

The role of digital informal learning in the relationship between students' digital competence and academic engagement during the COVID-19 pandemic

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Abstract

During the COVID-19 crisis, digital informal learning is important for students' academic engagement. Although scholars have highlighted the importance of students' digital competence in improving digital informal learning (DIL), the mediating role of DIL between digital competence and academic engagement has remained ambiguous. The purpose of this study is to investigate the relationship between students' digital competence and their academic engagement with the mediating role of DIL in the higher education context. This study used a descriptive correlational design, and the data were analyzed using structural equation modelling (SEM). The study sample included 308 students from Shiraz University, Iran. The results showed that digital competence positively and significantly correlated with students' DIL and their academic engagement. Furthermore, DIL, as the mediator variable, was found to mediate the relationship between students' digital competence and their academic engagement. Since higher education institutions have a key role in improving students' academic engagement, particularly in the COVID-19 pandemic, academic administrators should pay more attention to students' digital competencies and provide them with efficient and user-friendly DIL platforms that can increase their academic engagement.

KEYWORDS

academic engagement, digital competence, digital informal learning, higher education, structural equation modelling

1 | INTRODUCTION

Today, digital technologies have become more prominent in higher education than in the past (Heidari et al., 2020; Murphy, 2020). Many educational and academic institutions utilize digital technologies, which have consequently presented a host of challenges to the academic community (Toquero, 2020). Maintaining and increasing students' academic engagement is one of the challenges universities face in adapting to these digital processes (Bond, 2020; Campbell et al., 2019). Acquiring digital competence can improve students'

willingness to use technologies (Kim et al., 2018). Some studies have shown that students with higher digital competence are more successful in digital learning environments (Bergdahl et al., 2020; He & Zhu, 2017). Digital competence allows students to utilize digital technologies, such as MOOCs, social media, video streaming, and the Internet of Things, to facilitate their own learning (Perna et al., 2014; Veletsianos & Shepherdson, 2016). It can be suggested that students feel more engaged and motivated by digital environments because these environments encourage and foster autonomous learning (McGuinness & Fulton, 2019). This type of learning (i.e., autonomous

learning), although unintentional, can increase students' motivation and allow them to perform more learning activities (Lau & Gardner, 2019). Magulod Jr (2019) observed that the students' autonomy over their interests and preferences could play an important role in their academic performance and learning activities. Also, other researchers have noted that unintentional learning, which is more flexible regarding study schedule and learning style, can lead to more engagement in digital informal settings (Sackey et al., 2015). Given these conditions, it is expected that DIL would increase student engagement (Imlawi et al., 2015).

With the advent of the COVID-19 pandemic, digital technologies have received more attention in higher education compared to the past (Murphy, 2020; Toquero, 2020). Many educational and academic institutions have resorted to digital technologies, which have consequently presented a multitude of challenges to the academic community (Toquero, 2020). Universities and colleges around the world have been concerned about students' academic engagement and their abilities to use digital technologies (Villela et al., 2020). During the COVID-19 crisis, digital learning seems to be effective in increasing students' academic engagement. However, the extent to which students can benefit from these digital learning environments depends largely on students' competencies in using these environments. Therefore, this study aimed to investigate whether there was a significant relationship between DIL, students' digital competencies, and their academic engagement. Accordingly, the main research question was as follows: Does DIL play a mediating role in the relationship between students' digital competencies and their engagement in digital environments?

2 | LITERATURE REVIEW

Students' engagement in digital learning environments has received more attention since the onset of the COVID-19 pandemic (Bao, 2020; Villela et al., 2020). Academic engagement is defined as the desire to actively participate in classroom and academic activities (Skinner & Pitzer, 2012) and considered an effective predictor of the quality of students' learning experiences and outcomes (Redmond et al., 2018). One of the famous theories of engagement is Schaufeli et al.'s (2006) theory, which is the basis of the theoretical framework of this study. Schaufeli et al.'s (2006) proposed that engagement was characterized by vigour, dedication, and absorption. Vigour, they explained, refers to a high level of energy and mental resilience while studying and dogged persistence to overcome the obstacles arising during the study. Dedication refers to being immersed "in one's work and experiencing a sense of importance, passion, inspiration, pride, and challenge" (p. 702). Absorption is characterized by a full concentration on and happy engrossment in one's work.

Some scholars have stated that student academic engagement in digital learning environments can be improved by acquiring digital competence (Bergdahl et al., 2020; Kim et al., 2018). Digital competence is an essential skill for individuals, particularly students, in the 21st century because it can enhance learning and lead to greater

participation and engagement with digital environments (van Laar et al., 2017). Digital competence refers to the skill of using digital technologies effectively and the ability to critically analyze online information (Basantes-Andrade et al., 2020; Hubbard, 2019).

Several theoretical frameworks have been proposed to study digital competence in the literature (van Laar et al., 2017). The framework proposed by Calvani et al. (2009, 2012) was used in the present study. Calvani et al. (2009, 2012) believed that digital competence included three dimensions, namely technical skill (TS), cognitive skill (CS), and ethical knowledge (EK). In their framework, the technical dimension comprises visual literacy, an understanding of technological concepts, and operative knowledge to solve common technological problems. The cognitive dimension includes a set of high-order cognitive skills, meaning that the user can select, interpret, evaluate, and organize the structured data. The ethical dimension, according to their framework, addresses the ability of users to interact with others via digital media and the effects of those interactions on users' sense of online responsibility and citizenship. This framework is based on the categorization of intertwined knowledge, skills, and attitudes, as envisaged by Bloom's taxonomy of learning domains (He & Li, 2019).

The empirical research on the relationships between digital competence and academic engagement is scarce and provides little evidence to support it. Some previous studies examined the relationship between digital competence and engagement but indirectly (Kim et al., 2018). For example, Kim et al. (2018) observed that perceived digital competence and attitude did not significantly affect student engagement. However, with the mediating role of learning agility, the relationship between perceived digital competence and student engagement was found to be significant. In contrast, having focused on digital skills as one aspect of digital competence, Bergdahl et al. (2020) found that students with higher digital skill levels showed more engagement when learning through digital technologies. Also, Reisoglu and Çebi (2020) found that practice on professional engagement, as one of the development factors of digital competence training, could improve teachers' digital competence.

In addition to digital competence, other factors also affect academic engagement. Graham et al. (2017) pointed out that one of the most effective ways to increase students' academic engagement is to facilitate their access to information and communication. DIL is a process through which students can access information easily and learn anywhere and anytime through communication with others (Ang et al., 2018). In other words, DIL can be described as a kind of self-controlled, self-directed, and flexible learning, which is not typically classroom-based, is relatively unstructured (Meyers et al., 2013), and embraces the potential of digital technologies in enabling students to acquire new knowledge (Ungerer, 2016). DIL is different from traditional learning in that it is not done through formal educational institutions (Hubbard, 2019; Toffoli, 2020). He and Li (2019) noted that DIL was characterized by cognitive learning (CL), meta-cognitive learning (MCL), and social and motivation learning (SML). Based on the CL aspect, learners use digital technologies to expand their knowledge and enhance their understanding of course materials in informal learning contexts (Mayer, 1998). MCL refers to the process of planning,

organizing, and storing knowledge as well as monitoring and facilitating learning to perform cognitive tasks (Vermunt, 1996). Finally, SML refers to the attempts made by learners to interact with others, which, in turn, can facilitate their learning and motivate them to engage more in learning (He & Li, 2019).

Some researchers have stressed that DIL can contribute to students' performance, motivation, and knowledge (Jin et al., 2019; Peters & Romero, 2019). Some previous studies have indirectly pointed to the potential of informal learning in digital settings to increase students' academic engagement (e.g., Imlawi et al., 2015; McGuinness & Fulton, 2019; Sackey et al., 2015). For instance, Imlawi et al. (2015) showed that exposing students to their instructor's posts related to self-disclosure and humour had a positive effect on their academic engagement. Also, in their study focusing on the effects of blended learning, McGuinness and Fulton (2019) reported a positive relationship between students' engagement in e-tutorials and their perceptions and experience toward online learning.

As shown above, most studies in the literature have focused on the relationship between DIL and academic engagement in a specific DIL setting (Imlawi et al., 2015; Liu et al., 2017; McGuinness & Fulton, 2019) but not the effect of the DIL on students' behaviour. This highlights the need for further research into the relationship between DIL behaviour and academic engagement in higher education.

It is not enough to simply emphasize that students engage more in DIL. Rather, researchers need to determine what factors underlie students' increased engagement with DIL. As some scholars have claimed, digital competence can improve both the quality and creation of DIL (He & Li, 2019). In other words, identifying and validating informal learning relies on the competence acquired during the digital learning process (Galanis et al., 2016).

Although a few studies have examined the role of digital competence as a predictor of successful DIL (He et al., 2018; He & Zhu, 2017), most studies have focused on the relationship between digital competence and DIL in different educational contexts and levels (Garzon Artacho et al., 2020; He & Li, 2019). For example, Garzon Artacho et al. (2020) found that teachers' digital competence was an important feature of the Lifelong Learning stage in Spain. In another study, He and Li (2019) investigated the mediating role of cultural differences on the relationship between university students' digital competence, their technology expectancy, and DIL. Their results showed that digital competence with the mediating role of culture had a more significant effect on Chinese students' than Belgian students' DIL behaviour. In this regard, future studies need to examine the relationship between digital competence and DIL in other countries that have different cultures.

As mentioned before, although some empirical studies have examined the indirect effects of digital competence on DIL (e.g., He & Li, 2019), only a few of them have focused on digital competence as a predictor of successful DIL (He et al., 2018; He & Zhu, 2017). These studies have reported a positive relationship between digital competence and DIL.

Although some studies have reported that there is a meaningful relationship between students' digital competence and their academic engagement (e.g., Bergdahl et al., 2020), this issue has remained largely unexplored. It seems that some variables have a mediating role in the relationships between digital competence and academic engagement. According to Kim et al. (2018), one of these mediating variables is learning agility. However, it is not clear how other variables affect the relationships between digital competence and academic engagement. On the one hand, some studies (e.g., Garzon Artacho et al., 2020; He et al., 2018; He & Li, 2019; He & Zhu, 2017) have suggested that there is a relationship between digital competence and DIL. On the other hand, some other studies (e.g., Imlawi et al., 2015; Liu et al., 2017; McGuinness & Fulton, 2019) have shown that there is a relationship between DIL and academic engagement. The results of these studies suggest that DIL can play a mediating role in the relationships between digital competence and academic engagement.

On the basis of an extensive literature review, the following research hypotheses were proposed:

Hypothesis 1. There is a positive and significant relationship between students' digital competence and their academic engagement;

Hypothesis 2. There is a positive and significant relationship between DIL and students' academic engagement;

Hypothesis 3. There is a positive and significant relationship between students' digital competence and their DIL;

Hypothesis 4. DIL plays a mediating role in the relationships between students' digital competence and their academic engagement.

Based on the above research hypotheses, the proposed research model is depicted in Figure 1.

3 | METHODS

3.1 | Study design and sample

This study employed a descriptive and correlational design using structural equation modelling (SEM). SEM is widely used to analyze repeated measures data and determine the relationship between latent constructs (Lei & Wu, 2007). It also uses a correlation matrix to estimate the direct and indirect effects of research variables. The statistical population of this study included students of Shiraz University, which is one of the largest comprehensive universities in Iran. This study used a stratified sampling design, with the field of study and degree level as marker variables. In this study, the Morgan table was used to estimate the sample size. It is an efficient method for determining the sample size because it allows researchers to determine a sufficiently large sample size that represents the target population,

FIGURE 1 Proposed model of the relationship between digital competence, digital informal learning and academic engagement

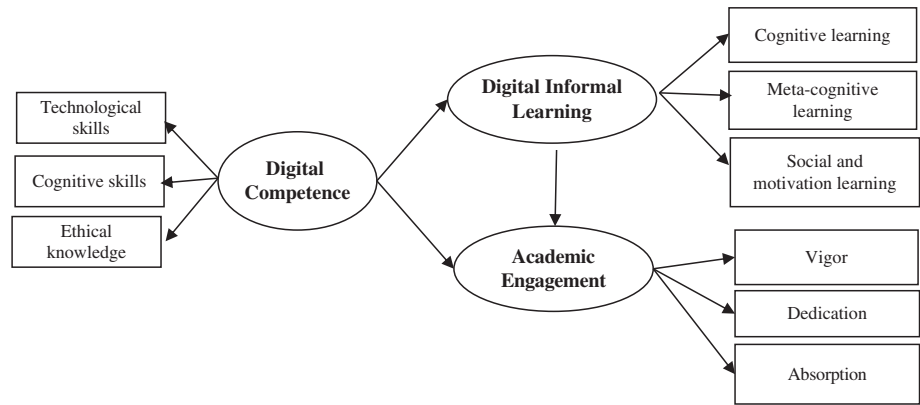


TABLE 1 Characteristics of the sample

		Perc.
Gender	Male	52.6
	Female	47.4
Level of degree	Undergraduate	61.4
	Master	24.7
	Ph.D	14
Fields of study	Social sciences and humanities	52.6
	Engineering	17.9
	Basic sciences	14

thus improving the reliability of the results and increasing the generalizability of the findings (Krejcie & Morgan, 1970). Therefore, 341 students were selected from the statistical population ($N = 3100$) as the study sample that was representative of the university. The questionnaires were sent to students and a total of 308 questionnaires were returned (a 90% response rate). All participants were fully aware of the nature of the study and were reassured of the confidentiality of their information. The demographic information of the study sample is shown in Table 1.

3.2 | Measures

3.2.1 | Digital competence

The questionnaire developed by He and Zhu (2017) was used to measure students' digital competence. Because this instrument included three dimensions (i.e., TS, CS and EK), which measured the particular types of skills and knowledge required for using digital technologies (He & Zhu, 2017). The TS, CS and EK dimensions had 11, 12 and 7 items, respectively. Each item had to be scored on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). The reliability of the instrument was Cronbach's $\alpha = 0.85$; in addition, the reliability of the TS, CS, and EK dimensions' was reported to be 0.81, 0.82 and 0.84, respectively (He & Zhu, 2017). Also, in the present study, the reliability of the instrument for the TS, CS and EK dimensions was measured

using Cronbach's alpha and their reliability was estimated to be 0.91, 0.86 and 0.81, respectively. The acceptable value of Cronbach's alpha typically ranges from 0.7 to 0.95; however, values above 0.6 have also been considered acceptable (Taber, 2018). In the present study, the validity of this instrument was examined using confirmatory factor analysis.

3.2.2 | Digital informal learning

The questionnaire designed by He and Li (2019) was used to measure students' DIL. Because measured the students informal learning behaviours in their daily life while using digital technology (He & Li, 2019). This instrument included three dimensions (i.e., CL, SML and MCL). The CL dimension contained four items, as did the SML and MCL dimensions. The reliability of the instrument was greater than 0.70. The Cronbach's alphas for the CL, SML and MCL dimensions were reported to be 0.79, 0.83 and 0.80, respectively, in Belgium (He & Li, 2019). The alpha coefficient for each of the above three dimensions in this study was 0.81, 0.82 and 0.83, respectively. The validity of this instrument was examined using confirmatory factor analysis.

3.2.3 | Academic engagement

Students' academic engagement was assessed using a shortened student version of the Utrecht work engagement scale, which measures engagement as a persistent and pervasive affective-cognitive state with as few items as possible (Schaufeli et al., 2006). This scale had three dimensions (i.e., vigour, dedication and absorption). The vigour and absorption dimensions included six items while the dedication dimension consisted of five items. Schaufeli et al. (2006) noted that the validity of this instrument was confirmed in 10 countries. In addition, they reported the reliability of the vigour, dedication, and absorption dimension as 0.77, 0.85 and 0.78, respectively, and the overall scale as 0.92. In this study, Cronbach's alpha was used to measure the reliability of the overall scale and its three dimensions. The alpha coefficients obtained were 0.92 for the overall scale, and 0.87,

0.82 and 0.80 for the vigour, dedication, and absorption dimensions, respectively. Similar to the other two instruments, the validity of this instrument was examined using confirmatory factor analysis.

3.3 | Procedures

The main objective of this study was to examine the relationship between students' digital competence and their academic engagement with the mediating role of DIL. To this end, three main questionnaires were translated from English into Persian. Then, the translated questionnaires were approved by several translators and experts. Afterward, the final versions of the questionnaires were sent to different groups in the sample. All sample students participated voluntarily in the study and received no incentive for participation. Student participants were asked to answer and return the questionnaires within a week. Later, a reminder mail was sent to all participants to increase the response rate to the questionnaires. After the questionnaires were collected, the non-responding participants were checked to see whether they were equally distributed among different fields of the study and degree levels as to avoid sampling bias. Finally, the data were analyzed using SEM to determine the relationship between the research variables. It should be noted that the data for this article is part of a larger data set—a part of it was used in this paper, and the other part was used in another paper by Mehrvarz et al. (2021). [Corrections made on 23 June 2021, after first online publication: The preceding statement and reference details for Mehrvarz et al. (2021) have been added in this version.]

3.4 | Data analyses

SPSS was used for descriptive analyses, and AMOS was used to perform SEM and assess the model fit. Moreover, the maximum likelihood method to estimate the parameters of the model, and all analyses were conducted on variance–covariance matrices (Hair et al., 1998). It should be added that model fit was assessed using several fit indices, including chi-square statistic (χ^2), the χ^2/df ratio, the incremental fit index (IFI), and the comparative fit index (CFI) (Hooper et al., 2008). In this study, the root mean square error of approximation (RMSEA) was also used to assess model fit (Browne & Cudeck, 1989). The acceptable ratio for χ^2/df was considered to be less than 3; in addition, values greater than 0.90 for IFI and CFI and values less than 0.10 for SRMR and RMSEA were considered to be acceptable (Hooper et al., 2008).

4 | RESULTS

Table 2 shows the scale means, standard deviations, skewness, kurtosis, Cronbach's alpha, and correlations between all the research variables. The means ranged from 3.32 to 3.77, and the standard deviations ranged from 0.59 to 0.74. Skewness and kurtosis were used to check the normality of the variables. All variables satisfied skewness <2 and kurtosis <7 as a multivariate normal distribution (Hu & Bentler, 1999).

As a result, the model was considered to be suitable for SEM analysis. The results of the correlation analysis showed that there was a significant relationship between all dimensions of the research variables, namely, digital competence, DIL, and academic engagement.

4.1 | Measurement model

In order to validate the measurement model, confirmatory factor analysis was performed according to the proposed model. Construct reliability and convergent validity were used to evaluate the measurement model. More information on construct reliability and convergent validity can be found in Appendix A. Construct reliability was assessed using composite reliability (CR). Both CR values, which ranged from 0.70 to 0.82, and Cronbach's alpha coefficients, which were higher than 0.81, were above the threshold value of 0.70 (Fornell & Larcker, 1981). The convergent validity of the measurement model was assessed using average variance extracted (AVE) and confirmatory factor analysis. Although the AVE for each of the three study constructs (i.e., digital competence, DIL, and academic engagement) was above the acceptable level of 0.5 (Hair et al., 1998), the AVE for the dimensions of these constructs, except MCL, was below the acceptable level. According to Fornell and Larcker (1981), the convergent validity of a construct can still be considered adequate even if AVE is less than 0.5, but CR is higher than 0.6. Since the CR of these dimensions was above the acceptable level, their lower-than-acceptable AVE can be ignored. In order to measure the confirmatory factor analysis, the factor loadings equal to or greater than 0.30 were considered to be adequate (Osborne et al., 2014). Based on this criterion, two questions from the TS dimension, one question from the CS dimension, and two questions from the EK dimension were removed due to low factor loadings. The results showed that the factor loadings of each item on latent variables (called factors) were significant, as indicated by the following values. In the digital competence variable, the factor loading for the TS dimension ranged from 0.43 to 0.69, for the CS dimension from 0.35 to 0.70, and for the EK dimension from 0.56 to 0.68. In the DIL variable, the factor loading for the CL dimension ranged from 0.43 to 0.76, for the MCL dimension from 0.64 to 0.82, and for the SML dimension from 0.47 to 0.76. Finally, in the academic engagement variable, the factor loading for the vigour dimension ranged from 0.46 to 0.68, for the dedication dimension from 0.55 to 0.76, and for the absorption dimension from 0.55 to 0.70 (see Appendix A).

As regards the discriminant validity, the square roots of the AVE were greater than the correlation between each construct and all other constructs, indicating good discriminant validity (see Table 3). The model fit index was acceptable ($\chi^2 = 2083.21$, $\text{df} = 1300$, $p < 0.0001$; $\chi^2/\text{df} = 1.60$; IFI = 0.90; CFI = 0.90; RMSEA = 0.04; SRMR = 0.06).

4.2 | Structural model

SEM was used to examine the research hypotheses. The results of the analysis showed that the structural model of the study had a good fit

TABLE 2 Means, standard deviations, correlations and reliabilities

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	Skewness	Kurtosis
1. DC	3.46	0.59	(0.80)												0.18	0.28
2. TS	3.44	0.72	0.84**	(0.91)											-0.22	0.60
3. CS	3.71	0.72	0.88**	0.71**	(0.86)										-0.33	-0.10
4. EK	3.41	0.69	0.58**	0.40**	0.45**	(0.81)									-0.63	1.68
5. DIL	3.71	0.59	0.40**	0.28**	0.41**	0.35**	(0.91)								-0.35	1.42
6. CL	3.69	0.65	0.35**	0.25**	0.37**	0.31**	0.82**	(0.81)							-0.59	1.5
7. MCL	3.77	0.67	0.37**	0.26**	0.37**	0.31**	0.87**	0.60**	(0.83)						-0.52	1.09
8. SML	3.67	0.73	0.31**	0.22**	0.31**	0.27**	0.86**	0.54**	0.65**	(0.82)					-0.48	0.65
9. AE	3.47	0.60	0.36**	0.23**	0.39**	0.32**	0.46**	0.44**	0.41**	0.35**	(0.92)				-0.36	0.60
1. Vigour	3.32	0.68	0.27**	0.15**	0.31**	0.21**	0.39**	0.40**	0.33**	0.26**	0.86**	(0.80)			-0.26	-0.05
11. Dedication	3.58	0.74	0.39**	0.27**	0.37**	0.33**	0.42**	0.42**	0.36**	0.32**	0.83**	0.62**	(0.82)		-0.42	0.07
12. Absorption	3.53	0.70	0.27**	0.17**	0.33**	0.28**	0.37**	0.30**	0.35**	0.31**	0.84**	0.58**	0.55**	(0.87)	-0.41	0.49

Note: The numbers in parentheses on the diagonal are coefficient alphas; $N = 319$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Abbreviations: AE, Academic engagement; DC, Digital competence; CL, Cognitive learning; CS, Cognitive skills; DIL, Digital informal learning; EK, Ethical knowledge; MCL, Meta-cognitive learning; SML, Social and motivation learning; TS, Technological skills.

TABLE 3 Discriminant validity

Variables	1	2	3
1. Digital Informal Learning	0.77		
2. Academic Engagement	0.57	0.76	
3. Digital Competence	0.48	0.46	0.75

to the data (CMIN: 54.39; df: 24; CMIN/df: 2.26; IFI: 0.97; CFI: 0.97; NFI: 0.95; RMSEA: 0.064; SRMR = 0.054). Figure 2 shows that there was a positive and significant relationship between students' digital competencies and their academic engagement ($\beta = 0.25$, $p = 0.0001$). Therefore, the first research hypothesis (H1) was accepted. Also, the results indicated a positive and significant relationship between DIL and students' academic engagement ($\beta = 0.45$, $p = 0.0001$), supporting the second research hypothesis (H2). Furthermore, digital competence had a positive and significant relationship with DIL ($\beta = 0.49$, $p = 0.0001$). In other words, students with more developed digital competencies seemed to be more successful in DIL. Thus, the null hypothesis was rejected, and our alternative third research hypothesis (H3) was accepted. Given that the results supported the research hypotheses, the proposed research model could be approved as the final model. The results of the research hypothesis testing and the direct and indirect effects of study variables are shown in Table 4.

4.3 | Mediation analyses

The bootstrap method with 5000 resamples was used to investigate the mediating and indirect effect of DIL on the relationship between students' digital competence and academic engagement. The bootstrap method was chosen as the preferred approach because it is particularly appropriate for conducting mediation analysis in large samples (Zhao et al., 2010). The results showed that students' level of digital competence had a direct effect on their academic engagement ($\beta = 0.0001$, $p = 0.25$). The indirect effect of DIL on the relationship between students' digital competence and their academic engagement was also supported by the results ($\beta = 0.22$, $p = 0.0001$). The 95% confidence interval ranged between 0.14 and 0.29. Thus, the fourth research hypothesis (H4) was also accepted.

5 | DISCUSSION

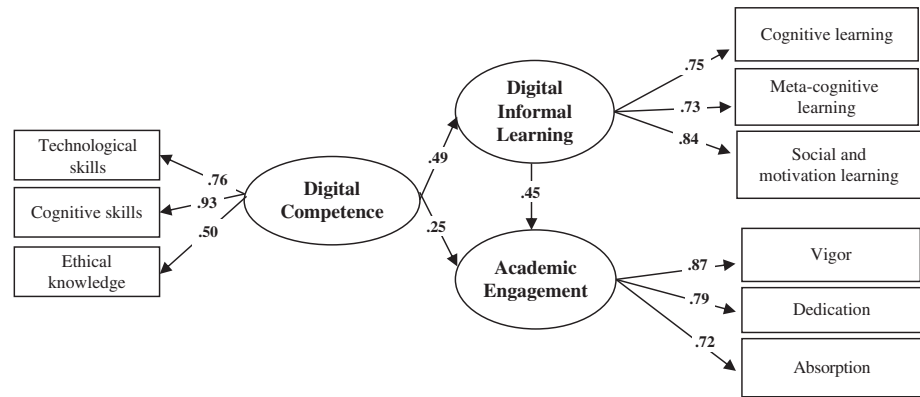
The emergence of COVID-19 has led many higher education institutions to hold their classes online, resulting in a host of serious challenges that need to be addressed properly (Toquero, 2020). In this regard, knowing how to keep students engaged in online environments and how to improve their digital competencies are of prime importance in higher education. DIL, along with formal learning, can play a crucial role in higher education. Accordingly, this study aimed to determine the relationship between students' digital competencies

and their academic engagement by considering the mediating role of DIL.

The results of this study supported the first hypothesis; that is, there is a positive and significant relationship between students' digital competence and their academic engagement. Some studies indirectly support this hypothesis. For example, Reisoğlu and Çebi (2020) argued that any comprehensive digital competence training should provide teachers with knowledge and practice on professional engagement, digital resources, teaching, and learning. Moreover, Bergdahl et al. (2020) found that there was a significant correlation between students' digital skills and their engagement in technology-based learning. Student academic engagement has become one of the major concerns of universities and higher education institutions around the world (Groves et al., 2015). Without academic engagement, students will have difficulty keeping themselves emotionally, cognitively, and physically engaged in their learning, and their enthusiasm for learning will gradually decrease (Bergdahl et al., 2020; Groves et al., 2015).

The second research hypothesis was also supported by the results, showing that there was a significant relationship between DIL and academic engagement. This finding is in line with the results of many previous studies (e.g., Kuo & Chuang, 2016; Lee & Dressman, 2018; McGuinness & Fulton, 2019; Trinder, 2017), of which some directly explored the relationship between DIL and students' academic engagement. For example, Kuo and Chuang (2016), in their studies on 73 teachers and students, concluded that gamification, as a digital tool, could create academic knowledge, products, and activities and increase student engagement. However, most of these studies focused on a specific platform (e.g., Imlawi et al., 2015; McGuinness & Fulton, 2019) and not on the overall process of DIL. For instance, Imlawi et al. (2015) showed that the time students spent using social networks and observing their instructors' behaviour and attitudes positively affected their academic engagement. It can be suggested that DIL sustains students' motivation in learning, engages them in constructive activities, and helps them complete their course successfully. Huang and Oh (2016) found that informal learning environments could actively engage undergraduate students because they allowed students to develop their own learning strategies, monitor their learning progress, and expand their learning opportunities. Thus, it can be argued that both formal learning and DIL can enhance students' academic engagement (Peters & Romero, 2019; Petrovic, 2018; Sackey et al., 2015; Toffoli, 2020).

In accordance with the third hypothesis of this study, the results revealed that there was a significant relationship between digital competence and DIL. That is to say, students' rate of success in DIL was associated with how efficiently they could use digital technologies. Some studies conducted in different cultural contexts also support this hypothesis. For example, in their studies on students from Chinese universities, He and Zhu (2017) and He et al. (2018) found that students' digital competence and compatibility were related to their DIL. Also, He and Li (2019) examined the mediating effect of cultural differences on Chinese and Belgian university students' digital competence, technology expectancy, and DIL. Their results showed that

FIGURE 2 Structural model analysis**TABLE 4** Structural equation modelling: hypotheses testing

Hypotheses	Relationships	Estimate	Conclusion
H1	Digital Competence → Digital Informal Learning	0.49	Supported
H2	Digital Informal Learning → Academic Engagement	0.45	Supported
H3	Digital Competence → Academic Engagement	0.25	Supported
H4	Digital Competence → Digital Informal Learning → Academic Engagement	0.22	Supported

digital competence had a stronger effect on Chinese students' than Belgian students' technology expectancy and DIL behaviour.

With the ubiquitous presence of technology in our lives, more attention needs to be paid to DIL (Ang et al., 2018) and digital competence (Kim et al., 2018). By developing their digital competencies, students can improve their digital literacy and critical thinking in dealing with the digital world (Bergdahl et al., 2020). Students with high levels of digital competence can find and organize the most suitable digital tools and avail themselves of them during the process of DIL (He & Li, 2019). Furthermore, informal learning opportunities can scaffold students' learning and facilitate their career decision-making processes. In this regard, it is imperative to equip students with the necessary digital skills. To achieve this objective, students should be explicitly taught these digital skills (He & Li, 2019). Therefore, higher education institutions, particularly those in which DIL is the dominant form of learning, should consider training and updating teachers' knowledge in the area of digital technologies so that they will be able to develop digital skills and competencies in their students (Basantes-Andrade et al., 2020).

In general, the results of this study showed that while digital competence could, directly and indirectly, affect students' academic engagement, DIL could also directly affect their engagement. In other words, the results showed that students' academic engagement was associated directly and indirectly with their digital competencies and directly with their DIL.

This study contributes to research on online and informal learning, especially online learning during the COVID-19. More specifically, this is the first study that gathers evidence on the structural relationship between digital competence, DIL, and academic engagement, to provide a framework for future research in this context. The results also indicate that the theory proposed by Calvani et al. (2009, 2012)

can effectively explain students' academic engagement in online learning environments. Furthermore, the mediating role of DIL highlighted by the results of this study shows that in order to increase students' academic engagement in online learning, their digital competencies should be improved. Improvement of students' digital competencies would lead to more effective, efficient, and appealing use of the digital spaces' affordances for a better learning.

6 | LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The first limitation of this study was that it focused on only one university in Iran. Consequently, the result cannot be generalized to other universities inside and outside Iran. Accordingly, it is suggested that future studies focus on more universities, both national and foreign universities, to allow greater generalizability of the findings. The second limitation of the present study was the use of self-report measurement to judge students' performance. Future studies should measure students' actual academic performance rather than asking them to comment on their own performance. Lack of attention to gender differences among students was the third limitation of this study. This is an important issue because the data from the International Computer and Information Literacy Study (ICILS) in 2018 showed that there was a significant association between students' computer and information literacy (CIL) scores and computational thinking (CT) scores, on the one hand, and their personal and social characteristics, such as gender, on the other hand (Fraillon et al., 2020). The fourth limitation of the current study was its methodology, that is, using SEM to examine the complex relationship between research variables without

any intervention. Thus, future studies need to consider intervention when examining the effects of these variables on each other. The fifth limitation of this study was that the relationship between digital competence and academic engagement was explored only in a DIL context. Future researchers, therefore, are encouraged to examine the relationships between these two variables in both DIL and formal learning contexts. Finally, as He and Li (2019) noted, the effects of students' digital competence on their DIL may vary in different cultures; therefore, the relationship between these two variables should be examined in different cultures in future studies.

7 | CONCLUSIONS

Although some conceptual and methodological shortcomings, as discussed in the previous section, this study showed that DIL, together with formal learning, could play a mediating role in the relationship between students' digital competencies and their academic engagement in the current climate of education, which is plagued by the COVID-19 pandemic. The results also indicated that students' digital competence could, directly and indirectly, affect their academic engagement. Therefore, if higher education institutions are to play a key role in improving their students' academic engagement, particularly in the face of the current crisis caused by the COVID-19 pandemic, they should pay more attention to students' digital competencies and provide them with efficient and user-friendly DIL platforms that can increase their academic engagement.

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CONFLICT OF INTEREST

There are no conflicts of interest. All co-authors had complete access to data supporting the manuscript.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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APPENDIX A. CONFIRMATORY FACTOR ANALYSIS, CRONBACH'S ALPHA, CR

Factors	Factor loading	Cronbach's alpha	CR	AVE
Digital competence		0.80	0.78	0.56
TS		0.91	0.82	0.35
1. I can use some software programs to deal with data visualization	-			
2. I can use a certain software program to edit pictures	0.57			
3. I can use a certain software program to make video	0.57			
4. I can use a variety of programs to deal with Antivirus problem for computer	0.67			
5. I can deal with computer system problems	0.66			
6. I can deal with software problems by searching online	0.69			
7. I can use at least one operating system skillfully (e.g., Windows, OSX, Android, IOS, etc.)	0.69			
8. I am able to operate at least a personal computer-related hardware (desktop, laptop, tablet device or smartphone device)	.57			
9. I am able to use social media well	0.45			
10. I am able to use some photo and video sharing tool well	-			
11. I am able to use a variety of APPs	0.43			
CS		0.86	0.82	0.31
12. I can represent a text with a graph by digital tools	0.70			
13. I can represent hierarchical classes with digital tools	0.69			
14. I can identify the keywords well in a digital text very well	0.69			
15. I can organize data in a table by a variety of digital tools	0.69			
16. I can find missing values in a table of digital context	0.40			
17. I can use digital technologies to design my plan or schedule	0.52			

Factors	Factor loading	Cronbach's alpha	CR	AVE
18. I am quite confident at searching for information online what I need	-			
19. I am quite confident at searching for information on a certain database	0.47			
20. I have a strong awareness of the credibility of information when search online	0.47			
21. I have a strong awareness of the reliability of information when search online	0.58			
22. I often consider the reliability of information online when I quote or share it	0.44			
23. I often consider the credibility of information online when I quote or share it	0.35			
EK		0.81	0.70	0.36
24. When I surf online, I have awareness of Privacy (personal information, personal Photos, etc.)	0.57			
25. When I deal with online payment, I am always aware of the safety issue	0.60			
26. When I see online content that makes me feel uncomfortable, unsafe or worried, I will leave it or take an action	-			
27. I often post pictures with my friends on the internet without their permission (reverse)	-			
28. I have an awareness of online bullying and behave myself decent online	0.68			
29. I have the awareness to comment or communicate with others online in a rational way	0.56			
Digital Informal Learning		0.91	0.81	0.60
CL		0.81	0.72	0.41
1. I often use digital technologies to enhance my understanding of school course materials in informal learning contexts	0.59			

Factors	Factor loading	Cronbach's alpha	CR	AVE
2. I often use digital technologies to expand knowledge of the discipline	0.72	0.83	0.81	0.52
3. I often use digital technologies to keep informed of the development in the discipline	0.76			
4. I often use digital technologies to engage in self-expression	0.43			
MCL				
5. I often use digital technologies to seek learning strategies and tips	0.64	0.82	0.74	0.42
6. I often use digital technologies to help myself to monitor learning progress	0.76			
7. I often use digital technologies to expand learning opportunities	0.82			
8. I often use digital technologies to seek engaging learning experiences	0.64			
SML				
9. I often use digital technologies to sustain motivation in learning	0.76	0.92	0.81	0.58
10. I often use digital technologies to elicit support and help	0.72			
11. I often use digital technologies to engage in constructive activities	0.60			
12. I often use digital technologies to collaborate with people for learning	0.47			
Academic Engagement				
Vigor		0.80	0.74	0.33
1. At my college, I feel bursting with energy	0.68			

Factors	Factor loading	Cronbach's alpha	CR	AVE
2. In my field of study, I feel strong and vigorous	0.63	0.82	0.80	0.44
3. When I get up in the morning, I feel like going to college	0.46			
4. I can continue doing activity for very long periods at a time	0.63			
5. At my college, I am very resilient, mentally	0.49			
6. At my college, I always persevere, even when things do not go well	0.53	0.87	0.78	0.42
Dedication				
7. I find the field of study that I do full of meaning and purpose	0.64			
8. I am enthusiastic about my field of study	0.62			
9. My field of study inspires me	0.55			
10. I am proud of the activity that I do	0.76	0.57		
11. To me, my field of study is challenging	0.65			
Absorption				
12. Time flies when I am doing activity	0.63			
13. When I am doing activity, I forget everything else around me	0.62			
14. I feel happy when I am studying and searching intensely	0.55			
15. I am immersed in my field of study	0.70	0.64		
16. I get carried away when I am doing activity	0.64			
17. It is difficult to detach myself from my college	0.57	0.57		

Technical Skill (TS), Cognitive Skill (CS), Ethical Knowledge (EK), Cognitive Learning (CL), Meta-Cognitive Learning (MCL), Social and Motivation Learning (SML)