The Relationship between Students' Incremental Beliefs of Digital Intelligence and Behavioral Engagement in Learning Management System Courses

Hoang Bao Ngoc Nguyen, Yi-Fang Lee*, Thi Phuong Vy Nguyen, and Hsin-Ling (Sonya) Hung

***Abstract*—While the Learning Management System (LMS) has been recognized as a key e-learning platform, there is no clear picture of the factors contributing to learners' engagement in LMS courses in literature. This study aimed at exploring the relationship between students' incremental beliefs of digital intelligence and behavioral engagement in LMS courses with achievement goal orientation as a mediator. The participants were 176 undergraduate students in a Vietnamese university. Implicit theory of intelligence and academic achievement goals theory were used to develop the research model. A Structural Equation Model (SEM) was applied to examine the relationship between students' incremental beliefs of digital intelligence and the selected variables. Results showed that students' incremental beliefs of digital intelligence were positively linked to four types of achievement goals: mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance goals. Moreover, except for mastery-avoidance goals, the other three types were positively linked to behavioral engagement in LMS courses. The findings suggest that instructors' encouragement can foster students' incremental belief in digital intelligence and achievement goals. Furthermore, to promote students' learning engagement, various approaches can be utilized to motivate students to appropriately combine different types of achievement goals.**

***Index Terms*—Digital intelligence, incremental beliefs, academic achievement goals, behavioral engagement, LMS courses**

I. Introduction

The emergence and rapid development of technology has transformed traditional classrooms into digital smart learning environments [1]. The Learning Management System (LMS) was developed due to the growing number of smart learning features, including computers, the internet, and mobile devices [2]. LMS was introduced in 1990 as a computer-based integrated learning system [3] and has now become a widespread option for higher education institutions, especially since the COVID-19 pandemic [2]. Recently, the LMS has been established as a key platform for e-learning technology that facilitates learning processes, such as having access to high-quality and diverse educational resources, offering various interactive features, and documenting students' participation and performance [4]. LMS-VNU is the platform designed explicitly for Vietnam National University (VNU) in Hanoi. It provides many functions supporting blended learning activities, such as forums, peer assessments, uploading assignments, and feedback. Since all courses at the University of Education-VNU are required to include at least 30% of learning time via LMS, it has become an essential part of student's learning experience. LMS is considered to be an efficient tool to enhance student's learning experience and achievement [4], so understanding the factors that influence learners' behavioral engagement in LMS courses is necessary. Some studies have pointed out the relationship between learners' beliefs of intelligence and their engagement in learning [5, 6]. However, very few studies have explored the relationship between students' beliefs about digital intelligence and their academic engagement in LMS courses. Therefore, this study aimed to explore the relationship between students' incremental beliefs of digital intelligence and their behavioral engagement in VNU-LMS courses with students' achievement goal orientation as a mediator.

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Hoang Bao Ngoc Nguyen and Yi-Fang Lee are with the Department of Industrial Education, National Taiwan Normal University, Taiwan. E-mail: ngocnhb09@gmail.com (H.B.N.N.)

Thi Phuong Vy Nguyen is with the International Doctoral Program in Integrative STEM Education, National Taiwan Normal University, Taiwan. She is also with the Quality Management Faculty, the University of Education, Vietnam National University, Hanoi, Vietnam. E-mail: phuongvynt.95@gmail.com (T.P.V.N.)

Hsinling Sonya Hung is with Evaluation and Assessment at the Center on Health Disparities. She is also with the Department of Health Behavior and Policy, School of Medicine, Virginia Commonwealth University, USA. E-mail: hlhung@vcu.edu (H.L.S.H.)

*Correspondence: ivana@ntnu.edu.tw (Y.F.L.)

II. Literature Review

A. Digital Intelligence

Digital intelligence has received more attention in education in recent years. Children who are digitally intelligent can navigate the digital world more properly, use its resources wisely, and avoid harmful information [7]. Digital intelligence is defined as "a comprehensive set of digital competencies rooted in universal moral values for individuals to use, control, and create technology to advance humanity" [8]. "Digital intelligence quotient encompasses a comprehensive set of technical, cognitive and socio-emotional competencies which enable an individual to face challenges and adjust to the digital era" [9]. Similarly, the Institute of Electrical and Electronics Engineers (IEEE) [10] considered digital intelligence as "a comprehensive set of technical, cognitive, meta-cognitive, and socio-emotional competencies that are grounded in universal moral values and that enable individuals to face the challenges and harness the opportunities of digital life" [10]. Moreover, the IEEE [10] initiated a digital intelligence standard which consists of eight digital intelligence areas, namely: identity, use, safety, security, emotional intelligence, communication, literacy, and

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digital rights. This standard aims at creating a global digital intelligence framework to aid in coordinating global efforts to promote digital competence and literacy [10]. In this study, we consider digital intelligence as one's ability to effectively use digital technology knowledge and skills in digital learning environments (see Fig. 1).

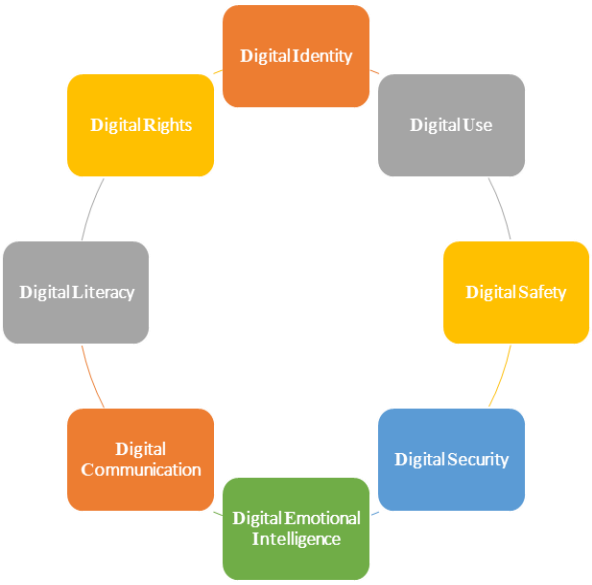

Fig. 1. The DQ framework proposed by the DQ institute [10].

B. Beliefs of Digital Intelligence

Implicit intelligence belief is an individual's underlying assumption regarding whether intelligence is a fixed attribute or a changeable one that may be developed with study and effort [11]. Fixed mindsets and growth mindsets are the acknowledged implicit theories that were originally known as entity and incremental theories [12]. According to Dweck and Leggett [13], fixed mindsets, or entity beliefs, are held by students who feel that their intellectual capacity is fixed by their degree of innate intelligence and cannot be raised by their own efforts, regardless of how much time and effort they devote to learning. Students tend to rate their own intelligence based on performance feedback, whereby they consider themselves smart when completing a learning task well, and vice versa [11, 14]. When they receive negative feedback, they tend to conclude that they are incompetent and so they may give up easily [11, 14]. On the other hand, students with incremental beliefs (growth mindsets) consider intelligence as a flexible ability that can be enhanced by effort and practicing time [13]. They focus on obtaining mastery through learning activities and feedback to gain insights into task commitments and learning strategies [11, 14]. In this study, we view students' incremental belief in digital intelligence as their belief that they can nurture their digital intelligence with effort and learning.

C. Achievement Goals

Achievement goals are one of the most common structures for motivating achievement [15]. They are perceived as a motivational purpose that drives people to engage in a particular task [15, 16]. Elliot and McGregor [17] proposed an achievement goal framework that contains four components: mastery-approach, performance-approach mastery-avoidance, and performance-avoidance goals. The mastery-approach goal connects individuals' efforts to improve at a task, while the mastery-avoidance goal is an effort to avoid losing their skills, abilities, or knowledge [17]. The performance-approach goal describes one's attempts to perform better than other peers, while the performance-avoidance goal focuses on one's efforts to try not to work worse than others [17]. These achievement goals are associated with various achievement and emotional outcomes [14].

D. Academic Behavioral Engagement

Academic engagement is a malleable meta-construct that describes students' commitment and involvement in learning activities [18]. Three common types of engagement in learning are cognitive engagement, emotional engagement, and behavioral engagement [18]. Behavioral involvement refers to students actively participating in learning activities [5], learning, and academic tasks [19]. It includes a set of students' behaviors such as effort, persistence, concentration, attention, questioning, and contribution to class discussion [19]. Ben-Eliyahu *et al*. [20] focused on the observable behaviors of students as they engaged in learning activities when studying behavioral engagement. Archambault et al. [21] suggested that students with higher behavioral engagement are more likely to participate actively in activities and meet expectations in the classroom. This study defines behavioral engagement in VNU-LMS courses as students' active participation in learning activities and efforts to complete learning tasks on LMS.

E. Students' Beliefs of Digital Intelligence (DI) and Achievement Goal Orientation

Intelligence beliefs have been found to be a significant factor that impacts achievement goals [22]. Different implicit beliefs of intelligence may foster the pursuit of different achievement goals [23]. Studies have indicated that incremental beliefs positively correlate with mastery-oriented goals but negatively impact performance-oriented goals [14, 23, 24]. While Elliot and McGregor [17] found that incremental beliefs have a negative relation with mastery-avoidance goals, Cury *et al*. [25] indicated that incremental beliefs positively influence two kinds of mastery goals. Camacho et al. [26] found that incremental beliefs were linked to increased adoption of mastery goals, while the relationship with performance-oriented goals was not significant. Obviously, more studies are needed to verify the relationships between incremental belief and different categories of achievement goal orientation.

F. Students' Achievement Goal Orientation and Behavioral Engagement

Achievement goals denote how individuals explain achievement situations, as well as how they feel and behave in them, which in turn affects the learning experiences they have [27]. Achievement goals could be explained for behaviors in achievement contexts [14]. Studies have revealed a connection between learning engagement and mastery goals [28] and performance-avoidance goals predict surface learning and task disengagement [29]. Achievement goals are the causes of individuals' engagement in achievement-oriented behaviors [30]. Mastery-approach

goals, but not performance-approach goals, are the predictors of behavioral engagement [30–32]. In addition, Mih *et al*. [33] found that behavioral engagement had a positive relationship with two kinds of approach goals while having a negative one with performance-avoidance goals. As such, previous studies have shown that achievement goal orientation influences behavioral engagement in various ways.

III. Research Model and Hypotheses

The current study employed both achievement goals theory and the implicit theory of intelligence to explore the relationship between students' incremental beliefs of Digital Intelligence (DI) and their behavioral engagement in VNU-LMS courses. Based on the theories and relevant literature, we propose the research model (see Fig. 2) with eight hypotheses as follows:

H1: There is a relationship between students' incremental beliefs of DI and their mastery-approach goals.

H2: There is a relationship between students' incremental beliefs of DI and their mastery-avoidance goals.

H3: There is a relationship between students' incremental beliefs of DI and their performance-approach goals.

H4: There is a relationship between students' incremental beliefs of DI and their performance-avoidance goals.

H5: There is a relationship between students' mastery-approach goals and behavioral engagement.

H6: There is a relationship between students' mastery-avoidance goals and behavioral engagement.

H7: There is a relationship between students' performance-approach goals and behavioral engagement.

H8: There is a relationship between students' performance-avoidance goals and behavioral engagement.

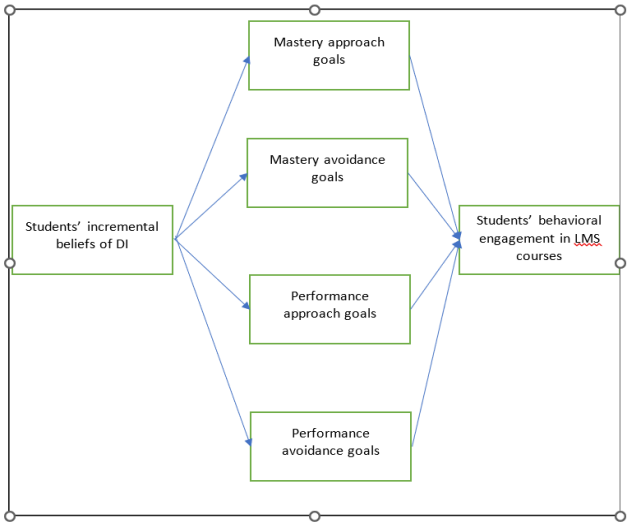

Fig. 2. Research model.

IV. Research Method

A. Participants

Participants were 176 students from VNU in Hanoi. They all enrolled in the VNU-LMS courses and were recruited through a purposive sampling strategy. The students were sent the questionnaire at the end of a VNU-LMS course. After invalid data were excluded, 168 samples were obtained, resulting in a 95.5% response rate. Regarding genders, 21 participants were male (12.5 %), and 147 were female (87.5%). There were 65 first-year students (38.7%), 98 second-year students (58.3%), and five third-year students (3%). The majority of the participants (56.3%) majored in math and natural science, followed by educational science (35.3%), literature-history-geography (6.6%), and elementary education (1.8%).

B. Survey Instrument

The study questionnaire consists of 32 items that were modified from previous studies. A 5-point Likert scale was used where one indicated strongly disagree and five strongly agree. These items were classified into six constructs as follows:

The *Incremental Beliefs of Digital Intelligence (IB)* construct has four items examining students' beliefs of changeable digital intelligence, which were modified from De Castella and Byrne's implicit theories of intelligence scales [34]. Example item statements are: "I believe I can always substantially improve on my digital intelligence" and "I believe I have the ability to change my basic digital intelligence level considerably over time."

Four following constructs were adapted from the framework of Elliot and McGregor [17].

The *Mastery-Approach Goals (MAP)* construct's five items look at students' mastery-approach goals in VNU-LMS courses. Statement examples are "I want to learn as much as possible from VNU-LMS courses" and "I desire to completely master the material presented in VNU-LMS courses."

The *Mastery-Avoidance Goals (MAV)* construct consists of five items regarding students' mastery-avoidance goals in VNU-LMS courses. "I worry that I may not learn all that I possibly could in VNU-LMS courses" and "I'm afraid that I may not understand the content of VNU-LMS courses as thoroughly as I'd like" are sample items.

The *Performance-Approach Goals (PAP)* construct includes five items about students' performance-approach goals in VNU-LMS courses. For example, "I desire to do better than other students in VNU-LMS courses" and "My goal in VNU-LMS courses is to get a better grade than most of the other students."

The *Performance-Avoidance Goals (PAV)* construct's five items explored students' performance-avoidance goals in VNU-LMS courses: "I just want to avoid doing poorly in VNU-LMS courses" and "My goal in VNU-LMS courses is to avoid performing poorly" are examples.

The *Behavioral Engagement (BE) in* VNU-LMS courses construct has eight items examining students' behavioral engagement in VNU-LMS courses. It was adapted from the student academic engagement scales of Zen and Ariani [35]. For example, "I make an effort to watch all video lectures and materials provided on VNU-LMS" and "I make every effort to finish all assigned tasks in VNU-LMS courses."

C. Data Analysis

This study utilized the PLS-SEM reflective model with two stages, which were questionnaire measurement assessment

and structural model assessment [36]. Questionnaire credibility assessment involves completing four steps to examine four evaluation criteria, containing Indicator and Internal reliability, convergent and discriminant validity [36]. Structural model assessment involves examining collinearity, significance and relevance of path coefficients, explanatory power and predictive power [36].

V. Results

A. Questionnaire Measurement Assessment

Table I presents that all Outer Loading (OL) values of the six constructs were larger than the threshold value of 0.70, which is recommended for a good instrument by Hair *et al*. [37]. Besides, all Cronbach's α values were higher than 0.80, and all CR values were above 0.80, indicating that the six constructs met the internal consistency reliability threshold value criteria [37]. In addition, all AVE values were larger than 0.59, thus meeting the threshold value requirement [37]. The results suggest that the six constructs have good convergent validity.

Construct discriminant validity is examined by a Heterotrait-Monotrait ratio (HTMT) of correlations. Table II shows that all upper boundaries of the one-sided 95% bootstrap confidence intervals are lower than the threshold value of 0.85 [37], signifying that the discriminant validity of these constructs was acceptable.

TABLE I: Reliability and Validity

Construct	*M*	*SD*	Cronbach's α	CR	AVE	OL
Incremental Belief of DI (IB)	3.85	0.839	0.923	0.946	0.813	0.869–0.926
Mastery Approach (MAP)	4.01	0.745	0.941	0.955	0.810	0.852–0.930
Mastery Avoidance (MAV)	3.75	0.794	0.929	0.947	0.781	0.865–0.922
Performance Approach (PAP)	4.03	0.799	0.927	0.945	0.775	0.847–0.910
Performance Avoidance (PAV)	3.78	0.811	0.827	0.878	0.590	0.729–0.810
Behavioral Engagement (BE)	3.74	0.724	0.932	0.943	0.676	0.763–0.862

TABLE II: The HTMT Ratio

Constructs	BE	MAV	MAP	PAV	PAP
MAV	0.526				
MAP	0.746	0.689			
PAV	0.666	0.725	0.763		
PAP	0.706	0.680	0.821	0.739	
IB	0.414	0.499	0.520	0.538	0.468

B. Structural Model Assessment

Table III reveals that the six inner Variance Inflation Factor (VIF) values are smaller than the threshold value of the suggested criteria [37], meaning that collinearity issues among the constructs do not exist. The path relationship analysis results (see Table III and Fig. 3) indicated that students' Incremental Belief in DI had a positive relation with Mastery-approach goals (β = 0.487, t = 7.404, p < 0.001), Mastery-avoidance goals (β = 0.468, t = 6.608, p < 0.001), Performance-approach goals (β = 0.438, t = 5.431, p < 0.001), and Performance-avoidance goals (β = 0.474, t = 6.927, p < 0.001). Likewise, students' Behavioral engagement in VNU-LMS courses was predicted by Mastery-approach goals (β = 0.425, t = 4.416, p < 0.001), Performance-approach goals (β = 0.261, t = 2.713, p < 0.01), and Performance-avoidance goals (β = 0.173, t = 2.184, p < 0.05). However, students' Mastery-avoidance goals were not related to their Behavioral engagement in VNU-LMS courses (β = -0.052, t = 0.738, p > 0.05).

TABLE III: Structural Model Assessment Results

Relationship	Hypothesis	VIF	Path coefficient β	*t*-value	*p*-value	f^2	Hypothesis test result
IB → MAP	H1	1.000	0.487	7.404	0.000	0.312	support
IB → MAV	H2	1.000	0.468	6.608	0.000	0.280	support
IB → PAP	H3	1.000	0.438	5.431	0.000	0.238	support
IB → PAV	H4	1.000	0.474	6.927	0.000	0.291	support
MAP → BE	H5	2.982	0.425	4.416	0.000	0.136	support
MAV →BE	H6	2.045	−0.052	0.738	0.461	0.003	fail to support
PAP → BE	H7	2.749	0.261	2.713	0.007	0.056	support
PAV → BE	H8	2.982	0.173	2.184	0.029	0.029	support

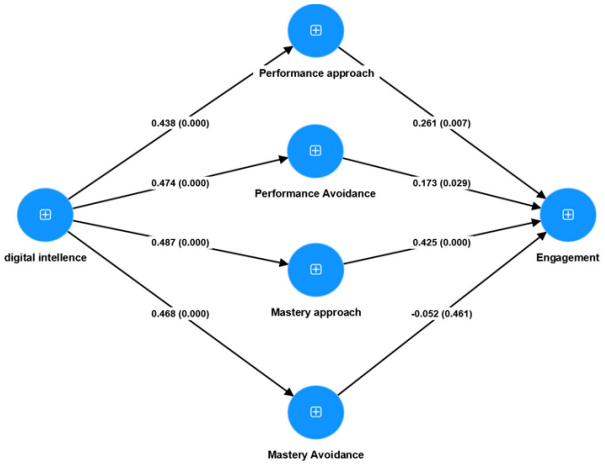

Fig. 3. Verification of the research model.

Results from explanatory power analysis indicate that the explanative power of students' Incremental Belief of DI on Mastery-approach goals was 23.8% (R^2 = 0.238), Mastery-avoidance goals was 21.9% (R^2 = 0.219), Performance-approach goals was 19.2% (R^2 = 0.192), and Performance-avoidance goals was 22.5% (R^2 = 0.225). The explanative power of Mastery-approach goals, Performance-approach goals, and Performance-avoidance goals on students' behavioral engagement in VNU-LMS courses was 55.5% (R^2 = 0.555). Those values are greater than the threshold value of 10% recommended by Falk and Miller [38]. This indicates that all variables are good predictors [37].

Regarding the effect size, Hair *et al.* [37] suggested using the f^2 values higher than 0.35, 0.15, and 0.02 to determine the

large, medium, and small effect sizes, respectively. Results in Table III shows that students' Incremental Belief of DI had a medium effect on all four kinds of approach goals, while two types of approach goals, and Performance-avoidance goals had a small effect on students' behavioral engagement in VNU-LMS courses.

VI. Discussion

The above findings supported hypotheses H1, H2, H3, and H4. In other words, students' incremental beliefs of digital intelligence were positively related to all four types of achievement goals. Students who believe they have the capacity to obtain and apply new digital technology knowledge, and they can improve their skills through effort and learning seem to be more likely to set high-performance goals, including proficiency and performance. The results are consistent with the previous studies' findings that incremental theories and mastery-oriented goals are positively correlated [14, 24, 25]. Previous studies found that incremental beliefs have a negative relation with mastery-avoidance goals [14] and have no significant influence on performance-oriented goals [26], while this study found a positive link. Similar findings were examined in Liu's [14] study, where he found that increased beliefs of intelligence of secondary students in Singapore related positively to both mastery-approach goals and mastery-avoidance goals in mathematics. Liu mentioned that such a positive link to mastery-avoidance goals could be explained by the moderating effect of low perceived ability [14].

The results also revealed that except for mastery avoidance goals, the others had a positive association with their behavioral engagement in VNU-LMS courses, which supports hypotheses H5, H7, and H8. H5 suggests that students who aspire to gain as much knowledge and skills provided by VNU-LMS as possible tend to complete all learning tasks on the system and actively discuss the learning content with teachers and classmates. H7 and H8 propose that students who desire to perform better than their peers or try not to perform worse than their counterparts in learning tasks also tend to participate actively in learning activities and strive to complete learning tasks on VNU-LMS. In contrast, in this study, students' mastery avoidance goals were not significantly related to their behavioral engagement in VNU-LMS courses, which implies that hypothesis H6 was not supported. The results are not in line with previous studies in which mastery-approach goals, but not performance-approach goals, can serve as predictors for behavioral engagement [30–32].

Such differences could be explained by the individuals simultaneously pursuing different achievement goals [14]. From the mastery goal perspective, performance approach and avoidance goals will lead to detrimental impacts, while from the multiple goal perspective, they can produce additional benefits when they are combined with mastery goals [14]. Another possible explanation for this case is cultural differences [14]. Students who tend to be anxious about losing face, afraid of shame with classmates and teachers, and worried about not meeting their parents' expectations for academic achievement might put more efforts into the learning process and be more actively engaged in learning and completing the tasks than their peers.

VII. Conclusion and Implications

This study was conducted to explore the relationship between students' incremental beliefs of digital intelligence and behavioral engagement in VNU-LMS courses with achievement goals as mediators. Implicit theory of intelligence and academic achievement goals theory were adopted to develop the research model. A structural equation model (SEM) was conducted to examine the relationship between the studied variables. The results showed that students' incremental beliefs of digital intelligence are positively linked to four types of achievement goals, particularly three kinds of achievement goals (except mastery avoidance goals) are positively linked to behavioral engagement in VNU-LMS courses.

The findings confirm that incremental belief in digital intelligence plays an important role in setting academic achievement goals and can therefore motivate students to engage in learning activities in VNU-LMS courses. Students who view that their digital intelligence can change seem to endorse achievement goals and are more likely to engage in learning on the LMS. Such expectations help students achieve better academic performance. Therefore, teachers are encouraged to foster students' incremental belief in digital intelligence and achievement goals in teaching.

Unlike most previous studies, the study findings point out that performance-based goals also make contributions to students' engagement in LMS courses when combined with mastery-oriented goals. This result can be interpreted from the multi-objective point of view or cultural differences [14]. Using Chinese students as an example, education may emphasize on encouraging students to work hard to support their high-achievement goals. In addition, educational efforts that strengthen support for mastery goals, the competitive learning environment, and the fear of losing face may lead students to maintain their high-performance goals [14]. Therefore, teachers are recommended to utilize various approaches to motivate students to appropriately combine different types of achievement goals to promote their learning engagement.

This study was limited by only using a sample from one university in Hanoi. Moreover, the influence of students' demographics on their incremental beliefs of digital intelligence and behavioral engagement was not examined. Further studies are needed to expand the sample frame to other settings that offer LMS courses and to explore the potential influence of students' demographics on their incremental beliefs of digital intelligence and behavioral engagement.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Hoang Bao Ngoc Nguyen conducted the research and

wrote the paper; Yi-Fang Lee conducted the research, reviewed and edited the paper; Thi Phuong Vy Nguyen analyzed the data; Hsin-Ling (Sonya) Hung reviewed and edited the paper; all authors had approved the final version.

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