

## Digital Literacy and TPACK's Impact on Preservice Elementary Teachers' Ability to Develop Science Learning Tools

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Keywords:	Abstract
<p>digital literacy;</p> <p>TPACK;</p> <p>elementary education;</p> <p>science;</p> <p>learning tools</p>	<p>The transition of education from the 4.0 era of the Industrial Revolution to the 5.0 era of the Social Revolution necessitates educators' skill development. Particularly, technology-based learning devices must be designed with digital literacy and Technological Pedagogical Kontent Knowledge (TPACK) skills in mind so that learning tools for teachers are more creative and innovative. The purpose of this study was to determine the impact of digital literacy and Technological Pedagogical Content Knowledge (TPACK) on the ability of prospective Madrasah Ibtidaiyah science teachers to create learning tools. This study employed a survey approach. Madrasah Ibtidaiyah (Islamic Primary School) IAIN Lhokseumawe sixth-semester preservice teacher students were the subjects of this study. The data collection method employed a questionnaire and a straightforward regression analysis. The results demonstrate a strong correlation between digital literacy and the ability to compose science learning tools. A t-table value of 9.880 indicated a positive and significant relationship between digital literacy and the capacity to organize science learning tools. With a t-table value of -0.562, TPACK has no significant effect on the ability to compose learning tools. Therefore, it can be concluded that digital literacy has a positive effect on the ability of preservice Islamic primary teachers to create science learning tools for their students.</p>

### INTRODUCTION

#### Background

Developing an education system from the age of Industry Revolution 4.0 to Society 5.0 requires educators to improve their skills, especially in designing technology-based learning

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devices. In the world of teacher education, it is necessary to improve the quality of human resources, especially the ability of Indonesian teachers, as it is one of the determinants of learning success. Furqon Arbiyanto et al. (2019) stated that trainee teachers are expected to increase their chances of becoming quality teachers and realise their position in the present era of the Industrial Revolution. The ability to integrate technology into the learning process, both in the learning requirements in the 21st century: planning and implementing learning plans and choosing the suitable learning media.

A lesson plan is a reference document used by teachers that provides an overview of the activities that teachers and students engage in during the learning process (Fahrurrozi & Mohzana, 2020). A well-developed learning implementation plan assist teaching activities. When developing learning media, teachers must integrate ICT into their activity steps. Education Pattern 4.0 necessitates a fundamental and comprehensive revolution in learning systems and educational administration in general. Changes in school systems and learning patterns influence the evolution of education technology. Therefore, educators must be tech-savvy and adaptable, especially given the rapid pace of technological development.

Individuals must possess digital competence to be able to study effectively, such as through distance education (Tang & Chaw, 2015). According to Setyaningsih et al. (2019), digital literacy is also defined as the effort to study, explore, comprehend, evaluate, and employ digital technology. The use of digital media facilitates contextual and audiovisual presentation of instructional materials. Digital-based learning is anticipated to produce engaging, meaningful, and interactive learning that can enhance the quality and achievement of learning objectives, foster collaborative learning attitudes, and increase critical, creative, and communicative thinking skills. Five digital literacy competencies are mapped by Hobbs (2010): (1) Access, which refers to the ability to conduct searches utilizing media and technology and to distribute appropriate and pertinent information to others. (2) Analyze and evaluate the message, which entails comprehending it and applying critical thinking to assess its quality, honesty, reliability, and point of view before taking the communication’s potential effects or consequences into account. (3) Create, which comprises writing or producing material with originality and self-assurance, supported by a focus on the reader and effective composing methods. (4) Apply ethical and social responsibility concepts from one’s own identity and life experience in communication behavior. (5) Act, which involves contributing as a member of society at the local, regional, national, and international levels by working both individually and collectively to exchange information and address issues in the family, workplace, and community.

In the twenty-first century, it is expected of teachers to be able to balance skills, pedagogy, and material content in addition to providing materials and mastering skills in engaging ways. According to Akhwani and Rahayu (2021), TPACK will be a fundamental learning structure in the twenty-first century and a means for teachers to accomplish their educational objectives. When teachers employ the Technological Pedagogical Content Knowledge (TPACK) skills, the use of technology in education is evident. A theoretical framework called TPACK unifies pedagogy, technology, and themes. In order to facilitate an effective and efficient learning process, the TPACK optimizes communication technology by combining content knowledge (CK), pedagogical knowledge (PK), and pedagogical content knowledge (PCK) into an integrated whole. Teachers should place equal emphasis on the knowledge and technological sides of education in addition to the pedagogical side. Technology, pedagogy, and content knowledge are all integrated into one framework called TPACK.

Schmid et al. (2021) explain how and why teachers are unable to separate knowledge and content. Teachers must understand the relationship between pedagogy and content in order to implement strategies that assist students in comprehending the material. Teachers

are expected to comprehend the interrelationships between technology, pedagogy, and content. Effective integration of technology into educational approaches and content areas is possible. TPACK comprises Educational Knowledge (PK), Content Knowledge (CK), and standardised technologies and technologies. Technological Knowledge (TC) refers to the skills needed to operate a technology. In his research, Zimmermann et al. (2021) stated that the use of TPACK in learning in the field of science, particularly chemistry, is crucial because it can improve students' skills in terms of content mastery, teaching materials, and technology integration. For this reason, prospective teachers must master literacy skills, particularly digital literacy, in order to maximize the use of technology in learning; this skill will also have a positive effect on the formation of self-efficacy.

### Problem of Study

Based on the results of interviews with preservice Madrasah Ibtidaiyah teachers at IAIN Lhokseumawe, it was determined that the preservice teachers comprehend technological development but are limited to completing their homework. Some of them still found it challenging to incorporate appropriate educational, content, and technological skills when preparing for learning planning tasks. Most of the preservice teachers also stated that an effective lesson plan should make the learning process more engaging and creative.

Improving the learning process with a lesson plan is necessary to achieve the intended learning objectives. In an effort to enhance the learning management plan, Uno (2011) proposes a lesson plan based on the assumption that: (1) To improve learning quality, a lesson plan for developing the learning activity is required. (2) A systematic approach to lesson design exists. (3) A person learns through a lesson design plan. (4) Refer to students individually when developing a lesson plan. (5) Learning is conducted to achieve learning objectives. (6) The ultimate purpose of lesson planning is to facilitate student learning. (7) The lesson plan includes all learning variables, allowing for the determination of the optimal method of learning to achieve the set objectives. (8) If the teacher possesses strong digital skills, it is prudent to incorporate technological, educational, and content-related skills into the lesson plan.

### State of the Art

In a study examining the TPACK development of pre-service science teachers during a science teaching methods course, Kartal et al. (2021) discovered that the experimental group had a positive ability to integrate technology into science teaching, teachers understood that teaching science with technology required more than technical knowledge and skills, and that it was essential to recognise the interaction between science, technology, and pedagogy. Aktaş & Ozmen's (2020) further research on the development of TPACK from preservice science teachers (PST) who participated in the TPACK Development Course (TPACK-DC) by conducting interviews revealed that TPACK-DC contributed to the association of PST Technology Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), and that with TPACK teachers are able to determine diverse learning methods and use the appropriate technology.

In a study by Hanik (2020) that analysed students' TPACK skills in relation to presentation activities in lectures, it was determined that students' TPACK skills were still in the moderate range, particularly in terms of adjusting material with the appropriate technology. According to Suyamto et al. (2020), the advancement of science and technology can be used to enhance the quality of education. According to Shopie Azizah et al. (2021), prospective teachers are expected to become teachers who are skilled at teaching effectively, mastering content, and able to use technology in the learning process. The ability of TPACK for prospective science teachers can be seen in the preparation of lesson plans that include elements of pedagogy, content, and technology. However, the results of the study indicate

that several prospective science teachers still lack the skills to use technology in the learning process.

### Gap Study & Objective

This study examined the impact of digital literacy and Technological Pedagogic Content Knowledge (TPACK) on prospective Madrasah Ibtidaiyah teachers’ ability to identify and develop science learning plans. In this study, it is hoped that prospective and elementary school teachers will be able to develop their competencies by understanding how technology, pedagogy, and content are subsequently integrated into learning in schools. Based on this description, the researcher conducted research to investigate in greater depth the impact of digital literacy and TPACK on the capacity of aspiring elementary school teachers to create learning media for science learning.

## METHOD

### Type and Design

The goal of this study was to thoroughly explain and analyse the data on digital literacy and TPACK’s impact on preservice elementary teachers’ ability to develop science learning media. Based on research methods, this study took a quantitative approach. The survey method is a survey method that appears in the relationship between the sample’s past or present beliefs, opinions, characteristics, behaviours, sociological and psychological variables. (Sugiyono, 2016).

### Data and Data Sources

All third-year preservice Islamic primary teachers at IAIN Lhokseumawe made up the population of this study. There were 57 participants in the study sample. The validation and reliability phases of survey data collection using questionnaires have been successfully completed. Using a questionnaire was the study’s method for gathering data. a closed questionnaire, in which each statement has a range of possible responses so the respondent can only select the options that best fit his needs. Prior to conducting the research, the instrument must first undergo a trial phase to assess its level of validity (validity) and reliability (reliability). While reliability demonstrates consistency when the measuring instrument is utilised, validity demonstrates the certainty, correctness, or accuracy of the measuring instrument. Using the SPSS 22 programme, this instrument’s validity was examined while accounting for the data in the Corrected Item-Total Correlation, namely the correlation between the individual item scores and the total item scores. The  $r$  table is used to evaluate the data, and if the calculated  $r$  value is higher than the  $r$  table value, the item is considered to be valid. The Gultman split half correlation value, which is compared with the  $r$  table, shows the reliability test’s results. If the calculated  $r$  value is higher than the  $r$  table value, the item is considered to be legitimate. The Gultman split half correlation value, which is compared with the  $r$  table, shows the reliability test’s results.

### Data collection technique

#### Observation

Both direct observation and participatory observation were used in this study. The researchers watched the informants, the teachers, assess students both inside and outside of the classroom. When evaluating students' social attitudes, the reserachers took part in the activities of the teachers.

Following are the elements that informants (teachers) have reported seeing: (1) Observing the social attitudes of the students (2) Noting the social attitudes of the students

(3) Reporting the social attitude notes to the students (4) Signing the social attitude notes in the journal assessment (5) Making a summary of the social attitudes of the students.

#### Questionnaire

Questionnaire tools for retrieving independent variable data are digital literacy and TPACK, and documentation tools for retrieving dependent variables are science learning plans at Madrasah Ibtidaiyah.

**Table 1.** Research Instruments Grid

VARIABLE	INDICATORS
Literacy Digital	1. Internet Search
	2. Guide hypertext (hypertextual navigation)
	3. Evaluation of information content (content evaluation)
	4. Knowledge assembly
TPACK	1. TK (Technological Knowledge)
	2. PK (Pedagogical Knowledge)
	3. CK (Content Knowledge)
	4. PCK (Pedagogical Content Knowledge)
	5. TCK (Technological Content Knowledge)
	6. TPACK (Technological Pedagogical Content Knowledge)
Learning Tools	1. Identify general learning objectives
	2. Teaching analysis
	3. Identify the input behavior and characteristics of students
	4. Development of test items or evaluation tools
	5. Learning Strategies

#### Data analysis / Analisis Data

Simple regression methods are data analysis techniques used in quantitative research that use statistics to determine the impact of the independent variable (X) on the dependent variable (Y) and how much of an impact it has (Sugiyono, 2016). R has a value between 0 and 1, and as it approaches 1, it indicates a stronger relationship; conversely, as it approaches 0, it indicates a weaker relationship. The significance of the regression equation and the linearity test using SPSS 22 are then presented.. The final stage is to test the hypothesis, carried out to test the effect between the variables as well as to find out how big the influence between the independent variable and the dependent variable is, test the hypothesis in this study using the t test, to determine whether there is an effect of variable X on variable Y with a 95% confidence level or = 0.05 or Sig value <0.05. The statistical hypotheses in this study are;

$$H_0 : r_{y1} = 0$$

$$H_1 : r_{y1} > 0$$

#### RESULT

##### Normality Test Result

To check for normality in this study, the Kolmogorov-Smirnov test is used. The calculated result must be higher than 0.05 to satisfy the one-sided test significance criterion. It has to

be evenly distributed, in other words. The digital ability normality test result showed a value of 0.114 or greater than 0.05. In other words, the distribution of the digital capability data is normal. The TPACK normality test yields a result of = 0.200 or > 0.05, indicating that H0 is accepted and H1 is rejected. The TPACK data is therefore normally distributed. Table 2 displays the findings of the normality analysis.

**Table 2.** Result of variable Normality Test for Digital Literacy (X1) and TPACK (X2)

One-Sample Kolmogorov-Smirnov Test			
		Unstandardized Residual	Unstandardized Residual
<b>N</b>		34	34
<b>Normal Parameters<sup>a,b</sup></b>	Mean	.0000000	.0000000
	Std. Deviation	.52919851	.52652493
<b>Most Extreme Differences</b>	Absolute	.136	.101
	Positive	.136	.101
	Negative	-.096	-.059
<b>Test Statistic</b>		.136	.101
<b>Asymp. Sig. (2-tailed)</b>		.114 <sup>c</sup>	.200 <sup>c,d</sup>
<b>a. Test distribution is Normal.</b>			
<b>b. Calculated from data.</b>			
<b>c. Lilliefors Significance Correction.</b>			
<b>d. This is a lower bound of the true significance.</b>			

**Linearity Test Results**

The linearity test results show the relationship between digital ability and the ability of future teachers to plan learning. Since the significance value = 0.000, the probability value (column Sig) = 0.72 and F = 0.522. It can be concluded that the regression model is linear (0.72>0.05). For the result of the relationship between TPACK and future teacher ability in the learning plan, the regression model is linear for the value of probability value (column Sig) = 0.857 and F = 0.328 because the p-value = 0.857> 0.05. The results of the linearity analysis of Literacy digital can be seen in the table 3, and The results of the linearity analysis of TPACK can be seen in the table 4.

**Table 3.** Result of Linearity for variable Literacy Digital

			ANOVA				
			Sum of Squares	Df	Mean Square	F	Sig.
Learning Plan *	Between Groups	(Combined)	31.871	5	6.374	20.753	.000
Literacy Digital		Linearity	31.229	1	31.229	101.675	.000

	Deviation from Linearity	.642	4	.160	.522	.720
	Within Groups	8.600	28	.307		
	Total	40.471	33			

Table 4. Result of Linearity for variable TPACK

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
Learning Plan * TPACK	Between Groups	(Combined)	4.213	5	.843	.651	.663
		Linearity	2.513	1	2.513	1.941	.175
		Deviation from Linearity	1.700	4	.425	.328	.857
	Within Groups		36.257	28	1.295		
	Total		40.471	33			

### Results of Hypothesis Test

Based on the results of the regression test, the results of the first hypothesis test (H1) showed significant values of the trainee's digital literacy impact on 0.00 and t- scientific learning plans. I did. With a value of  $9.880 < t_{table} < 2,032$ , we can conclude that H1 was accepted. This means that teachers' up-and-coming digital literacy has an impact on their ability to plan scientific learning. The coefficient of determination is  $0.772 \times 100 = 77.2\%$ . This shows that 77.2% of the impact of digital ability on the planning ability of scientific learning can be explained as a pure impact. The remaining 22.8% is not due to other observed effects cause from the author. Based on these results, we can conclude that the impact of future teachers' digital literacy on science learning plans is important.

The results of the second hypothesis test (H2) showed that the significant value of the TPACK effect of the ambitious teacher on the science learning plan is 0.578 and the t count value is  $-0,562 < t_{table} < 2,032$ . Since it is 2.032, it can be concluded that H1 is rejected. This means that there is no TPACK on science lesson planning abilities for aspiring teachers. The coefficient of determination is  $0.062 \times 100 = 6.2\%$ . This indicates that the impact of future teachers on TPACK on science learning planning can be explained by only 6.2%, with the rest being influenced by other author-dependent factors 93,8%. Based on the results of data analysis, it can be concluded that there is no significant effect of TPACK on the ability of teachers to prepare lesson plans on science material. The results of the regression test result can be seen in the table 5.

Table 5. Result of Regression Test

		Coefficients <sup>a</sup>				
Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.274	5.012		1.651	.109
	Literacy Digital	.782	.079	.895	9.880	.000
	TPACK	-.041	.073	-.051	-.562	.578

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**a. Dependent Variable: Learning Plan**

Based on the results of the hypothesis test, digital literacy has a positive and significant impact on the ability of Madrasah Ibtidaiyah teachers to plan science learning for students. The calculated F is 108.132 and the F table is 0.304. Therefore, since the calculated F-number > F-table is 108.132 > 0.304, we can conclude that digital ability and TPACK simultaneously affect the ability of future teachers in Madrasah Ibtidaiyah to plan science learning. Increase, the magnitude of the correlation coefficient between digital literacy and TPACK regarding the ability of an ambitious primary school teacher to prepare tools for science lessons is 0.774 or 77.4%, the rest being influenced by other factors. The result of the multiple regression significance test that the two variables have a significant effect together is shown by the following regression equation.  $Y = 8.274 + 0.782 X_1 - 0.41X_2$  The standard error of the estimate is 5.012. The results of this test show that digital literacy and TPACK have a significant impact on the ability to plan scientific learning.

## DISCUSSION

Based on the results of data analysis carried out by Madrasah Ibtidaiyah teachers using the interpretation of digital literacy variables regarding the ability of students to plan science learning, the magnitude of the effect, both individually and collectively, has a significant effect with 77.2 percent. As a result, it can be said that trainee teachers' digital literacy has a 77.2 percent impact on educational quality, with other factors responsible for the remaining 22.8 percent. This supports the claim made by Schmid et al. (2021), who found a positive correlation between TPACK components and the use of technology in lesson plans among teacher candidates. Additionally, Sholihah et al. (2016) discovered that learning PostPack enhanced the capacity to develop TPACK and aspirant physics teachers' learning tools.

Only 6.2 percent of Madrasah Ibtidaiyah teachers' ability to plan scientific instruction for future students is impacted by the TPACK variable. These findings demonstrate that TPACK does not significantly affect science learning plans development, with other factors accounting for the remaining 93.8% of the variance. According to Aktaş and Zmen (2020), TPACK skills enable science candidates to select the best teaching strategy by using technology to teach pertinent subjects. helpful for engaging students, classroom management, and using the right direction when instructing science subjects.

The simultaneous data analysis results can be interpreted using the teacher of the Ibtidaiyah madrasah's ambitious TPACK, which is very good at planning concurrent science lessons, and the variables of digital aptitude. The analysis yielded a R value of 0.878 and a coefficient of determination value of 0.774, or 77.4%. This finding supports the assertion made by Prasetyo et al. (2019) and demonstrates that teachers' TPACK is significantly impacted by their ICT skills, with an effect size of 14.21%. In other words, both variables are highly significant. Additionally, the study by Kartal et al. (2021) showed that the experimental group can successfully integrate technology into science classes because they have aspirational science teachers. Reacted. Given that there are only knowledge, skills, and technical skills, it takes skills to achieve interactions between science, technology, and pedagogy..

Overall, TPACK and digital literacy have a positive and significant impact on ambitious teachers' capacity to plan lessons, particularly at the basic education level and especially with scientific materials, according to the findings of hypothesis testing. According to Altun (2019), who conducted research at a university in Turkey to examine the impact of digital literacy and the attitudes that prospective early childhood education teacher students developed as a result of applying TPACK, it was discovered that students' understanding and

mastery of digital literacy affects their ability to integrate technology in learning, which is one of the components of TPACK. The ability of teachers to have ambitions to plan learning, especially at the basic education level and especially with scientific material, is generally based on the results of testing the hypothesis that digital literacy and TPACK have a positive and significant effect on that ability. Therefore, it is expected that teachers will need to develop their teaching skills by understanding how to incorporate technology into the creation of appropriate lesson plans and apply it during the learning process in order to produce quality graduates who can think critically and creatively. In order for educators to be more competent in their line of work, it is also hoped that the involvement of stakeholders will increase the calibre of educational personnel. Adequate facilities and infrastructure must also be improved.

### CONCLUSION

According to the survey's results, future Madrasah Ibtidaiyah teachers will be better able to plan their students' science lessons if they are digitally literate. Based on these findings, efforts should be made to raise the standard of digital literacy so that future educators can become more professional and timely. The ability of Madrasah Ibtidaiyah teachers to plan science lessons for future students is impacted by TPACK. Its worth is inferior to the effects of digital literacy. Other, stronger variables may have an impact on a teacher's capacity to design a science lesson plan for elementary school students. In conclusion, the ability of Madrasah Ibtidaiyah IAIN Lhokseumawe teachers to prepare science lessons for future students is significantly impacted by digital literacy and TPACK. Therefore, in order to enhance the quality of education and make it competitive in today's changing times, digital literacy and TPACK need to be appropriate for all aspiring and primary teachers.

This study still only included students who attended Madrasah Ibtidaiyah IAIN Lhokseumawe, which is one of its major limitations. Before students create learning plans, there is a need for prerequisite courses to further cover TPACK and digital literacy in order to make the data more significant. A larger sample, including madrasah ibtidaiyah teachers in Lhokseumawe City and Aceh Utara District, needs to be studied for future research on the role of digital literacy and educators' TPACK in planning. Two recommendations come from this study: 1) in the context of Islamic Primary Teacher Education, lecturers' ability to incorporate digital literacy into materials and learning processes needs to be strengthened; 2) there should be a workshop for principals and teachers to improve teacher competency, particularly for madrasah Ibtidaiyah teachers to integrate digital literacy and TPACK both from planning and the learning process.

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