THE ROLE OF SUPPORT SYSTEM, DIGITAL LITERACY AND LEARNING STRATEGY ON LEARNING OUTCOMES FOR PRESERVICE TEACHERS IN A BLENDED LEARNING ENVIRONMENT

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ABSTRACT

The purpose of this paper is to determine and discuss the factors that influence the learning outcomes of preservice teacher students in a blended learning environment. This quantitative study used a structured online questionnaire to collect responses from preservice teacher students (n=602) from five universities in Indonesia. Measurement analysis was used to validate the instrument, and the structural equation model was used to test the relationship between constructs. The model had four constructs: support system, learning strategy, digital literacy, and learning outcome. This study integrates three factors, namely support systems, learning strategies, and digital literacy, to identify the determinants of student-teacher learning outcomes in a blended learning environment. The research revealed that support systems and learning strategies have an effect on digital literacy and that digital literacy has a direct effect on learning outcomes. This research provides important insights regarding the contribution of support systems, learning strategies, and digital literacy to improve student learning outcomes in a blended learning environment.

Keywords: *blended learning, digital literacy, learning strategy, support system*

INTRODUCTION

Teachers and prospective teachers need to have digital literacy skills to critically evaluate digital technology tools and platforms for safe, wise, and productive use (Akayoglu et al., 2020). These skills need to be carefully prepared in higher education before entering the work environment (i.e., school). Learning good digital literacy skills and having the support of a digital learning environment for prospective teachers will help them develop as educators in the future (Al-Qallaf & Al-Mutairi, 2016). One way to create an interesting and challenging digital learning environment is to apply blended learning. Students prefer blended learning over face-to-face or online learning because there is a correlation between learning environment preferences, self-efficacy constructs, motivation, and task scores in a blended learning environment (Keskin & Yurdugül, 2019; McGuinness & Fulton, 2019).

Digital literacy skills are learning objectives needed by various programs, including prospective teacher programs (Godwin-Jones, 2015). It is very important for prospective teachers to combine digital literacy with their other professional skills (Dooly & O'Dowd, 2012). There are three levels of digital literacy, namely digital competence, digital usage, and digital transformation (Martin

& Grudziecki, 2006). However, the preliminary research shows that the digital literacy skills of prospective teacher students are at the level of digital competencies in terms of their skills, concepts, and approaches. While many students have digital competence, the number of students who have reached digital usage and digital transformation is still limited. Based on the results of the student digital literacy test, the indicators of student digital literacy are weak, including indicators of student information literacy and computer literacy. The ability of students to locate sources and analyze and synthesize learning materials either through the Learning Management System (LMS) or through other search applications is low. Likewise, the ability of students to use computers, especially software for specific purposes, is also low.

This varied level of digital literacy needs to be improved (Akayoglu et al., 2020; Dewi & Fatkhiyani, 2021) by mapping and modeling the various factors that influence it. Improving digital literacy in the education of prospective teachers involves increasing knowledge, optimizing the role of professors, and using social media platforms (Akayoglu et al., 2020) through implementing blended learning (Dewi & Fatkhiyani, 2021). The application of blended learning requires system support, learning planning and strategies, and, most importantly, digital literacy in a blended learning environment.

Adequate planning, content availability, learning activities, and learning assessments can optimize learning resources to increase digital literacy and have an impact on the final results of teacher education programs. This is the support system, one of the components of the model of teaching (Joyce et al., 2015) that includes lesson plans, content, activities in the LMS, and assessment. This research provided an alternative prototype for a blended learning support system to improve preservice teachers' digital literacy (Rahmi et.al; 2022). Furthermore, various studies also have proven that the support system can increase students' digital literacy. Positive student perceptions of content contribute to digital learning and are involved in blended learning in higher education (McGuinness & Fulton, 2019). This student involvement with learning cannot be separated from the scenarios designed, the content available, activities on the LMS, and the form of the assessment carried out.

Along with student perceptions of support systems, digital literacy and learning strategies also affect core competencies (Kim, 2019). This shows that support systems, learning strategies, and digital literacy can improve the performance of prospective teachers. The learning strategy referred to in this study is elearning readiness (Keskin & Yurdugül, 2019). The learning strategy directs the students to learn and utilize the learning technology (Geng et al., 2019) and plays an important role in preparing learning experiences to improve student learning outcomes (Cheng et al., 2019). Learning strategies also support students in completing core competencies by goal setting, time management, and metacognition (Al-Qallaf & Al-Mutairi, 2016; Dzhengiz & Niesten, 2020).

Based on the description of the problem, it is very important to learn how support systems and learning strategies contribute to digital literacy and the learning outcomes of preservice teacher students in a blended learning environment. System support and student digital literacy need to be linked in learning so that learning outcomes can be in accordance with predetermined goals. To the best of our knowledge, this is the first study to investigate support systems as a whole with a focus on learning strategies and digital literacy to identify learning outcomes for prospective teacher students, especially in a blended learning environment. These findings will bring a new understanding for lecturers and instructional designers regarding the determinants of learning outcomes for prospective student teachers, especially in blended learning environments. This research is very important considering the urgency of the need for prospective teachers to develop digital literacy skills, improve the quality of digital literacy, and provide for the next generation. This study aims to determine and discuss the factors that influence the learning outcomes of prospective teacher students in a blended learning environment.

LITERATURE REVIEW

Blended Learning in the Preservice Teacher Program

The education of preservice teachers refers to education that focuses on preparing teacher competencies, including professional competencies related to content/subject matter, pedagogical competencies related to the ability to manage classes,

and social and personal competencies. To prepare these four competencies, preservice teachers are prepared with Technological Pedagogical Content Knowledge (TPACK) involving seven domains (Chai et al., 2010; Ouyang & Scharber, 2018) consisting of: (a) content knowledge/CK, namely mastery of the field of study or learning materials; (b) pedagogical knowledge/PK, namely knowledge about learning processes and strategies; (c) technological knowledge/TK, namely knowledge of how to use digital technology; (d) pedagogical content knowledge/PCK, namely a combination of knowledge about the field of study or learning materials with learning processes and strategies; (e) technological content knowledge/TCK, namely knowledge about digital technology and knowledge of subject areas or learning materials; (f) technological pedagogical knowledge/TPK, namely knowledge about digital technology and knowledge about learning processes and strategies; and (g) technological, pedagogical, content knowledge/TPCK, namely knowledge about the digital technology, knowledge of learning processes and strategies and knowledge of subject areas or learning materials. This competence is provided by educational institutions in a blended learning environment. Regarding learning outcomes, a variety of learning outcomes can be achieved by considering the learning strategies students have, their digital literacy skills, and the support systems that have been prepared for the learning process.

Digital Literacy (DL)

Broader digital literacy recognizes the diverse knowledge, abilities, and dispositions needed by future teachers (Falloon, 2020). Digital literacy refers to an individual's ability to find and evaluate information, use information effectively, create new content using information that has been obtained, and share and communicate it using appropriate digital technology (Reddy et al., 2020). Digital literacy brings together many sub-literacy skills (Lankshear & Knobel, 2008), such as information computer, media, communication, visual, and technology literacy (Covello & Lei, 2010). Digital literacy has an influence on learning outcomes so digital literacy is a prerequisite for achieving effective blended learning (Tang & Chaw, 2015, 2016). Previous research revealed that digital literacy is a prerequisite for success in implementing blended learning (Kim, 2019), while this research reveals how digital literacy relates to learning outcomes and the availability of support systems in blended learning.

Hypothesis 1: Digital Literacy (DL) has a positive relationship with Learning Outcomes (LO).

Support System (SS)

The support system is one of the components in the model of teaching that is explicitly seen in the implementation of learning through a lesson plan, content, activity in LMS, and assessment (Joyce et al., 2015). It is important to integrate technology into support systems in order to improve the digital skills of preservice teachers (Anthonysamy et al., 2020; Güneş & Bahçivan, 2018). This support system is designed to increase the achievement of learning outcomes (Green et al., 2018). Support systems provide a role in increasing learning outcomes because they can improve learning strategies so that students are actively involved during learning (Eom, 2019), and they have a positive influence on student understanding and motivation (Lin et al., 2017). Other research also proves that digital support systems designed for implementing blended learning can determine the success of blended learning itself (Tang & Chaw, 2016). The support system in this article is in the form of technical aspects such as the provision of lesson plans, content, and activities in learning management systems as well as assessments. The perceptions of students of these four components and how they are used in the application of blended learning are examined. Support systems that integrate digital literacy skills have an impact on increasing digital literacy, learning strategies, and learning outcomes.

Hypothesis 2: Support System (SS) has a positive relationship with Digital Literacy (DL).

Hypothesis 3: Support System (SS) has a positive relationship with Learning Outcome (LO).

Hypothesis 4. Support System (SS) is positively related to Learning Strategy (LS).

Learning Strategy (LS)

The learning strategy is a technique for active learning that involves the students in the learning

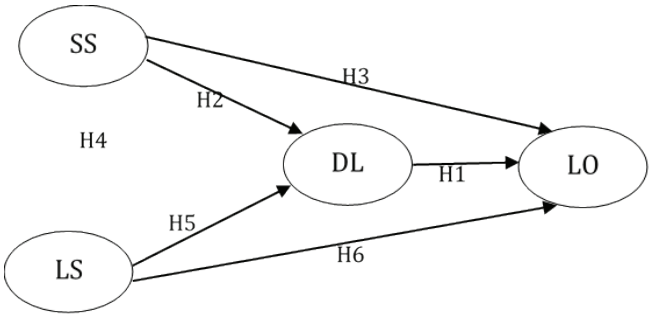
environment through cognitive, metacognitive, behavioral, and motivational components such as planning study, critical thinking, learning with peers, effort regulation, and goal orientation (Anthonysamy et al., 2020). This learning strategy performs better in a digital learning environment (Greene et al., 2018). This learning strategy and learning outcomes are interrelated (Tetteh, 2018), and there is a positive relationship between digital literacy, learning strategies, and learning outcomes (Kim, 2019). The motivation for learning by students is manifested in learning strategies that have also been proven to have a positive relationship to them (Anthonysamy et al., 2020). According to Kim (2019), the indicators of learning strategy consist of rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help-seeking, which are then used in the strategic learning instrument. Learning strategies that combinie evaluation forms and learning time settings have a significant positive effect on learning outcomes. In addition, student learning outcomes are influenced by understanding through learning strategies and collaboration in learning (Pham & Tran, 2020).

Hypothesis 5: Learning Strategy (LS) has a positive relationship with Digital Literacy (DL).

Hypothesis 6: Learning Strategy (LS) is positively related to Learning Outcome (LO).

Figure 1 shows the relationships among the four factors of Digital Literacy (DL), Support System (SS), Learning Strategy (LS), and Learning Outcome (LO).

Figure 1.
Theoretical Framework



METHOD

Participants

The participants in the study totaled 602 people consisting of educational students from five campuses, namely Padang State University, Imam Bonjol Padang State Islamic University, IAIN Bukittinggi and IAIN Batusangkar, and two private tertiary institutions, STKIP PGRI West Sumatra. The survey was carried out by giving questionnaires to students from these institutions. The respondents were divided into gender and scholarship groups, as can be seen in Table 1.

Table 1.
Sample Characteristics

No	Item	Respondents	Percentage
1	Gender	Male	27.3%
		Female	72.7%
2	Scientific	Science	25.4%
		Social	36.9%
		Vocational	37.7%
3	Year of entry	2021	36.7%
		2020	24.8%
		2019	24.3%
		> 2018	14.2%

Survey Instrument

The instrument used in this research measured students' perceptions of support systems, learning strategies, and their digital literacy abilities as well as the level of learning outcomes obtained by students. The instrument used a Likert scale of 1–5, with 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*. Before distributing the instrument to the participants, a validity test of the instrument was carried out by three evaluation experts who looked at the average rating. From the three validators, an average of 90.5 was found, placing the instrument in the very valid category. Then an ICC test was carried out from the validators' assessment to assess the similarity of the validators' consistency in assessing the instrument. The measuring instrument has adequate stability if the ICC between measurements is > 0.50, and high stability if the ICC between measurements is ≥ 0.80 (Polgar & Thomas, 2000; Streiner & Norman, 2000).

Table 2.
Variable Construct Indicators

Construct/Factors	Item	Outer Loadings	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Support System	Sis1	0.645	0.860	0.888	0.445
	Sis2	0.559			
	Sis3	0.698			
	Sis4	0.729			
	Sis5	0.705			
	Sis6	0.570			
	Sis7	0.715			
	Sis8	0.684			
	Sis9	0.667			
	Sis10	0.678			
Learning Strategy	Str1	0.751	0.852	0.882	0.437
	Str2	0.755			
	Str3	0.746			
	Str4	0.698			
	Str5	0.729			
	Str6	0.696			
	Str7	0.627			
	Str8	0.610			
	Str9	Out			
	Str10	0.540			
Digital Literacy	Lit1	0.543	0.915	0.923	0.375
	Lit2	0.604			
	Lit3	0.665			
	Lit4	0.578			
	Lit5	0.659			
	Lit6	0.644			
	Lit7	0.675			
	Lit8	0.582			
	Lit9	0.660			
	Lit10	0.599			
	Lit11	0.585			
	Lit12	0.569			
	Lit13	0.536			
	Lit14	0.665			
	Lit15	0.662			
	Lit16	0.580			
	Lit17	0.638			
	Lit18	0.640			
	Lit19	0.570			
	Lit20	0.567			

Learning Outcome	Lear1	0.541	0.916	0.928	0.463
	Lear2	0.629			
	Lear3	0.688			
	Lear4	0.726			
	Lear5	0.708			
	Lear6	0.711			
	Lear7	0.622			
	Lear8	0.654			
	Lear9	0.694			
	Lear10	0.707			
	Lear11	0.714			
	Lear12	0.738			
	Lear13	0.560			
	Lear14	0.754			
	Lear15	0.722			

Data Collection

After obtaining a valid instrument, data collection was then carried out by distributing the instrument to 602 students. The instrument queried students about the support system variables, learning strategies, their effect on digital literacy, and also the student learning outcomes.

Structural Equation Modelling

The relationship between the variables in this study was tested using structural equation modeling (SEM) using the SMART-PLS 3.32 application. The first model testing step was the model measurement test, which tested the validity and reliability of the model. The convergent validity test was carried out by looking at the value of the outer loading indicators to prove the relationship between the indicators and the latent variables of the model. If the loading factor value of the latent variable indicator is > 0.5, the indicator is said to be valid (Hair Jr. et al., 2017). Then the model reliability test was performed to test the consistency of model measurements. The reliability test has an internal reliability consistency value through the value of composite reliability and Cronbach's alpha > 0.7 (Hair Jr et al., 2017; Ringle et al., 2012). Next, a test was carried out between the variables of the model. The significance of the relationship between variables was seen by the t-statistic value, namely > 1.96 at the 5% level (0.05). If the t-static value > 1.96 it can be concluded that the relationship between variables is significant.

DATA ANALYSIS AND RESULTS

Reflective Measurement Model Analysis

The measurement model with the reflective mode of the indicators in Table 1 is based on the correlation between the item score/component score and the construct score. The reflective measure is said to be high if the correlation is more than 0.70. However, for research in the early stages of developing a measurement scale, a loading value of 0.5 to 0.60 is considered sufficient. The following is the outer loading value of the latent variable.

The loading factor values of the four variables are all above 0.5, which shows that the closeness of the indicators that make up these variables is classified as valid. After testing the validity of the instrument, the reliability of the instrument was tested. The reliability test looked at the value of Cronbach's alpha, which is the value of the reliability of a construct. The rule of thumb is that the alpha value or composite reliability of an instrument is considered to have good reliability if Cronbach`s alpha value is more than 0.7. Based on the reliability test, the value of Digital Literacy, Learning Outcomes, Learning Strategies, and Support System variables was > 0.7. Thus, the instrument had a good reliability value. Furthermore, construct discriminant validity is presented in Tables 3 and 4. Discriminant validity uses criteria (Fornell & Larcker, 1981) and cross-loading by comparing all loading items.

Table 3.
Descriptive Correlation between Factors and AVE Roots

	Mean	SD	DL	LO	LS	SS
DL	3.238	1,102	0.613			
LO	4.175	0.489	0.381	0.681		
LS	4.060	0.771	0.324	0.616	0.661	
SS	3.969	0.748	0.326	0.580	0.485	0.667

Based on the correlation value of the latent variables involved (see Table 3), the root value of the AVE variable was greater than the correlation between the underlying latent variables. This shows that the existing variables were valid. Table 4 shows the cross-loadings of all indicators. All indicators show the highest load on each construct among all other constructs (Hair Jr. et al., 2017). As a result, all items/indicators in a particular construct met the criteria of good discriminant validity.

Table 4.
Cross-Loadings Indicators of Latent Variables

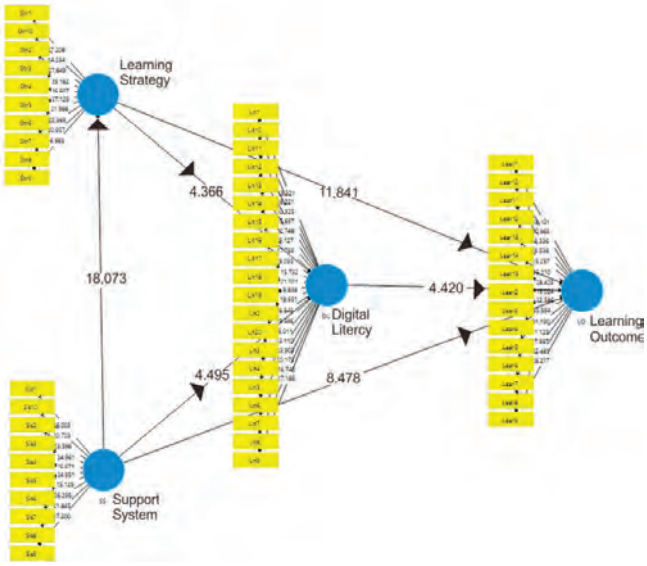
Indicator	Learning Outcome	Digital Literacy	Support System	Learning Strategy
Lear1	0.541	0.220	0.289	0.408
Lear2	0.629	0.283	0.338	0.393
Lear3	0.688	0.326	0.439	0.393
Lear4	0.726	0.304	0.397	0.494
Lear5	0.708	0.303	0.480	0.384
Lear6	0.711	0.251	0.413	0.407
Lear7	0.622	0.179	0.332	0.368
Lear8	0.654	0.182	0.443	0.380
Lear9	0.694	0.273	0.346	0.464
Lear10	0.707	0.272	0.379	0.505
Lear11	0.714	0.272	0.364	0.475
Lear12	0.738	0.229	0.425	0.454
Lear13	0.560	0.229	0.270	0.321
Lear14	0.754	0.240	0.480	0.414
Lear15	0.722	0.305	0.473	0.399
Lit1	0.229	0.543	0.160	0.188
Lit2	0.285	0.604	0.303	0.242
Lit3	0.236	0.665	0.171	0.229
Lit4	0.131	0.578	0.141	0.038
Lit5	0.304	0.659	0.193	0.235
Lit6	0.252	0.644	0.243	0.262
Lit7	0.253	0.675	0.177	0.259
Lit8	0.280	0.582	0.192	0.241
Lit9	0.227	0.660	0.221	0.217
Lit10	0.266	0.599	0.295	0.219
Lit11	0.167	0.585	0.183	0.119
Lit12	0.240	0.569	0.175	0.208
Lit13	0.214	0.536	0.164	0.191
Lit14	0.244	0.665	0.187	0.244
Lit15	0.232	0.662	0.210	0.206
Lit16	0.133	0.580	0.143	0.039
Lit17	0.205	0.638	0.218	0.183
Lit18	0.271	0.640	0.192	0.190
Lit19	0.137	0.570	0.138	0.100
Lit20	0.113	0.567	0.127	0.025
Sis1	0.413	0.219	0.645	0.465
Sis2	0.362	0.211	0.559	0.325
Sis3	0.392	0.253	0.698	0.381
Sis4	0.410	0.235	0.729	0.316
Sis5	0.426	0.199	0.705	0.311
Sis6	0.293	0.218	0.570	0.223
Sis7	0.383	0.222	0.715	0.268
Sis8	0.384	0.227	0.684	0.315
Sis9	0.385	0.167	0.667	0.292
Sis10	0.390	0.215	0.678	0.280
Str1	0.292	0.158	0.245	0.751
Str2	0.276	0.219	0.221	0.755
Str3	0.425	0.171	0.215	0.746
Str4	0.447	0.214	0.228	0.698
Str5	0.430	0.168	0.245	0.729
Str6	0.221	0.209	0.162	0.696
Str7	0.475	0.214	0.445	0.627
Str8	0.511	0.257	0.454	0.610
Str9	0.321	0.153	0.250	0.346
Str10	0.378	0.273	0.435	0.540

Based on the value of cross-loading Table 4, the correlation value of the construct with the indicators was greater than the correlation value with the other constructs. Thus, all constructs or latent variables already had good discriminant validity, where the indicators in the construct indicator block were better than indicators in other blocks.

Structural Model Analysis

Furthermore, the structural test (inner) model was carried out to see the relationship construct or how much influence there is between variables in the model, specifically the relationships between Digital Literacy, Learning Strategies, and Support Systems and their effect on student learning outcomes. The relationships between variables can be seen in Figure 2.

Figure 2.
Relationships Between Variables



FAs Figure 2 shows, Support System has a direct or indirect influence on Learning Outcome and a positive influence on Learning Strategy, Digital Literacy, and Learning Outcome. Table 5 shows the hypotheses devised from this study and the results obtained from the SEM analysis.

Table 5.
Summary of Hypothesis Testing Results

Lane	Hypothesis	Line Coefficient (β)	T-Value	Result
DL -> LO	H1	0.139	4.420	Positive and significant
SS -> DL	H2	0.220	4.495	Positive and significant
SS -> LO	H3	0.337	8.478	Positive and significant
SS -> LS	H4	0.485	18.073	Positive and significant
LS -> DL	H5	0.218	4.365	Positive and significant
LS -> LO	H6	0.407	11.841	Positive and significant

Based on Table 5, the statistical T value of each variable has a value of > 1.96 (significant t-value of 0.05), which means that the relationship between variables is significant. The direction of the relationship is positively seen from the original sample value, which has a positive number. Support System also indirectly influences Learning Outcome through Digital Literacy. This means that optimizing the support system and learning strategies in the model can increase student digital literacy. Thus, paying attention to the blended learning support system to improve the digital literacy of preservice teacher students is important because support systems and learning strategies can improve digital literacy and learning outcomes.

DISCUSSION

The results of the study show that digital literacy has a positive effect on the learning outcomes of student teachers (H1). The results of this study are supported by the results of previous studies stating that digital literacy is very important for increasing the effectiveness of student learning in a blended learning environment (Tang & Chaw, 2016). More specifically, digital literacy skills are considered a prerequisite for the success of blended learning. This means that individuals who have high digital literacy skills can adapt well to blended learning systems. Further, the results show that the support system has a positive effect on digital literacy (H2). This is in line with previous studies stating that active involvement of students using support systems that are integrated with digital literacy can improve digital literacy skills (Eom, 2019; Green et al., 2018). The first support system component that contributes to digital literacy is content and activity in LMS.

The results show that the support system has a significant positive effect on learning outcomes (H3). Support systems in a blended learning environment can improve convenience, access, and learning outcomes (Panigrahi et al., 2018). Students paying attention to the availability of content, being interest in the teaching content, and being involved with lecturers, fellow students, and activities in the LMS, all play an important role in student success when studying (Mahande et al., 2021). This means that the support system in learning must be an important thing for instructional designers

to note so that student learning outcomes can be achieved properly.

Also, there is a positive relationship between support systems and learning strategy (H4). This is in accordance with the results of previous research stating that activities in an LMS can improve learning strategies through student involvement. Thus, student involvement increases if online content is related to the lesson plan (Dwivedi et al., 2019). Learning strategies such as intrinsic motivation can predict engagement if adequate support systems are available (Dunn & Kennedy, 2019). Support systems in the form of increasingly mobile technology have also caused learning strategies to focus on mobile-based learning environments including blended learning. Support systems such as apps and the web complement learning platforms to support student learning strategies (Pérez-Álvarez et al., 2018). Thus, the role of the support system in a learning strategy becomes important, and system support determines the learning strategy chosen to carry out blended learning. In supporting blended learning, there are challenges that must be faced by lecturers and students, including challenges in independent learning and challenges in using learning technology (Rasheed et al., 2020).

Further, learning strategies have a positive effect on digital literacy (H5). This is also in line with and supports the results of previous studies. Blended learning strategies and support systems need to be prepared to facilitate student learning activities so that their digital literacy increases. One of the strategies and activity designs that can be carried out is discussion, because in discussion there is a dialogue between students and lecturers and students and students (D'Souza, 2013; Rahmi et al., 2021). These results have implications for tertiary learning because universities need to develop tools enhanced by digital technology and digital literacy-based learning to increase learning opportunities and make them meaningful for students. One tool is problem-based learning, which is used to develop the core competencies of undergraduate IT students (Mekovec et al., 2018). In addition, project-based learning is also a significant method for facilitating problem-solving, communication, and creative thinking (Wurdinger & Qureshi, 2015). Activities and support systems contribute to increasing student digital literacy.

The findings show that the model is a good fit with significant predictors of digital literacy. In addition, students have a high and positive perception of digital literacy competence, that is, students believe that they have many skills, both cognitive and technical, to use various technologies appropriately and effectively to manage and utilize information (Ata & Yıldırım, 2019; Garcia-Martin & Garcia-Sanchez, 2017; Güneş & Bahçivan, 2018).

Finally, learning strategy has a positive effect on learning outcomes (H6). This is also stated in research on blended learning showing that activities, opportunities, and student involvement are important for improving learning outcomes (Nortvig et al., 2018). Core competencies are defined as the cognitive, affective, and social skills students need to ensure success and a competitive advantage in their present or future educational and professional lives (Boyatzis & Saatcioglu, 2008; Kim, 2019). Other studies also show that improving students' digital literacy and their skills in using information and communication technology is an important condition for successful performance and achieving better results in the learning process (Shopova, 2014). Acquiring the necessary digital literacy competencies is a prerequisite for expanding access to information and communication technologies to ensure greater competitiveness of young people in the labor market.

IMPLICATIONS

This study provides better knowledge about the learning outcomes of preservice teacher students in a blended learning environment from three factors, namely support systems, learning strategies, and digital literacy. This research also provides practical implications for preservice teacher students, lecturers for preservice teacher students, and instructional designers to consider support systems and learning strategies and how they increase digital literacy, which in turn will also improve learning outcomes for preservice teacher students in a blended learning environment. Digital literacy skills are needed by various educational programs, including teacher education programs. This literacy skill is important for preservice teachers to be able to select and critically evaluate tools and optimize various platforms in learning. Lecturers and instructional designers also need to prepare learning components that require system support,

learning planning and strategies, and, most importantly, digital literacy in a blended learning environment. Adequate planning and availability of content, along with good learning activities, learning strategies, and assessments, can optimize learning resources to increase digital literacy and the learning outcomes of preservice teachers in a blended learning environment.

CONCLUSION

This study reveals a positive and significant relationship between support systems, learning strategy, digital literacy, and learning outcomes. The support system is an external part of the student that plays an important role in increasing digital literacy and learning outcomes. Meanwhile, learning strategy is an internal thing that students use to increase digital literacy with learning outcomes. Therefore, the joint action of the external and internal aspects within students plays an important role in increasing the digital literacy and learning outcomes of preservice teachers. Digital literacy also has a significant relationship with learning outcomes. Modeling digital literacy factors was successfully carried out in this study by grouping external and internal factors. External factors were examined separately in other studies, but in this study, they were assessed as a support system consisting of lesson plans, content, activities, and assessments. Thus, blended learning in the future will pay more attention to the support system as something that can be pursued to improve digital literacy.

LIMITATIONS

The implementation of blended learning to improve digital literacy still requires continuous improvement by taking into account other factors that have not been investigated in this study. This research was tested on only three scientific group samples that are not specific to each group. Hence, the results of the digital literacy factor are for the specific group that has been studied.

FUTURE RESEARCH

Future research needs to examine specifically in several scientific fields that have specifications that are richer in their characteristics to develop and test further the determinants of learning outcomes for preservice teacher students in a blended learning environment.

ACKNOWLEDGEMENT

The authors would like to thank Direktorat Riset dan Pengabdian Masyarakat, Deputy for Research and Development Strengthening, National Research and Innovation Agency, Indonesia with Universitas Negeri Padang with a contract number 1362/UN.35.13/LT/2022

FUNDING

This research founding by Direktorat Riset dan Pengabdian Masyarakat, Deputy for Research and Development Strengthening, National Research and Innovation Agency, Indonesia with a contract number 037.E5/PG.02.00.PT/2022

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