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LEARNING ENVIRONMENTS IN A DIGITAL AGE: AN EXAMINATION OF THE EFFECT OF THE DIGITAL DIVIDE ON STUDENT LEARNING OUTCOMES

ABSTRACT

The objective of this study is to comprehensively explore the learning environment in the digital age and obtain insights for pedagogical practices and policymaking through an all-inclusive examination of various dimensions, which include learning outcomes, learning motivation, learning attitude, and the digital divide. This study collected information from junior high school students by using a questionnaire and conducted statistical analysis on the data collected by using partial least squares. The data came from a random sample of 131 students from the junior high school students in the Chaiyi Taiwan. The empirical study indicate that learning motivation and learning intention have significant and positive effects on learning outcomes. Positive learning motivations and learning attitudes are typically associated with improved learning outcomes. However, the emergence of the digital age has also brought about a major challenge; some students may encounter learning obstacles because of insufficient access to technological devices, poor network connectivity, or inadequate ability to use digital tools. When teachers are teaching, they can provide encouragement and support to stimulate their students' learning motivations; concurrently, proactive teaching strategies can be applied to foster positive learning attitudes in students. Governments and schools can provide more digital resources and training to mitigate the effect of the digital divide on learning.

KEYWORDS: Digital divide, E-Learning, Learning attitude, Learning motivations, Learning outcomes

1. INTRODUCTION

The disruptions to students' education due to the COVID-19 pandemic has hampered their academic performance (Dong et al., 2021). Government policies required the suspension and postponement of school attendance. For most students, the psychological feelings and stress associated these disruptions have had unpredictable effects on their learning.

Advancements in information technology have worsened inequalities in access to tech resources among students. This study examines the impact of these factors due to remote learning and provides insights to help government agencies create effective post-pandemic remote learning policies.

2. LITERATURE REVIEW

Learning Motivations

Motivation and learning behavior are two key factors that determine a student's academic performance. Learning motivation refers to intrinsic or extrinsic factors or forces that prompt an individual to develop the intention or act to engage in learning activities.

Most scholars have agreed that motivation is an influencing factor for learning, emphasizing that individuals perform a given act typically because they are motivated to do so (Brodka & Parikka, 2019; Brown, 2016; Oroujlou & Vahedi, 2011).

Digital Divide
Davison and Cotton (2003) argued that digital divides tend to form when there are imbalances between groups and between people because of the unequitable distribution of digital resources, driven by geographical, demographic, financial, gender, or educational reasons.

Learning Attitude
Richards (2005) stated that attitude is consistent and that students learning about a similar event or matter tend to react similarly. Furthermore, in the learning process, students develop various emotions and thoughts about learning, and the steady inclination they exhibit while learning is defined as their learning attitude (Chang, 2017).

Learning Outcomes
Biggs (1996) defined learning outcomes as students' active participation in learning activities and goal achievement. Fink (2003) viewed them as the knowledge, skills, and attitudes students acquire in a class.

Pong and Morris (2002) stated that the most influential part of a student's learning journey is what is learned, and the effectiveness of learning is determined by a student's understanding of the content being learned.

3. RESEARCH METHOD

PLS regression, used for predictive modeling, was employed in this study. A key strength is its ability to handle multiple independent and dependent variables, reflective and formative indicators, and small sample sizes (Pirouz, 2006).

Junior high school students from Chiayi City, Taiwan, were selected through convenience sampling to complete a questionnaire. At least 20 students participated per school. After screening for missing data, 131 valid responses met the study criteria for analysis.

The questionnaire was based on the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich et al. (1999) and the Academic Motivation Scale (AMS) developed by Vallerand et al. (1992).

Hair et al. (2009) stated that an item's factor loading must exceed 0.6 to be acceptable. Cronbach (1951) asserted that α must exceed 0.7 for high reliability. Validity was assessed using AVE, which must exceed 0.5 for favorable convergent validity (Bagozzi & Yi, 1988; Fornell & Larcker, 1981).

4. EMPIRICAL ANALYSIS

This section has two subsections: 4.1 presents descriptive statistics of the study sample, and 4.2 analyzes respondents' attitudes toward remote learning using PLS. Demographic data, including gender, grade level, sibling ranking, and parents' education and professions, are summarized in Table 1.

Descriptive Statistics of Sample

Basic Demographics
Among the respondents, 57.3% were boys and 42.7% were girls. Ninth graders were the largest group (50.4%), followed by eighth graders (38.9%), while seventh graders were the smallest (10.7%). Eldest siblings were most common (37.4%), followed by second-eldest (24.4%), youngest (23.7%), and only children (11.5%); middle siblings were the fewest (3.1%).

High school or vocational school graduates were the largest group among both fathers (49.8%) and mothers (50.4%), followed by junior college graduates (fathers 33.6%, mothers 35.1%) and those with graduate degrees (fathers 11.5%, mothers 10.7%). Elementary school education was the least common (fathers 6.1%, mothers 3.8%).

Among the fathers, most were labor professionals (31.3%), while none worked in fisheries, were retired, or homemakers. Other professions included civil service (8.4%), trade (12.2%), and freelance (8.4%). Among the mothers, most were service workers (25.2%), followed by labor (14.5%), trade (9.9%), teaching (7.6%), homemakers (14.5%), and unemployed (7.6%).

Confirmatory Factor Analysis of Student Dimensions

A PLS structural model was built with 10 factors across four constructs: learning motivation (value, expectancy, emotional), digital divide (accessibility, capabilities, literacy, convenience), learning attitude (intention, approach), and learning outcomes. Table 2 presents the factor loadings, with items below the 0.6 threshold removed. After revisions, all remaining items met or exceeded 0.6.

The reliability and validity results for each construct following revisions are presented in Table 2. An analysis revealed that each construct had a Cronbach's alpha value of more than 0.7, CR of more than 0.8, and AVE of more than 0.5. The confirmatory analysis results obtained through the student model are presented in Table 3.

Figure 1. Cohen (1988) and Hair et al. (2009) recommended that the R^2 explanatory power must be greater than 10%. In the present study, the R^2 of learning outcomes was 76.3%, significantly exceeding the recommended threshold. This result indicates that the present study has favorable explanatory power.

According to Fornell and Larcker (1981), the p-value must be smaller than 0.5 to indicate significance. The supported hypotheses are as follows.

Hs1: The value motivation of students has a positive influence on their learning outcomes. The coefficient of the path from value motivation to learning outcome was 0.297 (t-value = 3.501), meeting the threshold value ($p < 0.001$) for a high level of significance. Hence, this hypothesis is supported.

Hs8: The learning intention of students has a positive influence on their learning outcomes. The coefficient of the path from value motivation to learning outcome was 0.577 (t-value = 8.126), meeting the threshold value ($p < 0.001$) for a high level of significance. Hence, this hypothesis is supported.

The following hypotheses are not supported because their p-values were greater than 0.05.

The path coefficient was −0.036 for Hs2, −0.081 for Hs3, −0.067 for Hs4, −0.004 for Hs5, 0.061 for Hs6, 0.043 for Hs7, and 0.158 for Hs9; the corresponding t-values did not meet the standard for significance ($p < 0.05$). Therefore, the learning outcomes of students are not significantly influenced by their expectancy motivation, emotional motivation, information accessibility, information capabilities, network literacy, learning convenience, and learning approaches. Accordingly, these hypotheses are not supported.

5. CONCLUSION AND SUGGESTIONS

The results show that only learning motivation and intention significantly affected learning outcomes, highlighting their key influence. Other factors had a weak impact.

Based on our results, schools should focus on enhancing students' value motivation and learning intentions to improve outcomes.

The pandemic compelled numerous changes, including the digital transformation of learning environments. Factors such as the stability of network equipment, changes in classroom interactions, and a reduction in after-class consultations are all major factors affecting learning outcomes. The changes in learning methods have also placed pressure on students to learn and may even have reduced their willingness to learn.

In the future, in addition to changing how students learn, educators and parents must also change and learn accordingly to adapt to digital learning methods and enhance the learning outcomes of students. We suggest providing more resources to students from rural communities or disadvantaged families, with the objectives of reducing the digital divide and bolstering support and training for digital learning through the education system.

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Table 1: Demographics of Student Respondents

Demographic	Variable	Count	Percentage
Gender	Male	75	57.3%
	Female	56	42.7%
Grade level	Seventh grade	14	10.7%
	Eighth grade	51	38.9%
	Ninth grade	66	50.4%
Ranking among siblings	Eldest	49	37.4%
	Second eldest (of three or more siblings)	32	24.4%
	Middle sibling (with two older siblings and at least one younger sibling)	4	3.1%
	Youngest sibling	31	23.7%
	Only child	15	11.5%
Education level of father	Elementary school	8	6.1%
	High (vocational) school	64	48.9%
	Junior college	44	33.6%
	Graduate school	15	11.5%
Education level of mother	Elementary school	5	3.8%
	High (vocational) school	66	50.4%

	Junior college	46	35.1%
	Graduate school	14	10.7%
Profession of father	1. Civil servant	11	8.4%
	2. School teacher	9	6.9%
	3. R.O.C military	4	3.1%
	4. Labor	41	31.3%
	5. Trade	16	12.2%
	6. Agriculture	4	3.1%
	8. Service	24	18.3%
	9. Freelance	11	8.4%
	10. Health care	4	3.1%
	11. Finance	3	2.3%
	14. Unemployed	4	3.1%
Profession of mother	1. Civil servant	8	6.1%
	2. School teacher	10	7.6%
	4. Labor	19	14.5%
	5. Trade	13	9.9%
	6. Agriculture	3	2.3%
	8. Service	33	25.2%
	9. Freelance	7	5.3%
	10. Health care	7	5.3%
	11. Finance	2	1.5%
	13. Homemaker	19	14.5%
	14. Unemployed	10	7.6%

Profession chart

1. Civil servants 2. Teachers 3. Military	4. Labor 5. Trade 6. Agriculture	7. Fishery 8. Service 9. Freelance	10. Health care 11. Finance 12. Retirement	13. Homemaking 14. Unemployment

Table 2: Reliability and Validity of Dimensions

Dimensions	Items	Factor Loading	Cronbach's Alpha	Coefficient of Reliability	Average
Value motivation	VM1	0.868	0.785	0.876	0.703
	VM2	0.898			
	VM3	0.740			
Expectancy motivation	EXM1	0.815	0.838	0.891	0.672
	EXM2	0.850			
	EXM3	0.838			
	EXM4	0.776			
Emotional motivation	EMM1	0.915	0.822	0.918	0.848
	EMM2	0.928			

Information accessibility	AI1	0.707	0.812	0.875	0.638
	AI2	0.888			
	AI3	0.768			
	AI4	0.821			
Information capabilities	IC1	0.860	0.915	0.940	0.797
	IC2	0.879			
	IC3	0.912			
	IC4	0.917			
Network literacy	LL1	0.837	0.862	0.906	0.708
	LL2	0.786			
	LL3	0.887			
	LL4	0.852			
Learning convenience	SC1	0.645	0.712	0.822	0.538
	SC2	0.745			
	SC3	0.703			
	SC4	0.828			
Learning intention	LM1	0.799	0.814	0.877	0.646
	LM2	0.899			
	LM3	0.871			
	LM4	0.615			
Learning approach	SM1	0.815	0.836	0.890	0.670
	SM2	0.822			
	SM3	0.868			
	SM4	0.767			
Learning outcomes	LO1	0.878	0.932	0.945	0.712
	LO2	0.845			
	LO3	0.878			
	LO4	0.829			
	LO5	0.799			
	LO6	0.862			
	LO7	0.815			

Table 3: Coefficients of Correlation and Square Roots of Aves

Factors	VM	EXM	EMM	AI	IC	LL	SC	LM	SM	LO
VM	0.838									
EXM	0.809	0.820								
EMM	0.491	0.397	0.921							
AI	0.423	0.465	0.391	0.799						
IC	0.529	0.569	0.37	0.708	0.893					
LL	0.49	0.522	0.453	0.675	0.692	0.841				
SC	0.651	0.692	0.347	0.557	0.574	0.642	0.733			
LM	0.729	0.647	0.492	0.422	0.547	0.525	0.601	0.804		
SM	0.659	0.64	0.44	0.507	0.598	0.657	0.663	0.749	0.819	
LO	0.641	0.599	0.619	0.467	0.572	0.503	0.543	0.831	0.73	0.844

Note: The values on the diagonal are the square roots of the AVEs of each construct. The non-diagonal values are the coefficients of correlation.

VM: Value motivation	LL: Network literacy
EXM: Expectancy motivation	SC: Learning convenience
EMM: Emotional motivation	LM: Learning intention
AI: Information accessibility	SM: Learning approach
IC: Information capabilities	LO: Learning outcomes

FIGURE CAPTION

Figure 1: PLS Path Analysis of Study Framework.