CONSTRUCTING A STUDENT ENGAGEMENT AND LEARNING DEVELOPMENT MODEL IN MOBILE LEARNING BY SEM

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ABSTRACT

This study aimed to build a model to detect the factors to enhance student engagement and learning development in mobile learning during the COVID-19 Pandemic. Data from a total of 400 junior-high-school students were collected in China in the fall semester of 2020, and a large proportion of students preferred accessing their study with cellphones (67.0%) than with computers (11.8%), laptops (11.3%) or pads (10.0%). Exploratory factor analysis and structural equation modeling (SEM) were used for data analysis. The fitness of the items for each scale of the student engagement and learning development indicated a sufficient fit ($\chi^2_{(19)}$ = 41.252, GIF = 0.974, AGFI = 0.951, CFI = 0.986, RMSEA = 0.054, NNFI = 0.979, IFI = 0.986). The results of SEM analysis show that emotional engagement is the most important factor (r^2 = 0.859) in the model, and student engagement has a significant positive impact on learning development in mobile learning. The findings of this study provide a good reference for enhancing student engagement or fostering students' learning development in mobile learning.

KEYWORDS

Mobile Learning, Student Engagement, Learning Development, Junior High School, COVID-19 Pandemic, Structural Equation Modeling (SEM)

1. INTRODUCTION

COVID-19 has resulted in schools being shut all across the world since 2020. While countries are at different points in their COVID-19 infection rates, worldwide there are currently more than 1.2 billion children in 186 countries affected by school closures due to the pandemic (UNESCO, 2021). Due to school closures and learning loss across the world, the use of technology in online education has exploded all over the world. In response to significant demand during the COVID-19 pandemic, many mobile learning platforms are offering free access to their services, including platforms such as Alibaba's distance learning solution, DingTalk, Cloud Class, etc. With this sudden shift away from the classroom in many parts of the globe, whether the adoption of mobile learning will continue to persist post-pandemic, and how such a shift would impact worldwide education will be an imperative issue in education research.

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2. LITERATURE REVIEW

2.1 Student Engagement in Mobile Learning

For most students, engagement can positively predict students' academic achievement and provide an excellent theoretical framework for predicting learning performance. Previous studies defined student engagement as a relevant and multidimensional conception with good construction that reflects the level of academic motivation (Skinner & Belmont, 1993), a concept that requires psychological connections within the academic environment (Chapman, 2003; Furlong et al., 2003; Kuh, 2001), or the concept classified into behavioral, emotional, and cognitive dimensions (Fredericks, Blumenfeld, & Paris, 2004; Jimerson, Campos, & Greif, 2003).

Behavioral engagement indicates to what extent learners engage in learning based on their behavior in learning activities which show positive associations with course achievement and completion (Kahan et al., 2017). Emotional engagement refers to learners' perceptions of their learning in mobile learning, such as their course satisfaction, perceptions of learning experiences, and benefits (Post et al., 2019). Cognitive engagement refers to a knowledge test, of which quizzes, assignments, tests, examinations, surveys, self-assessments, discussion forums, exercises, essays, labs, and writing projects were employed to assess the intellectual skills that learners acquired in mobile learning (Chiu & Hew, 2018; Krasny et al., 2018).

2.2 Learning Development

It is encouraged to cultivate students' core competences (2009) and to promote the high-level competences in educational settings. The high-level competences are classified into five dimensions as collaboration (Chuang et al., 2012; Huang et al., 2012), communication (Lan et al., 2012), complex problem solving (Hung et al., 2012a; Hwang et al., 2014), critical thinking (Hung et al., 2012b; Kuo et al., 2012), and creativity (Wu et al., 2013). Several studies have further signified the positive impacts of incorporating mobile technologies into school curriculums on students' higher-order thinking performances, such as their problem-solving, critical thinking and creativity (Kim et al. 2015; Kong and Song 2014). According to Hwang's study, students' engagement in communication and collaboration are important mediators between their technology preferences and higher-order thinking tendency (e.g., problem-solving, critical thinking, and creativity)(Hwang, et al., 2018). The performance of these competences could be regarded as a reference for measuring high-level learning development.

2.3 Mobile Learning

Mobile learning refers to a learning context in which learners utilize their individual portable devices to access a mobile network to conduct their learning, whether in or out of the classroom (Song, 2014).With the rapid advancement and popularity of mobile technology, researchers have further indicated using mobile technology to support learning could be an effective learning mode for facilitating student-centered learning (Chang, et al., 2011). This study addresses students studying remotely, specifically handheld devices. The connection between engagement and mobile devices is confirmed by 88.2% of the sample in this study.

3. METHODOLOGY

A students' self-reporting opinion survey collected in the fall semester of 2020 regarding student engagement and high-level competences development in mobile learning was developed as a quantitative measure. The data analysis in this study has been shown to be a flexible and powerful means of examining the relationships among constructs. This study developed nine hypotheses regarding junior-high-school students' engagement and learning development in mobile learning. The Theoretical framework is as shown in Figure 1.

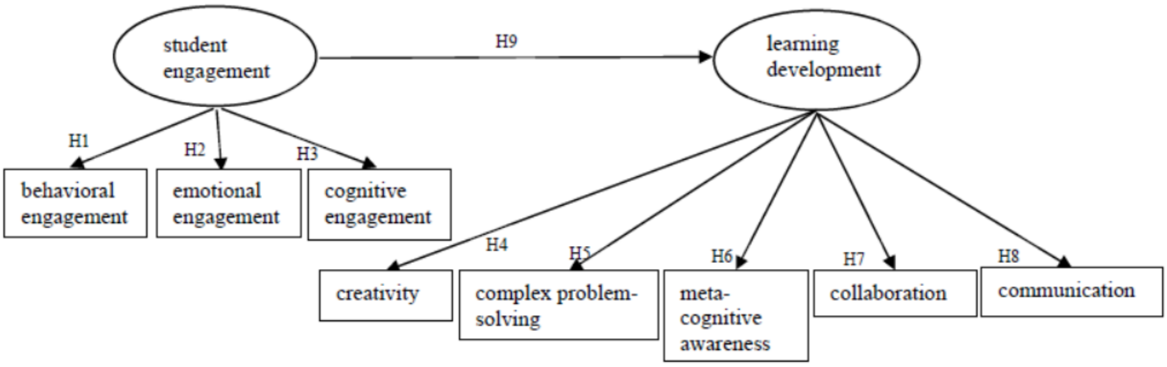


Figure 1. Theoretical framework of student engagement and learning development

3.1 Participants

The survey sample was a non-probability sample of convenience, consisting of eight junior high schools in Nanning City, Guangxi, China. The ranking of the schools was around the average. A total of 400 junior high school students (14.0 years old on average), including 193 males (48.3%) and 207 females (51.8%), 142 (35.5%) 1st grade, 131 (32.8%) 2nd grade, and 127 (31.8%) 3rd grade, were surveyed. The responses of the learning equipment used in mobile learning indicated that a large proportion of students preferred accessing with cellphones (67.0%) than with computers (11.8%), laptops (11.3%) or pads (10.0%). The return rate was approximately 83%. Ethical approval clearance and informed consent clearance were granted due to the use of anonymous questionnaires.

3.2 Instruments

To achieve the research objectives, a survey consisting of two dimensions, learning engagement and high-level competences, was adopted to measure the students' perceptions. All of the items in the questionnaire were presented using a 5-point Likert scale, ranging from 1 - *strongly disagree* to 5 - *strongly agree*.

The aspect of student engagement consisted of three scales: behavioral engagement (BE), emotional engagement (EE), and cognitive engagement (CE), with seven, seven, and six items, respectively. Behavioral engagement included basic behaviors such as participation, motivation, and support from teachers. Emotional engagement refers to the students' attitudes towards mobile learning. Cognitive engagement values the learning outcomes that assess multidimensional students' perceptions of mobile learning.

In addition, the learning development measure was developed by Lai and Hwang (2014), which was modified from the surveys cited as follows: (1) Creativity represents the creative tendencies of the students; creativity (CRE) was modified from the Creativity Assessment Packet (Lin & Wang, 1994). (2) Complex problem solving represents the students' ability when they are solving problems; complex problem solving (CPS) was modified from the problem-solving questionnaire by Pan (2001). (3) Meta-cognitive awareness is for assessing the students' metacognition when they are learning; meta-cognitive awareness (MCA) was developed based on metacognitive awareness (Schraw & Dennison, 1994). (4) Collaboration represents the students' experience of collaborating with others; collaboration (COL) was modified from the knowledge integration capability survey developed by Jeng and Tang (2004). (5) Communication represents the interactions when students communicate with others. Communication (COM) was revised from the Communicative Adaptability Scale (Duran, 1992).

3.3 Data Analysis

With the statistical software of SPSS and AMOS, the exploratory factor analysis and confirmative factor analysis were utilized to identify the structure of each survey. Variable difference was examined by exploratory factor analysis and SEM. The Structural Equation Modeling (SEM) was implemented to determine the relationship of each source of student engagement on learning development. The results determined the magnitude and consistency of any relations.

ISBN: 978-989-8704-47-4 © 2023

4. RESULTS

4.1 Exploratory Factor Analysis of Student Engagement and Learning Development

To validate the questionnaire of student engagement and learning development, exploratory factor analysis (EFA) with varimax rotation was performed to clarify the structure. According to the results of EFA of student engagement, the participants' responses were grouped into three factors: behavioral engagement (BE), emotional engagement (EE), and cognitive engagement (CE). Hair et al. (2006) noted that an item is remarkable if its factor loading is greater than 0.50. The factor loadings of all the items in the measure range from 0.654 to 0.836, thus meeting the threshold (0.50), and demonstrating convergent validity at the item level. The Cronbach's alpha coefficients for the factors were .87, .89 and .87, with 56.09%, 61.27%, 60.31% of variance explained, respectively, the overall alpha was .94, and the total variance explained was 60.46%. The KMO value was 0.939, and the Bartlett χ^2-value was 4474.127 (p<0.000), as shown in Table 1, suggesting that these factors have highly acceptable reliability for assessing student engagement.

Table 1. Rotated factor loadings, Cronbach's alpha values, item means, and standard deviations for the three factors of student engagement

Items	Factor 1	Factor 2	Factor 3
Factor 1: behavioral engagement (BE), α = .87, mean = 3.47, *SD* = 0.72			
BE_1	0.755		
BE_2	0.777		
BE_3	0.749		
BE_4	0.654		
BE_5	0.762		
BE_6	0.799		
BE_7	0.737		
Factor 2: emotional engagement (EE), α = .89, mean = 4.37, *SD* = 0.71			
EE_1		0.815	
EE_2		0.836	
EE_3		0.806	
EE_4		0.818	
EE_5		0.740	
EE_6		0.736	
EE_7		0.720	
Factor 3: cognitive engagement (CE), α = .87, mean = 3.69, *SD* = 0.71			
CE_1			0.826
CE_2			0.805
CE_3			0.785
CE_4			0.743
CE_5			0.734
CE_6			0.762
% of variance	56.09%	61.27%	60.31%

Note. loading less than 0.50 omitted, N = 400, overall α = .94, total variance explained is 60.46%.

According to the results of EFA of learning development, the participants' responses were grouped into five factors: creativity (CRE), complex problem-solving (CPS), meta-cognitive awareness (MCA), collaboration (COL), and communication (COM). The factor loadings of all the items in the measure range from 0.665 to 0.854, thus meeting the threshold (0.50), and demonstrating convergent validity at the item level. The Cronbach's alpha coefficients for the factors were .86, .85, .86, .82 and .85, with 64.42%, 63.19%, 64.60%, 58.86%, 62.63% of variance explained, respectively, the overall alpha was .92, and the total variance explained was 64.35%. The KMO value was 0.919, and the Bartlett χ^2-value was 5266.870 (p<0.000), suggesting that these factors have highly acceptable reliability for assessing the learning development.

Table 2. Rotated factor loadings, Cronbach's alpha values, item means, and standard deviations for the five factors of learning development

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1: creativity (CRE), α = .86, mean = 3.69, *SD* = 0.82					
CRE_1	0.693				
CRE_2	0.820				
CRE_3	0.841				
CRE_4	0.828				
CRE_5	0.822				
Factor 2: complex problem-solving (CPS), α = .85, mean = 3.79, *SD* = 0.70					
CPS_1		0.751			
CPS_2		0.797			
CPS_3		0.819			
CPS_4		0.813			
CPS_5		0.791			
Factor 3: meta-cognitive awareness (MCA), α = .86, mean = 3.64, *SD* = 0.73					
MCA_1			0.775		
MCA_2			0.803		
MCA_3			0.817		
MCA_4			0.852		
MCA_5			0.768		
Factor 4: collaboration (COL), α = .82, mean = 3.58, *SD* = 0.71					
COL_1				0.794	
COL_2				0.810	
COL_3				0.668	
COL_4				0.756	
COL_5				0.798	
Factor 5: communication (COM), α = .85, mean = 3.89, *SD* = 0.72					
COM_1					0.768
COM_2					0.665
COM_3					0.854
COM_4					0.846
COM_5					0.809
% of variance	64.42%	63.19%	64.60%	58.86%	62.63%

Note. loading less than 0.50 omitted, $N = 400$, overall α = .92, total variance explained is 64.35%.

4.2 Results of SEM

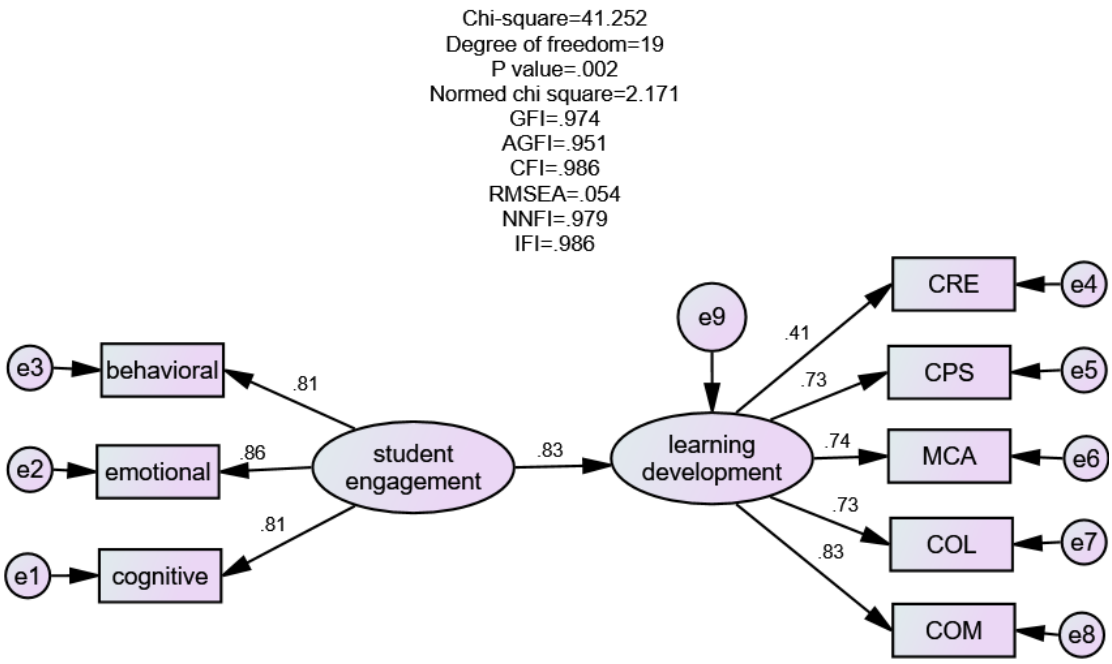
The results of SEM, along with the recommended values for the common model fit, and the suggested saturated and independence models, are shown in Table 3. Most of the model-fit indices exceed their respective common acceptance levels suggested by previous research, thus demonstrating that the default measurement model exhibits a good fit with the data collected ($\chi^2_{(19)} = 41.252$, GIF = 0.974, AGFI = 0.951, CFI = 0.986, RMSEA = 0.054, NNFI = 0.979, IFI = 0.986), as shown in Table 8. This implies that the suggested model is a good fit.

The paths from the behavioral engagement, emotional engagement, and cognitive engagement factors to student engagement showed significant difference. As expected, the results support H1, H2, and H3. The result reveals that emotional engagement is the most important factor ($r^2 = 0.859$), with 85.9% variance explained, then behavioral engagement ($r^2 = 0.811$), with 81.1% variance explained, and cognitive engagement ($r^2 = 0.807$), with 80.7% variance explained in the model. In the meantime, as expected, the results support H4, H5, H6, H7 and H8. The result reveals that communication is the most important factor ($r^2 = 0.827$), with 82.7% variance explained, then meta-cognitive awareness ($r^2 = 0.741$), with 74.1% variance explained, complex problem-solving ($r^2 = 0.735$), with 73.5% variance explained, collaboration ($r^2 = 0.730$), with 73.0% variance explained, and creativity ($r^2 = 0.415$), with 41.5% variance explained in the model.

There is also a significant path from student engagement to learning development. According to the standardized regression coefficient ($r^2 = 0.830$), and the Criteria Ratio (C.R.) = 7.648 > 3.29, $p < 0.01$, 83.0% of variance explained, it means that the correlation between student engagement and learning development is fairly high. As expected, the results support H9. It is confirmed that the standardized coefficients show high validity and reliability by SEM. Student engagement has a direct effect on learning development in the model, as shown in Figure 2.

Table 3. Fit indices for structural and independence models

Fit indices	Recommended	Default_m	Saturated_m	Independence_m
		Model fit summary		
χ^2/df	≤ 3.00	2.171	-	56.954
GIF	≥ 0.80	0.974	1.0	0.354
AGFI	≥ 0.80	0.951	-	0.169
CFI	≥ 0.90	0.986	1.0	0.000
RMSEA	≤ 0.1	0.054	-	0.374
NNFI	≥ 0.90	0.979	-	-
IFI	≥ 0.90	0.986	1.0	0.000
AIC (relative)	smaller	75.252	72.000	1610.712



Note. The figure shows standardized path coefficients; $p < 0.05$.

Figure 2. Paths of student engagement to high-level competences development in mobile learning

5. CONCLUSION

5.1 Educational Implications

The pandemic has brought about a paradigm shift in education which has resulted in new modes of educational delivery and new learning processes. While the pandemic and the extended school closures in 2020 have changed students' learning methods and habits, a comprehensive measure is required for monitoring and support to ensure students' learning outcomes.

According to the exploratory factor analysis in this study, the questionnaire showed good reliability for assessing student engagement and learning development. The item means and standard deviations for student engagement showed that the degree of students engaged in mobile learning was quite high, which implied that they commonly recognized the value of mobile learning during the COVID-19 pandemic. However, behavioral engagement had a lower mean than the other factors, which implied that some students had poor self-regulation and had trouble concentrating on lectures in mobile learning. As Barnard et al. (2009) advocated that the mobile learning environment is characterized by autonomy, self-regulation becomes a critical factor for success in mobile learning.

It was confirmed that the standardized coefficients show high validity and reliability by SEM in this study. The fitness of the items for each scale of the student engagement survey and learning development survey indicated a sufficient fit and also confirmed the questionnaire's structure. The SEM analysis shows that student engagement has a significant positive impact on learning development in mobile learning. The SEM results provided a valuable reference that student engagement is critical to determining how students perceive mobile learning and their learning development.

5.2 Implications for Research and Practice

This study contributes to our understanding of the effect of student engagement in mobile learning on learning development in junior high schools. Bozkurt et al. (2015) addressed that mobile learning is no longer peripheral or supplementary, but rather has become an integral part of mainstream society. An understanding of junior high school students' engagement in this study can provide references for improving the efficiency of students' learning development and adjusting teachers' teaching approaches. As engagement is an important factor affecting students' efficient learning and academic achievement, it directly affects the learners' learning results and learning effectiveness (Authors, 2021). An essential conclusion of this study is that teachers or developers must design mobile learning environments to match not only the expectations of the students but their engagement and competences development as well.

5.3 Limitations and Suggestions for Future Research

First, this study focused only on a special population of junior-high-school students in China. Discretion must be exercised in extending the results to other disciplines. Second, this study was an exploratory study of how student engagement affects learning development in mobile learning, but it provides little discussion on the arrangement of mobile learning platforms or system management. Third, whereas measuring methods of engagement by questionnaires have several strengths, they also have limitations, including the difficulty of interpretation without additional contextual information. In addition, the resulting model has not been compared with any other similar model, which makes it difficult to use the results in practice to improve learning and teaching processes. It is suggested that more models be constructed in mobile learning settings to improve learning and teaching designs for future research. The findings of this study could be a good reference for those who intend to develop a specific topic of learning on technology for enhancing student engagement or fostering students' learning development.

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