Design of Conceptual Framework Integrated Mobile Learning System (IMLS) to Foster Science Literacy of Elementary School Students

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Abstract. Science literacy in elementary school students in Indonesia shows undeveloped results, this is expanded by the COVID-19 pandemic which causes learning loss. The purpose of this study is to design a conceptual framework for an integrated mobile learning system (combining formal and informal learning) in developing science literacy in elementary school students to excel after the COVID-19 pandemic. The research method is the one-group pretest–posttest pre-experimental design. Data collection techniques such as essay tests to measure early science literacy before and after using IMLS on as many as 60 elementary school students aged 9 – 10 years in Tangerang, Indonesia. The time of the study is carried out during 2023. The results showed that IMLS has a theoretical foundation, namely learning design for media (combining formal and informal learning), elementary school student development, and science literacy made in one comprehensive framework so that it can be used as a basis for making IMLS. The next research recommendation is that the results of the conceptual framework can be developed into IMLS to be tested on elementary school students related to other science skills.

Keywords: science literacy, IMLS, elementary school students, formal learning, informal learning.

INTRODUCTION

Student excellence can be seen in the science literacy that students have. Science literacy is important for elementary school students to master because in the national education system in Indonesia, science literacy has begun to be accommodated in the 2006 Curriculum or Education Unit Level Curriculum and is more clearly seen in the 2013 Curriculum. Science literacy is used as a superior criterion for elementary school students because it is included in the 21st century students' skills in digital literacy [1]. Science literacy is important for Indonesian students because they live in a country that has rich natural resources and needs to be preserved. With rapid population growth, every action and decision taken will affect energy consumption, human personal health, natural resources, and the environment which ultimately the well-being of oneself, society, and the world requires early science literacy.

Many previous studies in Indonesia that examined the science literacy of elementary school students are still low[2]–[4]. Another study for science literacy also found that high school students in Indonesia showed that almost half (41%) had limited science knowledge. It was further revealed that no student can consistently identify, explain, and apply science concepts to life's more complex problems. In fact, the era of the ASEAN Economic Community (AEC) demands the preparation of superior quality of Indonesian human resources. The big challenge faced by Indonesia is how to fight for productive age people [5].

With the low science literacy possessed by high school students, it shows that at the elementary school level, students' science literacy still cannot be developed properly by teachers or parents. Practicing science literacy from an early age not only allows individuals to cope with everyday problems, but also forms the basis for individuals highly qualified in science [6]. The low condition of science literacy possessed by elementary school students in Indonesia was exacerbated by the incidence of Covid-19 in 2020. In Indonesia, school closures during the Covid-19 pandemic caused 60 million students to cause significant learning loss. In some areas, there is even an increase in the percentage of early grade students in elementary school who cannot read [7].

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A new World Bank study presents estimates *Learning loss* at children due to COVID-19 related school closures in Indonesia. Estimates show that school closures through June 2021 have resulted in the loss of approximately 0.9 years of learning-adjusted schooling and 25 points on students' Program for International Student Assessment (PISA) scores. *Learning loss* in Indonesia is caused more by existing learning support problems than by the length of school closures [8]. With the possibility of learning loss experienced by 60 million students, it will have an impact on students' science literacy skills.

Based on the results of a preliminary study in 2022 that has been conducted on 107 grade 4 elementary school students in Banten, DKI Jakarta, and West Java (when school closures are underway due to the Covid-19 pandemic) it was found that fathers helped students at home with assignments from school amounting to 5 (5.35%) students; assisted by mothers as many as 45 (48.15%) students; assisted by 6 (6.42%) students; and doing schoolwork is not assisted by adults (alone) totaling 43 (46.01%) students. Questionnaires were also given to parents when student learning shifted from school to home, finding that most parents (70%) responded slowly to help children when receiving assignments from teachers. This is because parents who work are also in the network so they cannot monitor the child's learning progress. Teachers often contact and remind parents personally to constantly monitor the child's learning progress. This shows that parents and teachers are not used to learning online, to anticipate if such things happen, a media is needed that can help and monitor the learning process, as well as connect formal and informal learning so that parents and teachers can establish good communication in learning. With this effort, it is necessary to minimize learning loss so that students can still have good science literacy.

So far, research in Indonesia (before the Covid-19 pandemic) related to science literacy in elementary school students has discussed more about the use of technology to improve science literacy skills [2]; Measure science literacy using categorization of nominal literacy, functional literacy, conceptual literacy, and multidimensional literacy [2], [9]. Supporting factors or components for cultivating science literacy [10]; and assess science literacy skills instruments [11]. However, it has not addressed the involvement of parents and teachers in instilling science literacy in elementary school students. Therefore, this study designed the conceptual framework of the Integrated Mobile Learning System (combining formal and informal learning) in developing science literacy in elementary school students to excel after the COVID-19 pandemic.

Science Literacy for Elementary School Students

In the 21st century, society needs to adopt the increasingly rapid development of technology and science. This makes there a need to teach students to know and use new technological and scientific tools. Previous research studies have shown that many individuals in emerging or developing countries do not have adequate knowledge and skills in science and technology [12].

Science is studied by elementary school students to help in practicing thinking skills. In order for students to truly understand science well, teachers must direct students through actions that reflect the values of scientific practice [13]. Science literacy can be seen in the ability to ask questions, develop models, plan and conduct investigations, analyze data, use mathematics, construct explanations, engage in arguments, and communicate information [14]

Students proficient in science are characterized by: 1) knowing, using, and interpreting scientific explanations of nature; 2) generate and evaluate scientific evidence and explanations; 3) understand the nature and development of science; and 4) participate productively in scientific practice and discourse [13]. When students master these four traits, they can participate in society as educated citizens. All young children have the intellectual ability to learn science. Even when they enter school, young children have a rich knowledge of nature, demonstrate causal reasoning, and are able to distinguish between relevant and irrelevant sources of knowledge [13].

Science literacy according to the measurements from PISA in 2018 is determined by three competencies, namely *first,* explaining phenomena scientifically, this competence requires knowledge of the content of science – hereinafter referred to as content knowledge; knowledge of the way the ideas are generated (procedural knowledge); as well as an understanding of the underlying reasons for these procedures and the justifications for their use (epistemic knowledge). This competence is in the form of a series of activities such as recognizing, offering and evaluating explanations of various natural and technological phenomena through: 1) remembering and applying appropriate scientific knowledge; 2) identify, use and produce explanatory models and representations; 3) make and correct correct predictions; 4) offer explanatory hypotheses; and 5) explain the potential implications of scientific knowledge for society.

Second, competence about evaluating and designing scientific investigations; in the form of explaining and assessing scientific investigations and proposing ways to answer questions scientifically through: 1) identifying questions explored in certain scientific studies; 2) distinguish those questions that allow for scientific investigation; 3) propose ways to explore certain questions scientifically; 4) evaluate how to explore a particular question scientifically; and explain and evaluate the various means scientists use to ensure data reliability and objectivity and generalizability of explanations.

Third, competence regarding interpreting data and evidence scientifically; in the form of analyzing and evaluating scientific data, claims and arguments in various representations and drawing appropriate conclusions through: 1) transforming data from one representation to another; 2) analyze and interpret data and draw appropriate conclusions; 3) identify assumptions, evidence and reasoning in science-related texts; 4) distinguish arguments based on evidence and scientific theory from arguments based on other considerations; as well as evaluating scientific arguments and evidence from a variety of sources (e.g. newspapers, the Internet, journals) [15].

Although the three competencies are related to content, procedural, and epistemic knowledge, in this study, participants were tested in the context of material content knowledge because it was adjusted to cognitive development which was still a concrete operational level.

Integrated Mobile Learning System (IMLS)

Today, mobile learning (M-Learning) has become a popular research topic by reviewing how to use mobile devices for learning and learning activities [16], [17]. M-learning is a learning model that uses smartphones, tablets, netbooks or notebooks as a means of learning and is part of learning through electronics (e-learning). M-learning is more flexible than e-learning because students can learn anywhere, anytime[17] and mobile devices are now an essential tool in students' daily lives.

Many studies have linked learning *Mobile* with student motivation and learning outcomes [18]–[26]. Traxler concludes that research on M-learning in developing countries should be valued for understanding the challenges associated with unique cultures, infrastructure, and learning environments [27]. Related to the learning environment, so far m-learning is more directed at formal learning [18], [19], [30], [20]–[26], [29].

Several studies prove that m-learning has become an important factor in the learning process for 21st century learners because m-learning can improve the learning process such as providing learning experiences outside the classroom [31]. A study conducted by [31] Shows that m-learning has been introduced early, although the focus of this study is only on children's interaction with m-learning in terms of communication with their friends and reading materials. This research shows that mobile learning can be provided also for elementary school students.

IMLS is mobile learning as an integrated learning system that combines supporting concepts in it. Integrating mobile learning can help address connectivity and convenience issues [32]. Several previous studies have discussed that online learning can combine formal and informal learning [33]–[35]. In the context of formal and informal learning, mobile devices such as smartphones and tablets make learning take place anywhere and anytime. The transmission of learning from traditional school settings—face-to-face classes—to informal school settings or outside educational institutions is now made possible by incorporating mobile technology in education [36]. Smartphones and tablets have expanded learning opportunities; With mobile apps, the gap between formal and informal learning can be mixed or combined into one unit that supports student learning. This indicates that students inside the school (formal learning) and students outside the school (informal learning) can work together, exchange ideas and ideas, collaborate, interact, and increase motivation.

Formal and Informal Learning in Elementary School Science Learning

Formal learning takes place in educational institutions such as schools and universities [37], [38]. Formal learning is structured in terms of learning objectives, learning content and learning support and the results are certified regularly. Learning opportunities can be placed in both informal and formal settings. In contrast, informal learning can be defined as the development of competencies that are not structured in terms of learning objectives, study time or learning support and usually do not lead to certification. For informal learning, learning opportunities are not organized by educational institutions (e.g. schools). Against this background, informal learning can also be described as non-institutional learning [37], [38].

With the advent of social software and the advancement of web-based technology, online learning provides invaluable opportunities for learning, both formal and informal. Formal learning is a top-down, instructor-centered, and carefully planned formal learning setting; In contrast, informal learning networks offer more bottom-up, student-centered but somewhat disorganized participatory learning opportunities for students [35]. Many researchers [34], [35], [39], [40] emphasizing the social nature of informal learning in the digital age, as student experiences are heavily influenced by social technologies. For example, students today use instant messaging, visit websites, listen to music, play games, and download materials as informal learning tools [33], and all these methods are key to social interaction.

The scope and practice of informal science learning focuses more on distinctive experiences and activities such as science centers and museums, zoos, exhibitions, competitions, field trips, and so on [41]. Science informally looks at learning outcomes from daily activities related to work, family, or recreation, which are not organized or structured in terms of learning objectives, time, or support, and are largely unintentional from the learner's perspective [41]. Therefore, the degree of intentionality plays an important role in both informal learning.

Integration of Mobile Learning with Formal and Informal Learning

Several studies have been conducted to eliminate the gap between formal and informal learning [42]–[45]. Research conducted by [46] has developed an approach that brings together formal and informal learning using mobile apps; Their approach is based on Science, Technology, Engineering, and Mathematics (STEM). The results demonstrate the capabilities of mobile apps, and the way they can be used to facilitate and design learning activities in different contexts. Therefore, teachers can design and deliver learning through various mobile applications so that they can be accessed inside and outside the school environment.

By using mobile technology, wherever students are (inside or outside the school environment), there are no superiors or barriers to the time and location of learning thus expanding learning mobility and allowing educating everyone in different situations anywhere and anytime. [47] affirms that the nature of the learning process does not separate between formal and informal learning, because when formal and informal are mixed, it means educational institutions have the knowledge and skills they need to provide, while serving what students need to have: a collaborative and creative learning environment through their mobile technology, a place of independent learning.

To blur the gap between formal and informal learning environments, it can be done by building knowledge communities, such as conversation, discussion, interaction, sharing and engagement between all communities, in a variety of learning environment ways. Informal learning in mobile technology can be through the mobile cloud space, in hybrid mobile applications, and in the social networking space. Virtual meeting points can be created where learners can collaborate with each other through an app on their phones [48]. They can communicate, engage and create, then get the ideas and learning resources they acquire in one location and apply or develop them in another – and that can happen in the classroom in a formal setting [49]. Thus, the gap between formal and informal learning can be bridged with mobile technology, so that a new and innovative learning order is formed in a hybrid, dynamic, and synergistic manner. It is also important for schools to design and integrate tools and devices that can be used across subjects in the classroom, allowing flexibility and portability [50].

METHOD

Research Design

This study used the one-group pretest–posttest pre-experimental design. The design of this study is (see table 1)

TABLE 1. Research design

Pre-test	Treatment	Post-test
O_1	X	O_2

Information:
O_1 : Pre-test
O_2 : Post-test
X : Treatment (provision of IMLS for science learning)

Participants

The participants of this study were elementary school students who were in grade IV as many as sixty students with an age range of 9 – 10 years and were distinguished by 32 men and 28 female students. Study participants were selected without consideration because elementary school age tends to have the same stage of development. The sixty students belong to the same public school in Tangerang, Indonesia, although they are divided into classes IVA and IVB, which are heterogeneously divided. The study was conducted during 2023.

Procedure and Materials

This study involved grade IV elementary school students from one school in Tangerang, Indonesia as many as 60 students with four numbers of description tests asking about morphological adaptations in ducks; utilization of renewable energy in everyday life; rice field ecosystems, various problems and how to overcome them; and metamorphosis. Student answers were assessed using an assessment rubric that has been adapted from the PISA 2018 science literacy indicator and adjusted to the stages of cognitive development of students aged 9 to 10 years. The rubric of science literacy indicators of elementary school students can be seen in table 2.

TABLE 2. Rubric of science literacy indicators of elementary school students (PISA Adaptation 2018)

Science Literacy Competence	Competency Indicators	Answer Criteria
Explain phenomena scientifically	Knowledge of the content of science scientifically	Give more than one short answer complete with explanations
Design and evaluate scientific investigations	Explain, assess, and propose scientific investigations	Determine the formulation of relevant problems based on the given phenomenon Distinguish scientifically investigable questions Propose ways to answer questions of scientific inquiry Design experiments that are appropriate and in accordance with the objectives of scientific investigation Evaluate ways to answer questions of scientific inquiry Evaluate the design and results of scientific experiments
Interpret data and evidence scientifically	Analyze and interpret data and draw appropriate conclusions	Transform data from one representation to another Analyze and interpret data and draw appropriate conclusions Identify assumptions, evidence and reasoning in science-related texts

Data analysis

After obtaining the data results for the science literacy test, which has been quantified through an assessment rubric made based on competency criteria from PISA 2018, the next step is to conduct data analysis. This research uses quantitative data analysis techniques, namely descriptive statistical analysis and inferential statistical analysis. Before testing the hypothesis, a prerequisite test for proving the hypothesis is carried out, namely the normality test. In this study to test whether the sample is normal is calculated with the Statistical Product and Service Solution (SPSS) 22.0 for windows program. With the Kolmogorov-Smirnov one sample test using a signification level of 0.05. The data is declared normally distributed if the significance > 0.05. Then it is done, the calculation of homogeneity using the F test is done by comparing Ftable with Fcalculate. If Ftable < Fcalculate, then the data group is homogeneous. Hypothesis testing using t-test. The t-test is used to compare between two variables whether significant or not.

RESULTS

Descriptive results

The descriptive test for science literacy was conducted by measuring the pretest and posttest through the science literacy assessment rubric from the PISA 2018 adaptation. The results of the science literacy test can be seen in table 3.

TABLE 3. Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	60	.00	62.50	32.2917	13.57490
Posttest	60	.00	93.75	51.9792	19.57884
Valid N (listwise)	60				

Based on the table 3, students have a maximum score of 62.50 for the science literacy description test given with an average score of 32.2917, while for the minimum score in the school of 70.00 so that sixty students can be said to all still not meet the minimum score standards set by the school.

During the pretest, learning media were given that had been used by teachers, namely PowerPoint and learning videos with scientific learning models. The scientific learning model is in accordance with what is contained in the 2013 national curriculum. For the implementation of the posttest, students are given IMLS which is a scientific learning model, however, combining formal and informal learning, so that what distinguishes it from the pretest is parental involvement, and IMLS media that accommodates students' informal learning activities. Inferential statistical analysis in this study carried out several tests such as normality, homogeneity, and hypothesis.

Normality Test

To obtain data on the increase in scientific literacy, the pretest and posttest results from the developed descriptive test were used. The test was given before and after the IMLS was implemented. The pretest and posttest results were then tested for normality to determine whether the data was normally distributed or not. The normality test was carried out using the Shapiro-Wilk test using the SPSS 22.0 program. The results of the normality test for the pretest and posttest results can be presented in Table 4.

TABLE 4. Tests of normality

		Tests of Normality					
	Class	**Kolmogorov-Smirnova**			**Shapiro-Wilk**		
		Statistics	**Df**	**Sig.**	**Statistics**	**Df**	**Sig.**
Value	Pretest	.164	60	.000	.953	60	.022
	Posttest	.110	60	.070	.982	60	.533

a. Lilliefors Significance Correction

Based on the table 4, the normality test results are known to pretest significance values of 0.000 < 0.05, so, it can be concluded that the values are not normally distributed. Pretest values are not normally distributed, due to the presence of *outliers*. Outliers in the form of students obtaining extreme low scores that even score 0. The 0 score for the pretest is not because students do the evaluation carelessly, but because they cannot do the evaluation, students try to answer, but the answer is wrong. This can be because, one of them is that students are still in a condition to enter face-to-face learning meetings after the Covid-19 pandemic for four months, so learning adjustments still need to be made, while for posttest scores it is found that the normality test results are known post-test significance values of 0.070 > 0.05, so, it can be concluded that the values are normally distributed.

Homogeneity Test

After the normality test was conducted, the data of the pretest and posttest results of students' science literacy were then tested for homogeneity to determine whether the data had homogeneous variance or not. The homogeneity test used the SPSS 22.0 program. The results of the homogeneity test of the data of the pretest and posttest results of students' scientific literacy are presented in Table 5.

TABLE 5. Tests of Homogeneity of Variances

		Levene Statistic	**df_1**	**df_2**	**Sig.**
Value	Based on Mean	7.795	1	118	.006
	Based on Median	7.166	1	118	.008
	Based on Median and with adjusted df	7.166	1	106.541	.009
	Based on trimmed mean	7.676	1	118	.007

Based on the results of the homogeneity test for pretest and posttest values, it is known that the significance value is 0.006 < 0.05, so, it can be concluded that the value of the data distribution is homogeneous, while for the t test a calculation is carried out.

T-Test

Based on the results of the normality and homogeneity test of the pretest and posttest results which indicate that the data is normally distributed, and the data has homogeneous variance, then for hypothesis testing using parametric statistical tests. The parametric test used is the paired samples t-test which is processed with the help of SPSS 22 data processing software. The paired samples t-test is used to determine the significance of the difference in pretest and posttest values. Based on data analysis using the SPSS 22 program, the results are as in Table 6.

TABLE 6. Paired samples test

		Paired Samples Test							
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	Df	Sig. (2-tailed)
Pair 1	Pretest - Posttest	-19.68750	25.23263	3.25752	-26.20578	-13.16922	-6.044	59	.000

Based on the table 6, a significance value (2-tailed) of 0.00 < 0.05 shows a significant difference between the initial variable and the final variable, this shows that there is a significant influence on the difference in treatment given by each variable. In conclusion, there was a significant difference when students were given PowerPoint media and learning videos with science learning models compared to when given IMLS with science learning models.

DISCUSSION AND CONCLUSIONS

Initial Conditions of Science Literacy Skills of Elementary School Students

Science literacy is divided into three competencies, namely explaining phenomena scientifically, designing and evaluating scientific investigations, and interpreting data and evidence scientifically. The description test given to students assesses students in these three competencies. The explanation is directed at each of these competencies.

Explain phenomena scientifically

Based on the results of research in this study found that most (83%) students have well given more than one short answer complete with explanations. Explaining phenomena scientifically in science education involves integrating language, experience, and interaction in the classroom [51]. With the ability of students to explain phenomena scientifically in this study, it shows that students have been able to integrate what has been known with new knowledge and experience gained so as to provide scientific support for certain phenomena.

Questions asked to students related to this competence are about Duck Morphological Adaptations. Students can explain with answers 1) webbed duck feet make it easy for him to swim; 2) duck feathers are not translucent so that when swimming their body does not get wet; and 3) a wide duck's beak makes it easy to find prey or food. The explanations given by elementary school students in science education involve scientific knowledge, and can be based on theory, evidence, and mixed with everyday life experience [52]. Therefore, it is necessary for teachers to provide questions that are in accordance with previous student experience, so that identifying prerequisite knowledge is needed so that students do not experience great difficulties to answer a phenomenon scientifically. The taking of themes or events for Science learning should also be adjusted with students' everyday experiences [53].

For students who have not been able to explain the phenomenon scientifically, it can be caused by low data reading ability because good reading skills certainly have an impact on students' science literacy [54]. In the context of literacy, teachers can use science to improve reading comprehension and reading to improve science comprehension in the classroom [55], so that the two are very related and show that science literacy assessment is not only part of knowledge, but also the science process is included in the science literacy part. Research results [56] shows that students' science literacy ability is inseparable from the variables that affect it. External factors such as curriculum and education system, selection of learning methods and models, learning facilities, and learning resources, while internal factors that are thought to consistently affect students' science literacy are reading ability, mathematical ability, and facilities that support learning. Therefore, in further learning, it is necessary to pay more attention to several variables related to the development of science literacy so that learning can be more optimal.

Design and evaluate scientific investigations

Based on the results of the research obtained, almost half (91.6%) of students have not mastered this competency. This competency is given in a description test on the Identification of Renewable Energy and Its Utilization in Society and Daily Life. Elementary school students are still at the concrete operational stage, so they are not yet able to design and evaluate scientific experiments. As research conducted by [53] revealed that elementary school students have difficulty connecting abstract concepts and reasoning about hypotheses that demand logical and deductive thinking. Both thoughts are needed in designing and evaluating scientific investigations. Many studies reveal that students tend to use concrete examples when they prove [57]–[62].

To be able to design scientific investigations, elementary school students need the ability to construct hypotheses. To be able to propose a hypothesis, students need to use previous knowledge, so they are required to be able to test and trace meaningful explanations, and then, build new knowledge [53]. The hypothesis proposed by elementary school students is still general [63] and has not focused on building a specific hypothesis. In fact, to master science literacy skills, it is necessary to submit hypotheses as evidence of scientific literacy [53]. Therefore, the scientific investigations carried out by elementary school students, are largely determined by prior knowledge, and need to be carried out gradually to have more complex and coherent scientific abilities.

Interpret data and evidence scientifically

Questions are given for this competence regarding perfect and imperfect metamorphosis in animals. Based on the results of the research obtained, almost all (91.6%) students have been able to predict an action or phenomenon that occurred in an event, but half (50%) students have not been able to transform data from one representation to the next. This is reinforced by the results of the study [64] which shows that the learning process in Science should be linked to the concept of science events that occur in students' daily lives. Students who have a high level of content knowledge will more easily associate the new information received with existing knowledge.

IMLS as a Medium of Integration of Formal and Informal Learning

IMLS is intended to be a *mobile* learning system that combines formal and informal learning in elementary school students. Figure 1 describes the menu in IMLS by combining formal and informal learning.

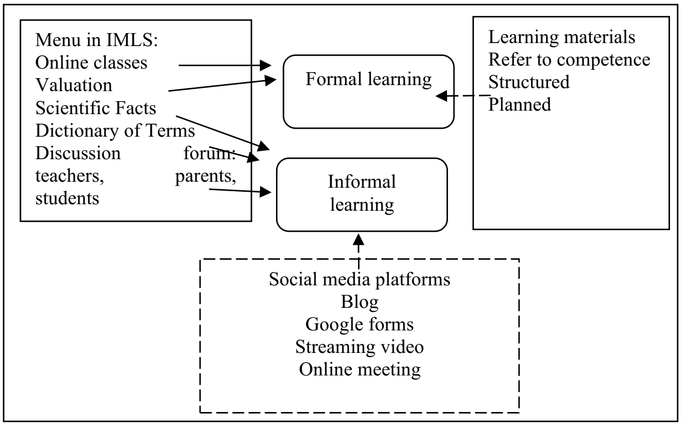

FIGURE. 1. Menu in IMLS

Learning in elementary schools does not only take place formally, but also involves informal learning so that a learning management system is needed that facilitates both things. Figure 1 describes menus in IMLS that involve formal and informal learning principles. Two menus, namely online classes and assessments, support formal learning because they contain mastery of learning materials presented in the form of text, images, and video. Learning materials are adjusted to the competencies that must be mastered by students so that it is planned, systematic, and structured. This effort is made to make it easier for parents to monitor students' formal learning progress. The assessment menu is used to measure the achievement of competencies that have been mastered by students and is open to assessment and assessment results so that they can be known by students, teachers, and even parents.

The menus in IMLS that support informal learning are scientific facts, dictionaries of terms, and discussion forums. Scientific facts contain knowledge in everyday life that can support mastery of learning material or outside the learning context. Scientific facts can be adjusted to the interests and knowledge that students want to have so that this menu is flexible, occurs suddenly without planning, pays attention to students' interests and hobbies, and is not accompanied by an assessment for mastery of knowledge.

The term dictionary menu contains an online dictionary for students to look up terms or words that are not understood while studying learning material or reading scientific facts. So, incomprehension can be resolved immediately without the need to wait for clarification from teachers and parents. The discussion forum menu is a means of communication between teachers, parents, and students regarding students' self-reflection on informal knowledge to be learned, student difficulties experienced during formal learning and reviewing student learning activities in IMLS. For informal learning, it involves much more diverse media than formal learning which is only in the form of text, images, and videos. Media in informal learning used are social media platforms, blogs, google forms, video streaming, and *online meetings*. Media in mobile apps pushes students into everyday activities and is widely available and globally spread to learning in all fields. The menu in IMLS makes learning and learning activities arise from teachers, students, and parents. Figure 2 describes the activities of teachers, students, and parents in IMLS.

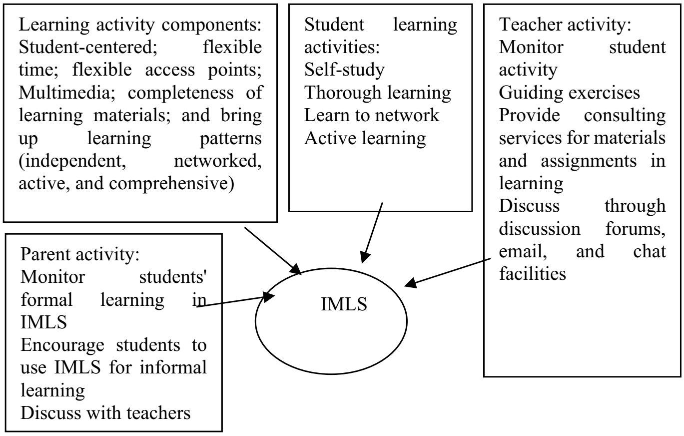

FIGURE 2. Learning activities of teachers, parents, and students

Figure 2 shows that the success of learning and learning cannot only come from the teacher, but parental involvement needs to be for learning programs that have been designed by the teacher so that in IMLS, the three parties need to be coordinated and accommodated according to their respective roles and functions, so that integration between formal and informal learning becomes an important thing to do.

IMLS to Train Science Literacy of Elementary School Students

IMLS can be used to train the science literacy of elementary school students. This can be seen from the menus in IMLS that can be adjusted to the indicators contained in science literacy. Figure 3 describes the indicators of science literacy that can be placed in the menu in IMLS.

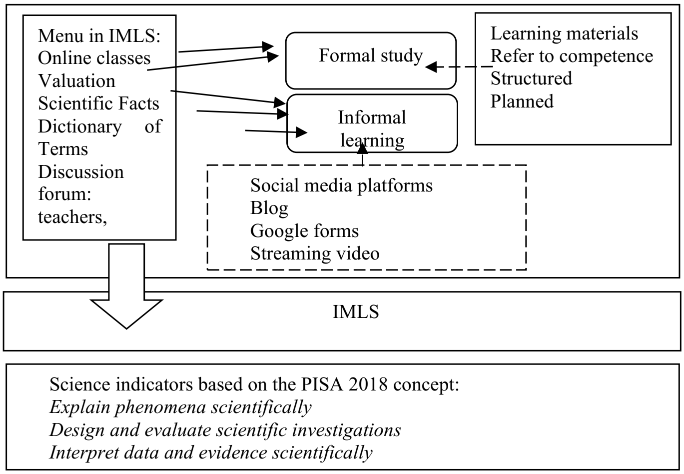

FIGURE. 3 Integration between IMLS, Formal and Informal Learning, and Science Literacy

Figure 3 is the result of the conceptual framework of research activities carried out as the basis for the concept of IMLS formation. This conceptual framework should not be followed for other research activities that have the same concern as science literacy in elementary school students. Student characteristics and environmental analysis are instrumental in determining the conceptual framework used. However, figure 3 can be used as reference material when research will be carried out related to the involvement of technology and science literacy in elementary school students.

LIMITATIONS

The limitations of this study can be seen in the research design included in the preexperiment so that no comparison occurs in the control class. This can be data biased because students get the same learning material twice, even though they are given different treatments before and after the test. Therefore, the results of the study cannot be generalized. The next study can use a research design that is pure experiment, so that it can be compared in two different classes. Then, another limitation of research is that no initial competency analysis for the use of technology is carried out, so that when conducting research, students still need to learn to use IMLS. The next research can be carried out analysis of students' initial technological abilities as a form of needs analysis. IMLS also still does not accommodate parents in assessing student learning progress, which can be done only to monitor student activity.

IMPLICATIONS AND FURTHER RESEARCH

Implications are obtained when implementing research that can be improved for subsequent research. Teachers when teaching Science Education students, need to use mobile learning. Teachers need to get used to this medium, as it allows students to access it flexibly. Students are also assigned at home with a menu in mobile learning so that the assignments given allow students to make observations or scientific investigations and report the results in mobile learning. Based on the research obtained, the next research recommendation is to measure attitudes in science literacy so that it is not only related to students' science knowledge. In addition, mobile learning for different subjects can be developed, and comparative studies can be conducted with participants with different demographic characteristics.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest: The authors declare that they have no conflict of interest.

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