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The Mediating Effect of Online Student's LMS Literacy Between Motivation and Online Teaching Effectiveness: Focusing on the Importance of Technology Literacy After COVID-19*

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This study was to confirm whether students' evaluation of online teaching effectiveness (SEOTE) was significantly predicted by Instructional Material Motivation Survey (IMMS) and Literacy of Learning Management System (LLMS). It was also to examine whether LLMS had a significant mediating effect between IMMS and SEOTE. Pearson correlation, multiple-regression, and mediated regression analysis were used. Participants were online college students in South Korea. A total of 210 students meaningfully responded to the Google Drive web-survey via the internet of three scales: IMMS, LLMS, and SEOTE. This study revealed that motivation had a significant effect on SEOTE ($r=.78$, $p<.01$). There was a significant positive correlation between LLMS and SEOTE ($r=.64$, $p<.01$). In addition, motivation and LLMS were significant predictors that influenced the prediction of SEOTE. The overall model of IMMS and LLMS significantly predicted SEOTE, explaining 31.4% variance in SEOTE. This study used mediated regression analysis to determine whether there was a significant mediating effect of LLMS between IMMS and SEOTE. As LLMS was added between IMMS and SEOTE, the β coefficient of motivation was decreased. Models of IMMS and LLMS significantly influenced the prediction of SEOTE. LLMS showed a significant mediating effect by influencing the prediction of SEOTE by IMMS according to the method of Baron and Kenny (1986). Consequently, meaningful parameter of LLMS showed a significant indirect or mediating effect with IMMS in predicting SEOTE.

Keywords : Motivation, Literacy of Learning Management System (LLMS), Online Teaching Effectiveness, Online Learning & Teaching, Technology Literacy

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Introduction

In the early COVID-19 pandemic, most universities were closed and students were unable to attend classes preventing the spread of the epidemic. Fortunately, non-face-to-face (non-f2f) learning using online, technology, and digital device allowed students to learn and study without serious disruptions to the regular curriculum. E-Learning site of the Korea Education and Research Information Service (KERIS) and online classes of Educational Broadcasting System (EBS) have created about 470,000 online classrooms, and despite the COVID-19 pandemic, which has 3.97 million daily users, the Korean government is using various digital tools and technologies along with e-learning and hybrid learning to help students continue all the classrooms without much confusion (Academy Information Disclosure Center, 2015; Ministry of Education, 2020; Shin & Hickey, 2020).

In particular, there have been critical educational changes in the COVID-19 pandemic in 2020. For instance, educators needed to be proficient in using technologies and digital devices (e.g., ZOOM, Google Classes, LMS, etc.). And most students were getting familiar with e-learning and hybrid learning rather than traditional f2f learning in online and offline classes. Learners and educators can think of e-learning and hybrid learning as very important educational alternatives to overcome their difficulties. For this reason, we have to consider changes in the educational circumstances due to the increase in non-f2f classes.

Researchers anticipate the following changes in the educational environment after the COVID-19 pandemic (Shin & Hickey, 2020) as follows; First, because of the pandemic, educators and students have become more reliant on technologies, including video conferencing platforms, online learning management systems, e-learning platforms, and digital tools for non-f2f learning and hybrid learning engagement. Although the end of COVID-19 pandemic has led many universities to return traditional f2f learning from e-learning and hybrid learning, many educators still adhere to the non-face-to-face learning method. Recently, although online

learning or classes using ZOOM have decreased sharply, various technologies (i.e., AR and VR, chat GPT using AI) are becoming more and more advanced. Also, important trends in the recent digital educational environment will be e-learning trends such as generative AI, VR, AR, gamification-based learning, mobile/micro-learning, and versatile learning platforms (Suresh, 2024; Vipin, 2023). Even in the face of disasters and epidemics, students' safety and educational rights must be guaranteed, so the dependence on technology in the future educational settings will increase (Ministry of Education, 2020; Shin & Hickey, 2020).

Second, in a transformable educational environment, both learners and educators will increasingly need excellent digital literacy (or technology digital literacy). During the COVID-19 pandemic, web-based e-learning has played a vital role in activating non-f2f classes. Online learners with a lack of digital literacy have been encouraged to improve digital technology literacy, as it can be difficult to access, analyze, and synthesize various information through the internet (or online). Therefore, it can be said that e-learning requires a certain level of ability to utilize digital literacy (Alakrash & Razak, 2021; Kasımoğlu et al., 2022).

Finally, Shin and Hickey (2020) argued in their study on the direction of cultural content education after COVID-19, that digital learning or online learning provides many conveniences for online learners and becomes an important topic for educators as well. As online classes expand and digital technologies are used in the pandemic, educators need to step up and act as coaches and counselors, not just teachers.

In summary, as the new educational environment shifts from teacher-centered learning (TCL) to student-centered learning (SCL), students actively access, analyze, and synthesize a variety of information instead of receiving information and knowledge from teachers. These educational changes require educators to use innovative SCL methods (e.g., flipped learning or hybrid learning) considering students' self-directed learning and a harmony of f2f/non-f2f learning. Previous studies have emphasized that the use of diverse technologies and digital devices enhances and supports SCL as well as e-learning (Buchem et al., 2020; Garrison, 1997;

Marín, 2022; Väätäjä & Ruokamo, 2021).

Thus, educational factors such as students' technology literacy, motivation, and self-directed learning level may become more online students' important internal factors for e-learning effectiveness in the changed educational environment after COVID-19. In other words, considering the changing educational circumstance, it is very necessary to study the impact of these educational internal factors on the effectiveness of online learning.

In addition, various studies on the influence of students' technology utilization and internal factors (e.g., self-directed learning level, motivation and interest, self-efficacy, etc.) on the e-learning effectiveness can contribute to the development and research of efficient teaching/learning methods in the digital educational environment that has changed after COVID-19 pandemic. In this study, the importance of online students' digital literacy is being focused due to changes in the educational environment after the COVID-19 pandemic. In addition, examining the mediating and direct effects of students' digital literacy on e-learning effectiveness is different from previous researches and has significance for future research.

Therefore, this study will examine whether important internal/external factors (i.e., literacy of learning management system, educational motivation) are influential in predicting online educational effectiveness, given the changes in education after the COVID-19 pandemic. In addition, this study will also examine whether LLMS has a significant mediating effect between SEOTE and IMMS in the context of the digital educational environment after the COVID-19 pandemic.

Literature Review

Previous researches presented that internal and external factors (e.g., motivation, learning strategies, communication tools, advanced technologies. etc.) were influential factors which significantly affect e-learning (Kasımoğlu, et al., 2022,

Lalduhawma et al., 2022; Muntu et al., 2023; Wang et al., 2021). Also, e-learning and hybrid classes have become active during COVID-19 pandemic, and many studies have been actively conducted on educational factors affecting e-learning such as utilization of digital devices and online students' technology literacy. Thus, previous researches has shown that utilization of digital devices, online students' technology literacy, and the application of digital systems enhance the effectiveness of e-learning (Mohammadyari & Singh, 2015; Muntu et al., 2023; Techataweewan & Prasertsin, 2018).

However, there are very few studies that have verified the mediating effect on online students' digital literacy between various educational factors and e-learning efficiency. Therefore, considering the importance of online students' digital literacy after COVID-19 pandemic, it would be very important to examine whether various educational factors affect the efficiency of online education through the mediator variable of the digital literacy.

The important variables in this study are as follows.

Online Teaching Effectiveness

Chickering and Gamson (1987) presented seven principles of effective learning: Student-faculty contact, students' reciprocity and cooperation, use of active learning techniques, prompt feedback, emphasizing time on task, high expectations, and respect for various talents. Meanwhile, Bangert (2004) also identified seven effective teaching practices for constructive evaluation of online teaching effectiveness (student-faculty contact, students' cooperation, active learning, rapid feedback, time on task, high expectation, and various talents and learning methods). Smith et al. (2021) identified six key factors in their study of factors affecting online teaching effectiveness: 1) teaching philosophy, 2) teaching presence, 3) self-efficacy in online teaching, 4) student engagement, 5) relationships, and 6) trust.

On the other hand, Lalduhawma et al. (2022) cited poor internet connectivity, low

data limitations, slow data speed, and lack of smart tools as inefficient online learning environments. Effective online instruction is made possible by well-organized lecture content, prepared instructors, and advanced technologies. Therefore, online learning effectiveness and technology digital literacy are important for non f2f classes to perform well in a changed educational environment.

Technology Literacy or Digital Literacy

Acquisition of digital literacy is important for everyone. As the influence of online communication in all aspects of life is recognized as important, individuals must be equipped with appropriate digital skills. Digital literacy is critical to learning and career preparation, and in the context of education, digital literacy should be considered as important as traditional literacy (i.e. the ability to read) (Bandura & Leal, 2022).

"Digital literacy" can be defined as the ability to recognize, use, manage, analyze, and synthesize digital resources and tools, generate new information, and communicate with others (Martin, 2005). It is also the ability to use, release, manage, and analyze technology (Terra, 2023). This can be applied to any technology or digital devices (e.g., smartphones, laptops, tablets, etc.), and it is learning to manage system, software and programs related to the internet and computers. Although technology digital literacy is sometimes simply referred to as "digital literacy", it should actually be considered a sub-concept of technology literacy (Terra, 2023).

Digital literacy has become even more important in online learning after COVID-19. During the pandemic, distance education required the ability to use, understand, manage, and analyze the technology as well as acquire a certain level of skills (Kasımoğlu et al., 2022). This highlights the importance of digital literacy in promoting the utilization of online learning and improving academic performance. Therefore, students' technology literacy should be considered when evaluating the impact of online learning on academic achievement (Mohammadyari & Singh, 2015).

Furthermore, previous studies have emphasized that the use of various technologies and digital devices enhances and supports SCL (Buchem et al., 2020: Marín, 2021; Väätäjä & Ruokamo, 2021).

Literacy of Learning Management System

Literacy of learning management system (LLMS) is a feature that enables users to leverage digital-based learning manage system (Kenap et al., 2023; Marnita et al., 2023; Mtani & Mbelwa, 2022). LMS is a comprehensive system or web-based platform that manages and supports teaching and learning using web-based integrated tools and features (e.g., lecture materials, announcements, evaluations, bulletin boards, discussions, online lecture delivery, etc.). (Irlbeck & Mowat, 2007; Jeon, 2010). Saiyad et al. (2020) explained that various asynchronous e-learning tools/platforms (e.g., Blackboard, Moodle, Google classroom, Schoology) and synchronous ones (e.g., Google Suite, Gowebex, Zoom, Skype) can help students develop self-directed learning in online learning. LMS is also categorized into commercial LMS (e.g., Blackboard, Saka, WebCT, etc.) and customized or self-developed LMS.

LLMS enables appropriate information management and critical thinking skills, thus affecting the effectiveness of online education (Tang & Chaw, 2016). Many studies have mentioned that students with higher LLMS competencies have better learning outcomes (Izhar et al., 2022). Another study found a strong correlation between LLMS-based online education and cognitive ability (Rizal et al., 2021). For these reasons, online instructors should support online learners to deftly and early use of LMS. Instructors should also support students to use a variety of interaction and communication tools (i.e., bulletin boards, chat rooms, emails, etc.) to improve their learning effectiveness.

Research Questions

We specify the research questions to be addressed using multiple regression and correlation analyses:

1. Is there a significant linear relationship between online students' literacy of learning manage system (LLMS) and self-evaluation online teaching effectiveness (SEOTE)?
2. Is there a significant linear relationship between instructional materials motivation survey(IMMS) and self-evaluation online teaching effectiveness (SEOTE)?
3. Which of the possible predictor variables (i.e., IMMS, LLMS) are included in an equation for predicting SEOTE?
4. Does LLMS mediate the relationship between IMMS and SEOTE?

Method

Research Design

This study is a relationship/prediction research design using quantitative data. In this study, Pearson correlation analysis is performed to determine whether there is a significant linear relationship between SEOTE, LLMS, and IMMS. Additionally, we conduct a stepwise multiple regression analysis to determine the significant impact of IMMS and LLMS on predicting SEOTE. Finally, we perform a mediating regression analysis proposed by Baron and Kenny (1986) including Sobel test to verify the significant mediating effect of LLMS between IMMS and SEOTE.

Participants

College students taking online classes at cyber university in Korea participated in this study. 210 students responded to the Google Drive web-survey via the internet. Table 1 shows the general characteristics of the study participants.

Table 1
Participants' information

Characteristics		*n*	%
Variable	Category		
Gender	Female	152	72.4
	Male	58	27.6
School Year	Freshman	57	27.1
	Sophomore	8	3.8
	Junior	116	55.2
	Senior	29	13.8
Expectation on Online Learning	Very Low Expectation	0	0
	Low Expectation	5	2.4
	Medium Expectation	135	64.3
	High Expectation	70	33.3
Total		210	100

Instruments

Self-Evaluation Online Teaching Effectiveness (SEOTE)

Bangert (2004) developed SEOTE to evaluate the effectiveness of online teaching, which includes seven subscales consisting of a six-point Likert scale (from *strongly agree* to *strongly disagree*). The seven subscales are student-faculty contact, student-to-student collaboration, active learning, immediate feedback, time for task, high expectation, and respect for various talents. The coefficient alpha of this scale was .94, showing high reliability (Bangert, 2008).

In this study, we used abbreviated SEOTE to study the satisfaction associated with expectation and interactions in online learning (Heo & Han, 2011). The revised SEOTE has the following eight subscales, with new subscale of interest and motivation added: (a) student-faculty contact, (b) students' collaboration, (c) active learning, (d) rapid feedback, (e) time on task or effective educational design, (f) high expectation, (g) diverse talents and ways of learning, and (h) interest and motivation. For example, one question for the subcategory of effective educational design is, "the online course is designed to provide an effective learning environment." The maximum score was 120 and minimum was 24. This short form of SEOTE yielded a high reliability coefficient (Cronbach's alpha =.96) (Heo & Han, 2011). Finally, in this study, we evaluated the content validity of this tool for clarity, accuracy, and appropriateness for eight effective online teaching areas for a panel of online educators. In addition, the reliability coefficient for abbreviated SEOTE was high (Cronbach's alpha=.95).

Motivation

Keller (1993) developed two instruments that measure ARCS components of motivation (attention, relevance, confidence, satisfaction); the instructional Materials Motivation Survey (IMMS) and the Course Interest Survey (CIS). There are 5 subscales; one for each of the ARCS components and one for the ARCS total score. Ten of the 36 items are reversed (Keller, 1993). The IMMS measures the situational components of learn motivation with regard to specific instructional materials (Keller, 1993)

This study used a shortened IMMS that modified Keller's Instructional Materials Motivation Survey (Heo & Han, 2011; Keller, 1993). There are a total of 20 items with five subscales (e.g., attention, relevance, confidence, satisfaction, and external motivation) (Heo & Han, 2011), with a maximum score of 20 and a minimum score of 5 points. For example, one question on the subscale of external motivation is, "online learning and video clips are very helpful to my learning." Furthermore, this

tool uses a five-point Likert scale (from *always agree* to *always disagree*) to assess students' motivation, which showed a high reliability coefficient (Cronbach's alpha=.92) (Heo & Han, 2011). In this study, the reliability coefficient was also high at .94.

Literacy of Learning Management System (LLMS)

Self-regulated learning competency (SSLC) includes eight subscales: (1) LMS utilization, (2) learning motivation, (3) goal setting, (4) time management, (5) learning duration, (6) effort-attributive evaluation, (7) self-reflection, and (8) class satisfaction with LMS. In the revised SSLC, Cronbach's alpha of eight subscales ranged from .63 to .94 (Jeon et al., 2016).

In this study, we used LMS utilization, one of eight subscales of the SSLC, to measure how well online students are using LMS for learning, management, interaction, and communication. For example, there is a question like, "I use the learning platform(or Learning Management System, LMS) to check and self-manage my attendance rate, learning progress, and evaluation scores." Briefly, we used and modified LMS utilization as a short form LLMS to evaluate LMS literacy levels. In this study, a short form of LLMS produced a high reliability coefficient (Cronbach's alpha = .91).

Data Collection and Analysis

This study was conducted on 222 college students who took online classes for the spring semester of 2024 and data were collected by measuring IMMS, LLMS, and SEOTE through a web survey. And the data were analyzed with 210 students excluding 12 did not fill out the questionnaire.

In this study, descriptive statistics was used to identify participants' basic information. Also, we conducted Pearson correlation, multiple-regression, and mediated regression analysis to analyze the data. This study used an alpha level of .05 as the confidence level. Pearson's correlation analysis was performed to determine

whether there was a significant correlation between the three variables (SEOTE, IMMS, and LLMS). Next, we conducted stepwise multiple regression analysis to examine whether the two predictors (IMMS and LLMS) significantly influence SEOTE prediction. Finally, to determine whether there was a mediating effect of LLMS between IMMS and SEOTE, we performed a mediating regression analysis including Sobel test

Results

Bivariate correlation between a set of IVs (IMMS, LLMS) and DV (SEOTE)

Pearson's correlation coefficient was calculated to investigate the relationship between motivation and online teaching effectiveness. To understand the relationship between IMMS, LLMS, and the eight subcategories of SEOTE, it is also necessary to examine how much significantly IMMS and LLMS influence each subcategory of SEOTE. Table 2 showed that there was a significant positive correlation between IMMS and SEOTE ($r(208)=.777$, $p<.01$). Also, IMMS was shown to be significantly correlated with the eight subscales of SEOTE. Correlation between IMMS and a set of eight subscales of SEOTE has been reported to be

Table 2
Correlation between IVs (IMMS, LLMS) and DV (SEOTE)

V	SI	S2	S3	S4	S5	S6	S7	S8	Total
I	.653**	.639**	.703**	.511**	.744**	.571**	.652**	.731**	.777**
L	.501**	.619**	.463**	.517**	.566**	.464**	.525**	.575**	.639**

V=Variables; I=IMMS; L=LLMS; S=SEOTE
S1=Student Faculty Contact; S2=Students' Collaboration; S3=Active Learning; S4=Rapid Feedback; S5=Time on Task or Effective Educational Design; S6 =High Expectation; S7=Diverse Talents and Ways of Learning; S8=Interest and Motivation; Total of SEOTE=total score of Self-Directed Learning Readiness
**$p<.01$

between .51 and .73 (p<.01).

Through Pearson correlation between LLMS and SEOTE, significant positive correlation was found (r(208)=.639, p<.01) (see Table 2). In addition, LLMS was significantly correlated between .46 and . 62 with each of the eight subscales of SEOTE (p<.01).

Influence of IMMS and LLMS in Predicting SEOTE

A stepwise multiple regression analysis was performed to determine the effect of IMMS and LLMS (IVs) on SEOTE (DV). Data screening was performed to identify missing data and outliers. Mahalanobis distance was calculated to confirm that there were no missing values and outliers exceeding the threshold of chi-square (p < .001). The scatterplots were elliptical and the residual plot was not extreme. In addition, Box's homogeneity test was performed to test homoscedasticity for multivariate, no significance was found in .05 or .01. Thus, three significant assumptions (i.e., normality, linearity and homoscedasticity) were identified. There was no collinearity problem by showing that each IV had a tolerance greater than .1 (IMMS' tolerance =.68, LLMS' tolerance=.68). Also, all variance inflation factors (VIFs) were less than 10 (IMMS' VIF=1.47, LLMS' VIF=1.47).

Results of stepwise multiple regression analysis found that the first model using predictor (IMMS) accounted for 60.4% of the SEOTE variance and significantly influenced the SEOTE prediction. In addition, we reported that the second model using two predictors (IMMS, LLMS) significantly predicted online teaching effectiveness R^2 =.663, R^2_{adj}=.660, F(2, 207)=203,76, p<.001. Furthermore, the second model, which added 5.9% of the R^2 $_{change}$, accounted for 66.3% and had a significant impact on predicting baseline (SEOTE). The model explained 66.3% of the variance in online teaching effectiveness. The significant beta coefficients in table 3 suggested that IVs (motivation β=.61, t(207) =12.50, p<.001; and literacy of LMS β =.29, t(207)=6.01, p<.001) contributed significantly to this model. The results of

this study showed that IMMS and LLMS would have a significant impact on predicting the effectiveness of online classes.

Table 3
Stepwise multiple regression in predicting SEOTE

Variable	Model 1				Model 2			
	B	*β*	*SE*	*t*	*B*	*β*	*SE*	*t*
constant	-0.11		.25	-0.50	.03		.20	.12
IMMS	.96	.78	.05	17.83***	.76	.61	.06	12.50***
LLMS					.23	.29	.04	6.01***
F	317.78***				203.76***			
R^2	.604				.663			
R^2_{adj}	.602				.660			

*Note. N=210, ***p<.001*

Mediating Effects of LLMS between IMMS and SEOTE

To verify the mediating effect of LLMS between motivation and online teaching effectiveness, we performed the mediating regression analysis proposed by Baron and Kenny (1986). The first step was to take IMMS as IV and LLMS as DV (see Table 4). The standardized regression coefficient of IMMS was significant (β=.89, t(208)=9.88, p<.001) and IMMS accounted for 32.0% of LLMS variance, F(1, 208)=97.68 (p<.001). Therefore, IMMS (IV) significantly affected LLMS (DV). The second step was to use IMMS as IV and SEOTE as DV. IMMS significantly accounted for 60.4% of SEOTE, R^2 =.604, R^2_{adj}=.602, F(1, 208)=317.78 (p<.001). The β coefficient of IMMS was significant as β=.78, t(208)=17.83 (p<.001). Therefore, IMMS (IV) had a significant influence in predicting SEOTE (DV).

The third step is to establish IMMS and LLMS as IVs (or predictors) and SEOTE as DV (or criterion). The standardized regression coefficient of IMMS was considerable as β=.61, t(207)=12.50 (p<.001). In addition, the β coefficient of LLMS

was significant as β=.29, t(207)=6.01 (p<.001). These two IVs significantly predicted SEOTE (DV), R^2 =.663, R^2_{adj}=.660, F(2, 207)=203.76 (p<.001). Therefore, IMMS and LLMS had significant impacts in predicting SEOTE. In the final step, we compared the β coefficient of IMMS (IV) in steps 2 and 3. The β coefficient of IMMS (IV) in step 3 decreased with the addition of LLMS parameters between IMMS and SEOTE. In other words, the β coefficient of IV in step 3 (β=.61) was lower than that of IV in step 2 (β=.78**).** As a result, according to Baron and Kenny's (1986) method of mediated regression analysis when IMMS (IV) indirectly affects SEOTE (DV), the parameter of LLMS was found to have a significant mediating effect.

Table 4
Mediating regression analysis method on mediating effect of LLMS

Step	IV	DV	*B*	*SE*	β	*t*	Tolerance	VIF	*F*	R^2	R^2_{adj}
1	I	L	.89	.090	.57	9.88***	1.00	1.00	97.68***	.320	.316
2	I	S	.96	.054	.78	17.83***	1.00	1.00	317.78***	.604	.602
3	I	S	.76	.061	.61	12.50***	.68	1.47	203.76***	.663	.660
	L		.23	.038	.29	6.01***	.68	1.47			

I=IMMS; L=LLMS; S=SEOTE
***p<.001

Sobel test was performed to investigate the significant mediating effect of LLMS between IMMS (IV) and SEOTE (DV). In Table 5, we can identify the non-standardized regression coefficients and standard errors between IMMS and LLMS, LLMS and SEOTE. LLMS-mediated effect between IMMS (IV) and SEOTE (DV) was found to be significant (/z/=4.87, p<.001) (see Table 6). Briefly, LLMS-mediated effect between IMMS and SEOTE was found to be significant when IMMS (IV) significantly affected SEOTE (DV). Figure 1 showed the specific pathway of LLMS-mediated effect between IMMS and SEOTE.

Table 5
Unstandardized coefficients and standard errors for Sobel Test

	Model	DV	Unstandardized coefficients		Standardized coefficients	*t*
			B	*SE*	*β*	
1	(Constant)					
	IMMS	LLMS	.89	.09	.57	9.88***
2	(Constant)					
	IMMS	SEOTE	.76	.06	.61	12.50***
	LLMS		.23	.04	.29	6.01***

*** p<.001

Table 6
Sobel Test on mediating effect of LLMS

Relationship among Variables	Sobel Test /z/	*Sig.*
a→ b → c	4.87	.000

a. Instructional Materials Motivation Survey (IMMS), b. Literacy of Learning Management System (LLMS), c. Self-Evaluation Online Teaching Effectiveness (SEOTE)

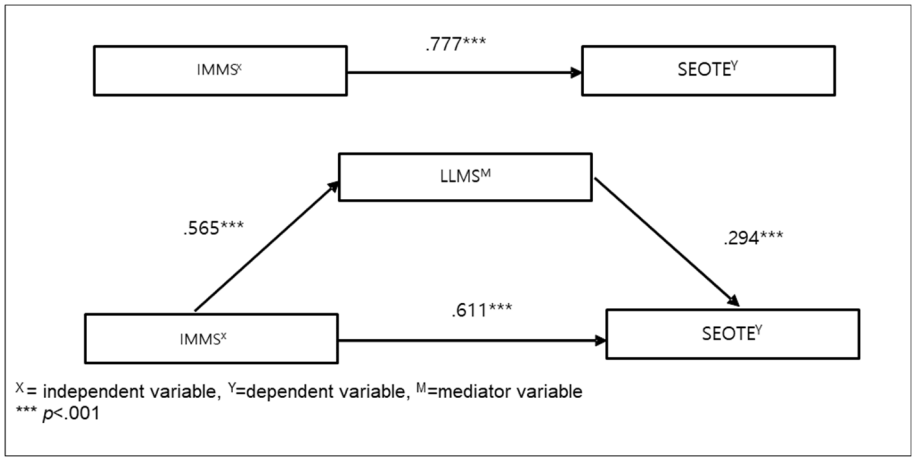

Figure 1. *Mediating effect of LLMS between IMMS and SEOT*

Conclusion and Discussion

This study revealed several important conclusions from the findings on research questions.

First, there is a significant linear relationship between the set of IMMS and LLMS and SEOTE. In other words, we found that there is a significant correlation between IMMS and SEOTE **(***r*=0.000. *p*<.001). The result of this study is consistent with that of Wang et al. (2021) that investigated the relationship among motivation, strategy, internal characteristics (willpower, attitude, etc.) and e-learning effectiveness, arguing that e-learning motivation has a significant impact on e-learning effectiveness, while e-learning strategies play a mediating role. In addition, a significant correlation was found between LLMS and SEOTE (*r*=0.000. *p*<.001). This is consistent with previous findings that effective online education can rely on technology literacy and advanced technologies (Muntu et al., 2023; Laldhhawma et al., 2022). Technology digital literacy is essential elements for f2f and non-f2f learning after the COVID-19 pandemic (Basantes-Andrade et al., 2020; Muntu et al., 2023).

In other words, due to changes in the educational environment after the COVID-19 pandemic, the effectiveness of e-learning can be positively enhanced if students' motivation and technology literacy are improved. Furthermore, the effectiveness of online learning can be significantly dependent on internal and external educational factors (e.g. motivation, the level of self-directed learning, digital literacy, communication tools, advanced technologies, LMS, etc.) (Gunawan et al., 2020; Lalduhawma et al., 2022; Muntu et al., 2023; Wang et al., 2021). Therefore, such studies on the influence of educational internal factors (e.g. motivation and interest, self-directed learning, technology literacy, etc.) on the effectiveness of e-learning can be helpful in developing effective online teaching/learning methods.

Second, significant predictors (i.e., IMMS, LLMS) that influence SEOTE predictions are identified. From the results of stepwise multiple regression analysis for IMMS and LLMS on SEOTE, it was found that IMMS and LLMS had a significant impact on online teaching effectiveness. Furthermore, the two predictors

(IMMS and LLMS) account for 66.3% of SEOTE. Many influential factors in terms of e-learning effectiveness were identified, including internal factors (e.g., motivation, learning strategies, well-structured course contents, etc.) and external factors (e.g., communication tools, advanced technologies, LMS, etc.) (Gunawan, Hui, Ma'sum, & Sukawati, 2020; Wang et al.,2021). These findings are consistent with Lalduhawma et al. (2022)'s findings that poor technological environments (e.g., poor internet connectivity, low data limits, slow data speeds, and lack of smart tools) can make online learning inefficient. Various internal and external factors may influence e-learning effectiveness during and after the COVID-19 pandemic (Gunawan et al., 2020; Lalduhawma et al., 2022; Muntu et al., 2023; Wang et al., 2021). Therefore, it is important to have a learning environment that focuses on technical literacy, advanced skills, and motivation for e-learning efficiency.

Lastly, there is a significant mediating effect of LLMS between IMMS and SEOTE. IMMS is shown to have a significant effect on LLMS, and LLMS has a significant effect on SEOTE. In summary, IMMS has been shown to have a significant indirect effect on SEOTE through LLMS. These results are indirectly consistent with that of Wang et al. (2021) who argued that e-learning strategies and experiences are mediators between e-learning motivation and effect in a research that studied the relationship among students' internal characteristics (e.g., willpower, attitude, etc.), motivation, strategy, and e-learning effect.

On the other hand, in terms of e-learning effectiveness, there have been attempts to enhance e-learning efficiency of students by reinforcing e-learning technologies such as LMS, virtual communities, and so on (Gunawan et al., 2020). Furthermore, prior research has shown that good utilization of digital devices, systems (e.g., LMS, the school of Minerva, etc.), software and programs (e.g., ZOOM, Skype, etc.) improves e-learning effectiveness (Muntu et al., 2023; Techataweewan and Prasertsin, 2018). In other words, it is very necessary for online instructors to support how online learners can fully utilize e-learning platforms (e.g., LMS, School of Minerva, etc.) and interaction tools (e.g., ZOOM, Skype, Google Classroom. etc.) early in the e-learning courses. In addition, online educators should not only present specific

educational goals and what to learn during the e-learning course, but also increase the motivation of online learners by leveraging LMS and advanced technologies that take into account students' digital literacy. As a result, improving online learners' digital literacy (e.g., LLMS, technology literacy) and motivation is critical to enhance the e-learning effectiveness of online learners.

Recommendations and Limitations

From this study, we would like to present the following recommendations and limitations. Technology literacy is the ability to use, comprehend, manage, and analyze technologies including digital devices, system, software, and programs (Terra, 2023). In this study, we measured LLMS, one of the sub-areas of SSLC, to partially evaluate learners' technology literacy or digital literacy. Future research will require evaluating online students' abilities in various areas (e.g., digital devices, system, interaction, software, and programs) related to technology literacy as well as LLMS. Muntu et al. (2023) explained that digital literacy is essential in the post-pandemic era. Therefore, what future researchers need to do is to analyze how various online learners' abilities and skills (e.g. technological literacy, literacy of digital devices, information analysis, data search, etc.) related to technology significantly affect the effectiveness of e-learning.

In addition, this study may have limitations in explaining causal relationships between various internal and external variables (e.g., motivation, learning strategies, well-organized course content, attitudes, technology digital literacy, etc.) that directly and indirectly effect on online teaching effectiveness. Therefore, developing effective online learning classes from the perspective of online learners and online educators will require additional studies to statistically analyze the direct and indirect effects of various key educational factors related to e-learning through path analysis or structural equation modeling.

References

Academy Information Disclosure Center (2015). *The state of dropout students in cyber colleges in 2015*. Retrieved August 16, 2016 from http://www.academyinfo.go.kr/UIPISA/uipnh/unt/ipsrch/UntUntCprsSrchRdviewer.do

Alakrash, H. M., & Razak, N. A. (2021). Technology-based language learning: Investigation of digital technology and digital literacy. *Sustainability, 13*(21), 12304. https://doi.org/10.3390/su132112304

Bandura, R., & Leal, E. I. M. (2022). The digital literacy imperative. *Center for Strategic & International Studies,* 1-6.

Bangert, A. W. (2004). The seven principles of good practice: A framework for evaluating on-line teaching. *The Internet and Higher Education, 7*(3), 217-232.

Bangert, A. W. (2008). The development and validation of the student evaluation of online teaching effectiveness. *Computers in the Schools, 25,* 25-47.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical consideration. *Journal of Personality and Social Psychology 51*, 1173-1182.

Basantes-Andrade, A., Cabezas-González, M., & Casillas-Martín, S. (2020). Digital competences relationship between gender and generation of university professors. *International Journal on Advanced Science, Engineering and Information Technology, 1*. 205-211. https://doi.org/10.18517/ijaseit.10.1.10806

Buchem, H., Tur, G., & Hoelterhof, T. (2020). The role of learner control and psychological ownership for self-regulated learning in technology-enhanced learning designs. Differences in e-portfolio use in higher education study programs in Germany and Spain. *Interaction Design and Architecture(s) Journal, 45*, 112-132.

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin,* 3-7.

Garrison, D. R. (1997). Self-directed learning: Toward a comprehensive model. *Adult Education Quarterly, 48*, 18-33.

Gunawan, I., Hui, L. K., Ma'sum, M. A., & Sukawati, N. N. (2020, October). Enhancing learning effectiveness by using online learning management system. In *2020 6th International Conference on Education and Technology (ICET)* (pp. 48-52). IEEE.

Heo, J., & Han, S. (2011). The college students' satisfaction related to expectation and interaction in the online counseling courses. *Educational Technology International, 12*(2), 117-134.

Irlbeck, S., & Mowat, J. (2007). Learning content management system (LCMS). In K. Harman & A. Koohang (Eds.), *Learning Objects: Standards, Metadata, Repositories, and LCMS*. (pp. 157-184). Informing Science Press.

Izhar, G., Wardani, K., & Nugraha, N. K. (2022). The development environmental literacy media learning for elementary school student. *Journal of Innovation in Educational and Cultural Research, 3*(3), 397-404. https://doi.org/10.46843/jiecr.v3i3.116

Jeon, G. (2010). *The effects of an e-learning information literacy instruction program on self-directed learning ability of university students.* [Master's thesis]. University of Soongsil.

Jeon, Y., Kim, K., & Cho, J. (2016). A study on the effect of LMS on the self-regulated learning competency and learning satisfaction in higher education. *Journal of Korean Association for Educational Information and Media, 22*(1), 55-84.

Kasımoğlu, S., Bahçelerli, N. M., & Çelik, M. U. (2022). Digital literacy during COVID-19 distance education; evaluation of communication-based problems in line with student opinions. *Frontiers in Psychology, 13*, 1-6.

Keller, J. M. (1993). *Manual for instructional materials motivational survey (IMMS).*

Lalduhawma, L. P., Thangmarwia, L., & Hussain, J. (2022). Effectiveness of online learning during the COVID-19 pandemic in Mizoram. *Journal of Education and e-Learning Research, 9*(3), 175-183.

Marín, V. I. (2022). Student-centered learning in higher education in terms of Covid-

19: A critical analysis. *Studies in Technology Enhanced Learning, 2*(2). https://doi.org/10.21428/8c225f6e.be17c279

Marnita, M., Nurdin, D., & Prihatin, E. (2023). The Effectiveness of elementary teacher digital literacy competence on teacher learning management. *Journal of Innovation in Educational and Cultural Research, 4*(1), 35-43.

Martin, A. (2005). DigEuLit –a European framework for digital literacy: A progress report. *Journal of eLiteracy, 2,* 130-136.

Ministry of Education (2020). *Responding to COVID-19: Online classes in Korea*. https://kosis.kr/files/covid/Responding_to_COVID-19_ONLINE_CLASSES_IN_KOREA.pdf

Mohammadyari, S., & Singh, H. (2015). Understanding the effect of e-learning on individual performance: The role of digital literacy, *Computers* & *Education, 82*, 11-25.

Mtani, H. & Mbelwa, J. (2022). Factors affecting learning management system usage in higher learning institutions in Tanzania: A Case of university of Dodoma. *International Journal of Education and Development using Information and Communication Technology, 18*(1), 7-26.

Muntu, D. F., Yuliana, O. Y., & Tarigan. Z. J. (2023). The influence of digital literacy on learning effectiveness through classroom management: Moderating effect IT infrastructure. *PETRA IJBS, 6*(1), 42-52.

Rizal, R., Rusdiana, D., Setiawan, W., Surahman, E., & Ridwan, I. M. (2021, June 12). *Digital literacy and cognitive abilities of preservice physics teacher in physics for school course using LMS3: How are the both correlated?* [Conference session]. International Conference on Mathematics and Science Education, Bandung, Indonesia. https://iopscience.iop.org/article/10.1088/1742-6596/2098/1/012011/pdf

Saiyad, S., Virk, A., Mahajan, R., & Singh, T. (2020). Online teaching in medical training: Establishing good online teaching practices from cumulative experience. *International Journal of Applied Basic Medical Research, 10*(3). 149-155.

Shin, M. & Hickey, K. (2020). Needs a little TLC: Examining college students'

emergency remote teaching and learning experiences during COVID-19. *Journal of Further and Higher Education, 45*(7), 973-986.

Smith, Y., Chen, Y., & Warner-Stidham, A. (2021). Understanding online teaching effectiveness: Nursing student and faculty perspectives. *Journal of Professional Nursing, 37*(5), 785-794.

Suresh, K. D. (2024). eLearning trends that will shape learning initiatives in 2024. Retrieved May 16, 2024 from https://elearningindustry.com/elearning-trends-that-will-shape-learning-initiatives-in-2024

Tang, C. M., & Chaw, L. Y. (2016). Digital Literacy: A prerequisite for effective learning in a blended learning environment?. *Electronic Journal of E-learning, 14*(1), 54-65.

Techataweewan, W., & Prasertsin, U. (2018). Development of digital literacy indicators for Thai undergraduate students using mixed method research. *Kasetsart Journal of Social Sciences, 39*, 215-221.

Terra, J. (2023). What is technology literacy?: Everything you need to know. Retrieved April 27, 2023 from http://www.simplilearn.com/what-is-technology-literacy-article

Väätäjä, J. O., & Ruokamo, H. (2021). Conceptualizing dimensions and a model for digital pedagogy. *Journal of Pacific Rim Psychology, 15*. https://doi.org/10.1177/1834490921995395

Vipin, H. (2023). The future of education: 5 eLearning trends to keep an eye on in 2024. Retrieved May 16, 2024 from https://elearningindustry.com/future-of-education-elearning-trends-to-keep-an-eye-on-in-2024

Wang, C., Zhang, Y., & Cheon, S. (2021). The empirical study of college students' e-learning effectiveness and its antecedents toward the COVID-19 epidemic environment. *Frontiers in Psychology, 12*, 1-14.

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