Influence of Digital Literacy and Self-Directed Learning in the Online Learning Success of STEM College Students

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Abstract: *This study sought to determine the singular and combined influence of digital literacy and self-directed learning in the online learning success of STEM college students. Thus, the study utilized a non-experimental, quantitative descriptive correlation research design. The study participants were undergraduate students enrolled in any STEM-related courses in Davao City. Three hundred (300) respondents were selected through a stratified sampling technique. Adapted questionnaires converted into google forms were utilized to collect data from the respondents. Statistical tools such as Mean, Pearson R, and Multiple Regression were employed to characterize individual variables and identify the relationships and influences among the study variables. The study's findings revealed that there was a significant relationship between digital literacy and online learning success and a significant relationship between self-directed learning and online learning success. Multiple regression indicated a significant single and combined influence of digital literacy and self-directed learning on online learning success. These findings implied that students are likely to succeed in online education when they possess a high degree of digital literacy and self-directed learning.*

Keywords: *COVID-19 pandemic, online education, digital literacy, self-directed learning, online learning success, multiple regression, stem college students, Philippines*

1. INTRODUCTION

Online learning has become a prompt response to combat the detrimental effects of the COVID-19 pandemic in education. Generally, education, particularly that of tertiary level, is greatly affected by the consequences brought by the proliferation of the disease. Thus, to cater to the needs of the students for non-stop and continuous learning, schools have instantaneously shifted from traditional face-to-face education to contemporary online learning. For some students, it is convenient as it provides an accessible environment for the current educational [1]. Still, for others, it is burdensome and complex [2]. The most pressing problems faced by students in online education include technological know-how and access [1], feeling of isolation [3]; [4], lack of support [5]; [3]; [4]; [6]and personal issues such as discipline and motivation [3]; [2]; [7]. Thus, failure to mend online learning issues would lead to problems that affect the higher education student attrition or drop-out rates. For years, students drop-out rates in online education have been substantially higher compared to face-to-face education [8].

As online learning harnesses independent learning [9], understanding the factors that may affect the students' performance and drop-out rate in an online education learning environment is vital for teachers and administrators to improve the quality of teaching. Thus, it is crucial to understand the needs of the students in a physically distant and virtual environment to alleviate its adverse effects, especially to those who are not used to this current set-up. To offer students a top-notch educational experience, schools should emphasize factors like a high level of interaction between students in online learning, adequate learner support, and the instructors' teaching techniques [3]. Student-to-student engagement and peer monitoring, on the other hand, have been found effective in learning structured STEM discussions in an online science program [10]. Also, a combination of online homework and online skill tests in problem-solving sessions as engagement practices showed

significant success in calculus courses [11]. Generally, understanding the online education learning environment helps teachers execute effective teaching and learning strategies to avoid the occurrence of students' negative learning attitudes and ensure online education effectiveness [7].

To become a successful online learner, an individual should possess a high level of digital literacy. Digitally literate individuals can quickly learn and adapt in an e-learning environment using technologies required for specific educational purposes while managing information effectively [12]. Such an idea is also supported by the study conducted by McGuinness and Fulton [13], that digitally literate learners can function effectively in a technology-enabled environment such as online education. Thus, online learning promotes independent learning. Students are expected to self-direct their learning as minimal supervision is put in place. The importance of self-directed learning in the success of online learning is grounded on the theory of Zimmerman, known as the Self-Regulation Learning Theory. This theory stresses the need for students to supervise their learning. As opined by Kohan N. et al [14], online learners need to have self-directedness in planning, analyzing, implementing and evaluating their learning. Geng et al. [15] also agreed that self-directed students could actively engage in learning and find effective learning strategies according to the learning situation, such as in online education.

Online education has been established and mainstreamed in several economically developed countries in the world, such as Australia [16], the USA [17], and Canada [18]. However, its full implementation is not yet widely embraced in less-economically developed countries due to "individual, instructional, and institutional-related challenges" [19]. In the Philippines, this is generally true as the traditional face-to-face teaching model is predominant in higher education schools. However, with the emergence of the COVID-19 pandemic, schools are compelled to provide alternative ways for lesson delivery to prevent viral proliferation through online or distance learning. Since the establishment of the University of the Philippines Open University, the primary distance education institution in the Philippines way back in 1995, which coined the term and promoted Open and Distance e-Learning [20], there are only a few studies that published about online education. Recently, Alipio [21] conducted a study about the students' readiness for e-learning as influenced by the emergence of the COVID-19 pandemic. For many years, online education is not yet widely studied in the Philippines, resulting in data deficiency. As a result of a thorough literature analysis, no findings have yet been published that discuss the integration and connectedness of the variables identified. Currently, there are no studies published about the online learning success of STEM College students in the city based on an intensive and thorough literature review. Therefore, it is necessary to carry out this study to assess the condition of STEM College students' online learning success and provide ways to understand these learners' needs in an online learning environment. As no previous studies were carried out to assess and evaluate the online learning success of STEM College students, the findings of this study would serve as baseline data for the city.

2. RESEARCH OBJECTIVES

This study aims to find out the role of students' digital literacy and students' self-directed learning on students' online learning success. Specifically, this sought to answer the following objectives:

1. To describe the level of students' digital literacy in terms of their:

    1.1 Technological Skill;

    1.2 Personal security skill;

    1.3 Critical skill;

    1.4 Devices security skill;

    1.5 Informational skill; and

    1.6 Communication skill

2. To ascertain the level of students' self-directedness to learning in terms of the following:

    2.1 Awareness;

    2.2 Learning strategies;

    2.3 Learning activities;

    2.4 Evaluation; and

    2.5 Interpersonal skills

3. To measure the level of students' online learning success in terms of the following:

    3.1 Computer skills;

    3.2 Independent learning;

    3.3 Dependent learning;

    3.4 Need for online learning; and

    3.5 Academic skills

4. To establish the significance of the relationship between:

    4.1 Students' digital literacy and students' online learning success; and

    4.2 Students' self-directed learning and students' online learning success.

5. To determine the singular and combined influence of Digital Literacy and Self-Directed Learning on Online Learning Success.

Hypothesis

The following null hypotheses were treated at a 0.05 level of significance.

1. There is no significant relationship between:

    1.1 Students' digital literacy and students' online learning success; and

    1.2 Students' self-directed learning and students' online learning success.

2. There is no domain of students' digital literacy and self-directedness that influence online learning success.

3. MATERIALS AND METHODS

3.1. Research Design and Study Sample

This study is a non-experimental, quantitative research which aims to determine the influence and relationship of the study variables from a significantly large population. This type of research focuses on finding associations and linkages between different variables which cannot be manipulated by the researcher [22]. A quantitative research design can afford to test larger samples and provide general data from a representative population [23]; [24]. Additionally, the design mainly uses standardized instruments for data collection and data analysis, thus, this promotes objectivity [25]. Additionally, descriptive-correlational design was utilized to determine the correlation that exists among the study variables. Descriptive-correlational design is employed when the researcher aims to describe systematically the characteristics of a population and to understand the relationships that exist between study variables to come up with answers that relate to an ongoing event [26]; [27]. As this study intends to determine the singular and combined influence of digital literacy and self-directed learning in the online learning success of STEM College students – descriptive-correlational design was employed.

The respondents of this study were the STEM college students enrolled in the programs of Architecture, BS-Biology, Computer Science, Engineering, Information Technology, Mathematics, Medical Sciences, Pure Sciences, and Teacher Education Major in Sciences in Davao City, Philippines. As the total population was relatively large, three hundred (300) respondents were chosen from the programs mentioned above. A sample size of 300 would yield similar statistical findings that were comparable to the true value in the chosen population [28]. This study employed a stratified sampling technique as it allows the involvement of different subgroups of similar interest and is useful if differences in a variable are observed among groups [29]. A simple random sample was then taken from each of the identified strata together with its sampling fractions to calculate the specific number needed in relation to the population size.

3.2. Research Instruments

The adapted Digital Literacy Scale was developed in 2016 by Igartua, Gonzalez-Vasquez, and Rodriguez de Dios. The scale comprises 47 close-ended questions measured in a 5-point Likert scale and classified into six (6) distinct factors or indicators: technological skill, personal security skill, critical skill, devices security skill, informational skill, and communication skill. It exhibits support for a reliable internal consistency for most of the factors, with Cronbach Alpha ranging from .63 to .75 [30].

Table1. *Categories of responses for Digital Literacy*

Range of Means	Descriptive Equivalent	Interpretation
4.20-5.00	Very High	Digital Literacy is always manifested.
3.40-4.19	High	Digital Literacy is often manifested.
2.60-3.39	Moderate	Digital Literacy is sometimes manifested.
1.80-2.59	Low	Digital Literacy is seldom manifested.
1.0-1.79	Very Low	Digital Literacy is never manifested.

An adapted, panel-validated questionnaire for Self-Directed Learning was used in the conduct of the study with a computed Cronbach Alpha value of .965, which means that the items have relatively high internal consistency. Williamson developed the adapted Self-Directed Learning Scale in 2007. The scale consists of 60 close-ended items, rated in a 5-point Likert Scale, grouped into five (5) distinct factors or indicators: Awareness, Learning Strategies, Learning Activities, Evaluation, and Interpersonal Skills. The scale has an internal consistency with Cronbach Alpha ranging from .70 to .79, significantly considered acceptable and satisfactory [31].

Table2. *Categories of responses for self-directed learning*

Range of Means	Descriptive Equivalent	Interpretation
4.20-5.00	Very High	Self-directed learning is always manifested.
3.40-4.19	High	Self-directed learning is often manifested.
2.60-3.39	Moderate	Self-directed learning is sometimes manifested.
1.80-2.59	Low	Self-directed learning is seldom manifested.
1.0-1.79	Very Low	Self-directed learning is never manifested.

The Test of Online Learning Success scale used in this study was developed by Kerr, Rynearson, and Kerr in 2003. It comprises 45 close-ended items measured in a 5-point Likert scale. The items are grouped into six (6) distinct factors or indicators: Computer Skills, Independent Learning, Dependent Learning, Need for Online Learning, and Academic Skills. The level of Cronbach Alpha for all the factors is ranging from .63 to .84 which is considered to possess a high internal consistency reliability [32].

Table3. *Categories of responses for online learning success*

Range of Means	Descriptive Equivalent	Interpretation
4.20-5.00	Very High	Online learning success is always manifested.
3.40-4.19	High	Online learning success is often manifested.
2.60-3.39	Moderate	Online learning success is sometimes manifested.
1.80-2.59	Low	Online learning success is seldom manifested.
1.0-1.79	Very Low	Online learning success is never manifested.

3.3. Data Collection Procedure

Initially, a set of adapted questionnaires validated by experts were converted into google forms and used in the data collection. Due to the COVID-19 pandemic, data collection was purely online. Then, the deans of any STEM-related programs within Davao City received a letter to conduct the study. Before the questionnaire administration, participants were oriented and instructed about the purpose of the study. Also, the confidentiality of their responses was guaranteed. Next, the validated adapted questionnaires were administered among the randomly selected three hundred (300) STEM undergraduate students in Davao City chosen through a stratified sampling technique. After that, the survey questionnaires were retrieved immediately after the respondents accomplished answering the questionnaires. Then, the data were organized and treated using Mean, Pearson r, and Multiple regression to characterize each variable and determine the significant relationship and influence among the study variables.

Lastly, the data garnered from the tests were interpreted and discussed thoroughly. The characterization of each of the study variables was identified and interpreted accordingly. Then, the significant relationship and influence among the study variables were identified and analyzed to see their relevance in the study and come up with a sound conclusion.

3.4. Statistical Tools

The data were treated using the following statistical tools:

Mean. To characterize the digital literacy, self-directed learning, and online learning success of STEM College Students.

Pearson Moment Product Correlation Coefficient. To determine the significance of the relationship between digital literacy and online learning success, self-directed learning, and online learning success.

Multiple Regression. To determine the significant influence of digital literacy and self-directed learning on online learning success.

4. RESULTS AND DISCUSSION

4.1. Level of the Digital Literacy of STEM College Students

Table 4 shows the level of digital literacy of students in terms of *technological skill, personal security skill, critical skill, devices security skill, informational skill*, and *communication skill* which is the first objective of the study. As shown, the overall mean score of students' digital literacy level is 4.43 with a computed standard deviation of 0.44, which is described as very high and indicates that the respondents manifest digital literacy. In particular, the indicator with the highest mean score is the technological skill (4.77) with a "very high" descriptive level. It is then followed by personal security skill (4.68), critical skill (4.55), communication skill (4.34), and information skill (4.27) which also have "very high" descriptive levels. The indicator with the lowest mean score is the devices security skill (3.96), which is high. The very high levels of most of the indicators imply that students are digitally literate, which means that they can easily navigate different technologies, effectively communicate through various digital media, and critically evaluate online information. However, the lowest mean garnered by the devices' security skills (3.96) further denotes that students put a lesser emphasis on protecting their devices from any potential threats such as viruses among all the indicators mentioned above.

Table4. *Level of STEM college students' digital literacy*

Indicator	SD	Mean	Descriptive Level
Technological Skill	0.39	4.77	Very High
Personal Security Skill	0.45	4.68	Very High
Critical Skill	0.50	4.55	Very High
Devices Security Skill	0.89	3.96	High
Information Skill	0.61	4.27	Very High
Communication Skill	0.55	4.34	Very High
Overall	**0.44**	**4.43**	**Very High**

The findings are in parallel to the results published by Tang and Chaw [33], Bernacki [34], and Baterna, Mina, and Rogayan [35] as they all emphasized the very high levels of digital literacy among their respective students. Furthermore, the cohesion in the findings of the studies suggests that students have increasingly prepared themselves with the digital literacies required to thrive in an online environment with the advancement of technology. Indeed, students who can effectively use and access various digital technologies have an edge in educational success [36], mainly undergraduate students engaged in digital learning [37].

4.2. Level of Self-Directed Learning of STEM College Students

Table 5 shows the level of self-directed learning of students in terms of *awareness, learning strategies, learning activities, evaluation*, and *interpersonal skills*. The overall mean score of the students' self-directed learning level is 4.24, with a standard deviation of 0.53, described as very high. Thus, this implies that self-directed learning manifested among the respondents. The indicator with

the highest mean score is awareness (4.33) and followed by evaluation (4.30), which both gained "very high" descriptive levels. On the other hand, learning strategies, learning activities, and interpersonal skills shared a mean score of 4.19, with "high" descriptive levels. The very high level of self-directed learning among the respondents further implies that they understand the different factors crucial for self-directedness and monitor the other learning activities they are engaged in. Furthermore, they also possess different learning strategies necessary for self-directed learning; they identify various learning activities where they should be involved and know how to build social relationships.

Table5. *Level of STEM college students' self-directed learning*

Indicator	SD	Mean	Descriptive Level
Awareness	0.56	4.33	Very High
Learning Strategies	0.68	4.19	High
Learning Activities	0.56	4.19	High
Evaluation	0.59	4.30	Very High
Interpersonal Skill	0.60	4.19	High
Overall	**0.53**	**4.24**	**Very High**

The very high and high descriptive levels obtained by all the indicators of self-directed learning based on its mean scores imply that it is manifested among STEM college students. Also, the results further suggest that STEM college students take control over their learning as they understand the factors crucial for self-directedness. The abilities to control, monitor, and evaluate learning are highly manifested among these students. The findings are congruent to the findings published by Swart [38], Behar-Horenstein, Beck, and Su [39], and Tekkol [40], as they reported high levels of self-directed learning among their study samples. Based on the cohesive results of the studies mentioned above, teachers need to carefully balance the amount of scaffolding given to students as they gradually take responsibility for their learning [41].

4.3. Level of Online Learning Success of STEM College Students

Table 6 presents the students' level of online learning success in terms of *computer skills, independent learning, dependent learning, need for online learning*, and *academic skills*, which is the third objective of this study. The overall mean score of students' online learning success is 3.88, with a computed standard deviation of 0.59, described as high. Generally, this indicates that online learning success manifested among the respondents. Specifically, the highest computed mean score indicator is *computer skills* (4.55) with a "very high" descriptive level. It is then followed by *independent learning* (3.97), *dependent learning* (3.94), and *academic skills* (3.91), which have "high" descriptive levels. However, the indicator with the lowest mean score is the need for online learning with a mean score of 3.03, which is described as moderate.

Table6. *Level of STEM college students' online learning success*

Indicator	SD	Mean	Descriptive Level
Computer Skills	0.53	4.55	Very High
Independent Learning	0.78	3.97	High
Dependent Learning	0.62	3.94	High
Need for Online Learning	1.25	3.03	Moderate
Academic Skills	0.66	3.91	High
Overall	**0.59**	**3.88**	**High**

The very high level of *computer skills* as the determinant for online learning success entails that these students can access, use, and navigate different computer functions. The high ranks for *independent learning, dependent learning*, and *academic skills* indicate that these determinants for online learning success are manifested all the time. However, the moderate descriptive level based on its mean score and standard deviation gained by "a need for *online learning"* further suggests that students do not prefer online learning. Thus, the existing circumstances appeared to compel them to engage in it as they have no other options to continue their studies.

As the literature suggested, there are still opposing views about the effectiveness of online learning compared to face-to-face education. The differences among studies further imply that online learning

success is highly influenced by demographics and students' conditions [43]. The study conducted by Lin, Tseng, and Chiang [44] noted that the online learning experience positively affected students' online learning outcomes in mathematics. Congruently, Mensah, White, Yankey, and Brown [45] also reported similar results as they investigated the effects of online learning on public health students in Georgia, USA. Their study found out that students have a good set of computer skills that propelled them to learn in an online environment conveniently. They also stated that online learning allows students to communicate with their friends and instructors on their own time, making them effective online learners.

On the other hand, the study published by Coman et al. [46] reported that in Romania, higher education institutions were not prepared for online learning as an exclusive mode of lesson delivery. This conclusion reflects students' poor online learning performance as technical issues are prevalent to both the learners and the teachers. Contributory to the problem is also the lack of communication between students and instructors and even among students. In general, the effectiveness of online learning in comparison to face-to-face learning is different among the reviewed literature, as mentioned above. In the earlier studies conducted by Glazier [47], Hart [48], and Hart et al. [49], the ineffectiveness of online learning is reflective of the low students' retention as compared to traditional face-to-face learning. Contrarily, Nguyen [50] and Holmes [51] opined that online learning is equally effective as conventional learning.

4.4. Significance of Relationship between Students' Digital Literacy and Online Learning Success

Table 7 shows the results derived from the analysis on the significance of the relationship between digital literacy and online learning success of STEM college students. As shown in the table, the r-value for the overall correlation between digital literacy and online learning success is .547, which implies a high positive correlation with a p-value of .000. Based on the data, it can be concluded that there is a significant relationship between digital literacy and the online learning success of the STEM College students who participated in this study. The Connectivism Theory further supports the result, as it states that digital literacy is an important component of online learning success.

The significant relationship between digital literacy and online learning success further implies the need for students to equip themselves with the necessary set of digital skills to survive in an online learning environment. Hence, teachers should capitalize on the use of different social media platforms and technological systems both for instruction and collaboration to provide students with an avenue to hone their digital skills. Aside from that, teachers need to teach students how to manage digital distractions since these elements negatively affect online learning.

Table7. *Significance of the Relationship between digital literacy and online learning success*

Digital Literacy	Online Learning Success					
	Computer Skills	Independent Learning	Dependent Learning	Need for Online Learning	Academic Skills	Overall
Technological Skill	.630** .000	.154** .008	.304** .000	.055 .344	.249** .000	**.296** .000**
Personal Security Skill	.715** .000	.185** .001	.364** .000	.185** .001	.386** .000	**.417** .000**
Critical Skill	.561** .000	.251** .000	.410** .000	.227** .000	.524** .000	**.465** .000**
Devices Security Skill	.537** .000	.224** .000	.306** .000	.194** .001	.271** .000	**.361** .000**
Informational Skill	.575** .000	.331** .000	.487** .000	.323** .000	.519** .000	**.543** .000**
Communication Skill	.330** .000	.381** .000	.334** .000	.257** .000	.505** .000	**.450** .000**
Overall	**.709** .000**	**.334** .000**	**.474** .000**	**.279** .000**	**.522** .000**	**.547** .000**

The findings of this study are consistent with the conclusions published by Li and Lee [1] as they investigated the relationship that exists between computer (digital) literacy to online learning attitude of Taiwanese students as a significant predictor for online learning success. According to the study's findings, they found out that 204 out of 252 respondents preferred online learning as it helps them enhance their confidence and offers a more flexible approach to learning. They also noted that digital skills and knowledge create a good foundation for online learning. Thus, computer (digital) literacy showed a strong positive relationship towards online learning success. Moreover, the discussions published by Maphosa and Bhebhe [52] also coincide with the findings of this study as they studied the role of digital literacy in open distance and e-learning students. They aimed to demonstrate the link between digital literacy and online learning success in their study.

4.5. Significance of the Relationship Between Students' Self-Directed Learning and Online Learning Success

Table 8 presents the results derived from the analysis on the significance of the relationship between self-directed learning and online learning success of STEM college students. The computed r-value for the overall correlation between self-directed learning and online learning success is .808, which indicates a very high, positive correlation with a p-value of .000. The computed p-value of .000 further implies that the null hypothesis is rejected. Generally, it can be stated that there is a significant relationship that exists between self-directed learning and the online learning success of STEM College students. Both Connectivism and Self-Regulated Learning Theory further support the result. Both state that self-directed learning is an essential component of students' online learning success.

The significant relationship between self-directed learning and online learning success suggests students need to learn basic self-regulated skills to succeed in an online learning environment. As facilitators of learning, teachers are expected to provide students with ways to acquire self-directed learning skills. Hence, teachers should leverage meaningful activities that are self-guided in nature. Teachers are also expected to design a learning framework that allows students to be more engaged with the material and content than their instructors.

Table8. *Significance of the relationship between self-directed learning and online learning success*

Self-Directedness to Learning	Online Learning Success					
	Computer Skills	Independent Learning	Dependent Learning	Need for Online Learning	Academic Skills	Overall
Awareness	.503** .000	.682** .000	.605** .000	.415** .000	.612** .000	**.706**** **.000**
Learning Strategies	.336** .000	.701** .000	.639** .000	.397** .000	.519** .000	**.660**** **.000**
Learning Activities	.413** .000	.715** .000	.644** .000	.457** .000	.683** .000	**.740**** **.000**
Evaluation	.402** .000	.744** .000	.674** .000	.513** .000	.684** .000	**.776**** **.000**
Interpersonal Skill	.394** .000	.703** .000	.714** .000	.388** .000	.614** .000	**.704**** **.000**
Overall	**.460**** **.000**	**.801**** **.000**	**.741**** **.000**	**.490**** **.000**	**.699**** **.000**	**.808**** **.000**

The findings also show that self-directed learners are more likely to succeed in an online learning environment because they can monitor and regulate their learning. Aside from that, they understand what activities should be undertaken to foster meaningful learning. Most significantly, they know how to assess various learning strategies and activities that would result in effective learning. The findings of this study are in parallel with the results published by Cigdem and Ozturk [53], as they examined the significant components of online learning readiness critical for online achievement in Turkish students. In the study, among its three main features, to wit, internet self-efficacy, self-directed learning, and motivation for learning, self-directed learning appeared to be the strongest predictor of online learning success. Torun [54] also reported a similar finding, as he investigated the effect of e-learning readiness as a predictor for online learning achievement. The predictors of e-learning readiness include computer self-efficacy, internet self-efficacy, online self-efficacy, learner control,

motivation toward e-learning, and self-directed learning. Lasfeto [55] also reported a similar result as he investigated the relationship between self-directed learning and online learning performance (online learning success) of Indonesian students. Based on the results, self-directed learning has a strong positive correlation with the online learning success of Indonesian students. It was evident as he noticed that students developed self-managerial skills as the study progressed.

Significance of the Influence of Digital Literacy and Self-Directed Learning in the Online Learning Success of the STEM College Students

Table 9 shows the results derived from the singular and combined influence of digital literacy and self-directed learning in the online learning success of STEM College students. Based on the multiple regression analysis results, an R2 of .662 and an F of 291.306 with a p-value of .000 were obtained. The p-value is lower than 0.05 rejects the null hypothesis, which further indicates that the variables digital literacy and self-directed learning have a significant combined influence on the online learning success of STEM college students. Furthermore, both the determinants have a significant singular influence on online learning success as digital literacy has a p-value of .005, while self-directed learning has a p-value of .000. Moreover, the indicator of IV1, information skill, had the highest beta coefficient of .382 with a p-value of .000, indicative of its significant influence on the DV. It is also worth noting that the indicators of the IV1, technological skill, personal security skill, critical skill, and devices security skill, showed no significant influence on the online learning success of the STEM College students. However, all the indicators of IV2 have a significant influence on the online learning success of the STEM College students as each recorded a p-value less than 0.05. Altogether, results show that both IV1 and IV2 influence online learning success by 66.2%. The remaining 33.8% are regarded to be factors not covered by this study.

The significant singular and combined influence of digital literacy and self-directed learning on online learning success suggest that students need to acquire digital and self-directed learning skills to survive in an online learning environment. Teachers are at the forefront of providing students with ways to capitalize on these skills as they engage themselves in online learning. As previously stated, science teaching should focus on using digital learning platforms to allow students to explore technology systems, making them digitally literate individuals. Furthermore, because self-directed learning significantly influences online learning success, teachers must ensure that students are equipped with skills they can rely on when learning independently.

Table9. *Significance of the influence of digital literacy and self-directed learning in the online learning success of STEM college students*

Online Learning Success					
(Variables)		*B*	β	*T*	*Sig.*
Constant		-.351		-1.666	.097
Digital Literacy		.160	.117	2.835	.005
Self-directed to Learning		.830	.740	17.865	.000
R	.814				
R^2	.662				
ΔR	.660				
F	291.306				
P	.000				

Additionally, it implies that digital literacy and self-directed learning are crucial factors in online learners' success. Students who know how to search, access, and evaluate online information using different digital technologies are more likely to succeed in online learning. Other than that, success in online learning is highly influenced by a good set of digital skills and a high degree of self-directed skills. Self-directed learning enables an individual to control, monitor, and evaluate their learning. In general, digital literacy and self-directed learning are necessary to be possessed by students engaged in online learning to succeed.

The study findings are synchronically consistent with the results published by Geng, Law, and Niu [56], as they examined the influence of self-directed learning and technology readiness, which includes digital skills in blended and online learning success of engineering students in Australia. The

study reported that self-directed learning and technology readiness (which provides for digital skills) positively influenced online learning success. Students who possessed these skills understood online courses better. A recent study by Wibowo et al [57] reported the significant influence of digital literacy on online learning success. They examined the relationship of the two variables among the Indonesian students. Durnali [58], on the other hand, concluded that self-directed learning has a significant influence on the online learning success of Turkish students.

This study is anchored on the Connectivism Learning Theory of Siemens [59]. CLT capitalizes on the idea that learners should prioritize the development of digital skills (becoming digitally literate), as this is critical in obtaining necessary information across different networks of connection. Also, it underscores the importance of autonomy (self-directed learning) since students are expected to validate previous links and continue to establish information networks that are relevant to them. CLT is regarded as the "learning theory for the digital age," as learning online takes over traditional face-to-face learning. The findings of the study showed a significant relationship both for digital literacy (IV1) and online learning success (DV) and self-directed learning (IV2) and online learning success (DV). Thus, it further indicates that the study results supported the premise of the Connectivism Learning Theory.

5. CONCLUSIONS

With the considerations on the findings of the study, conclusions are drawn in this section. There is a very high level of digital literacy among STEM College students. Similarly, these students manifest a very high level of self-directed learning. They also demonstrate a high level of online learning success. Additionally, there is a significant relationship between digital literacy and online learning success. There is also a significant relationship between self-directed learning and online learning success. Digital literacy and self-directed learning have a significant singular and combined influence in the online learning success of STEM college students. Generally, the findings are supported by the anchor theory – Connectivism Learning Theory by Siemens (2005). Thus, the findings were interpreted as a general rejection of the hypothesis.

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