of students' responses from a single higher education institution in Australia. Future research could include students from various higher education institutions across all course levels to provide a more holistic and fuller understanding of students' perceptions of readiness, grit, and learning achievement. Future studies can also consider more objective outcome measures (e.g., GPA/ academic outcomes) and consider demographic variables, such as gender, age, and previous e-learning experience. Another future area of research is to conduct the same research study across various countries to compare students' perceptions based on the cultural background in light of their cultural characteristics and e-learning preferences, which could contribute to the understanding of the noncognitive skills and factors affecting better e-learning success.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

First author conducted the research, while second author analyzed the data. Both authors wrote the paper and approved the final version.

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Marcela Fang is a senior lecturer in the Faculty of Higher Education at William Angliss Institute, Australia. Marcela's research focuses on leadership, leadership development, evaluation of higher education and training programs, strategy, and innovation.

Kijung Choi is a lecturer of resort and hotel management at William Angliss Institute, Australia. Her research focuses on travel technologies, services marketing, and consumer behavior, applied to a tourism/hospitality context.