Development of Mobile Learning Application System for Environmental Science Material (SARITHA-Apps)

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***Abstract*—The constraints posed by traditional learning tools for environmental science materials hinder the advancement of innovative and interactive learning resources, which are essential for enhancing the understanding of environmental science concepts. This research aims to develop a mobile-learning application for environmental science material to increase students' interest in learning and cognitive abilities in environmental science material. This study uses a quantitative approach. The research population was students of the Biology Education Study Program, FKIP, Palangka Raya University, totaling 243 people. The sampling technique uses purportive sampling. The target sample is students who are taking environmental knowledge courses. The sample size was 24 people. The research approach uses the Hannafin & Peck model by identifying and designing mobile-learning media along with environmental science material content, testing its performance on respondents, and analyzing learners' cognitive skills and respondents' learning interests. Data collection was carried out using product reflection questionnaires by a team of experts, pre-test and post-test instruments, and reflection questionnaires by users. The results show that: (1) a mobile learning application for environmental sciences materials has been produced, namely the SARITHA-Apps (abbreviation of Sistem Aplikasi Mobile LeaRning Materi Ilmu PengeTaHuan LingkungAn) as one of the materials in biology education in schools; (2) the average result of the expert team's assessment on the product feasibility is 91%, which means the qualification is "Very Eligible"; (3) the SARITHA-Apps can improve learning cognitive skills of the respondents with an N-Gain of 0.4 or the "Moderate" category and ; (4) based on the survey, 73% of total respondents agreed (or in "Strong" qualification) that the SARITHA-Apps has a strong impact on the increasing their scientific interests for better understanding on environmental sciences subject.**

***Keywords*—mobile-learning, environmental sciences, SARITHA-Apps, biology education**

I. Introduction

Media plays an essential role in the process of learning [1]. It acts as a crucial channel for conveying messages that are essential to achieving learning objectives. Media used for learning can be advantageous in conveying messages that may be too verbose in oral form (Zhang, 2020). Additionally, these learning tools can help overcome limitations related to space, time, and sensory capabilities (Hikmah, 2019; Greg Lowan-Trudeau, 2023). The advancement of information and communication technology is rapidly changing the learning process. This shift in learning orientation encourages self-guided learning, knowledge construction, and the exploration of students' potential [2]. Considering the limitations of existing conventional media, it is a challenge for conventional media to improve their quality by developing more innovative and interactive learning media [3], including learning media designed using mobile technology, also called mobile learning (M-learning) [3, 4].

With the increasingly widespread ownership of mobile phones and the increasing availability of other portable and wireless devices, mobile learning has helped change the learning landscape supported by technology to be more flexible in carrying out teaching and learning activities [5]. Mobile technology can extend learning beyond the classroom and offer greater flexibility in "where" and "when" learning can occur. However, this flexibility causes mobile learning to sometimes be beyond the reach of lecturers or teachers so it is necessary to develop a clear mobile learning design by identifying what is best learned in class, what must be learned outside, and ways of connecting it between these two conditions [4].

Mobile learning currently plays a crucial role in learning systems [6], because it is easy to use, not bound by place and time, can be repeated until proficiency is achieved, and is highly flexible in its application (Hu, et al, 2020). All groups of students are able to make good use of mobile learning, without any technical or other obstacles [7].

The advantage of mobile learning is that it can be easily used by students and students do not get bored with learning [8]. Student achievement is also expected to increase easily. The use of mobile learning is also able to provide learning freedom for students in terms of time, partner and place of study [9].

The rationale of the study can be explained as being motivated by the limited learning media that are capable of effectively increasing student competence in both cognitive, affective and psychomotor aspects. Teacher-made learning media is also very limited, while students feel bored when the learning media used by teachers is only limited to conventional learning media which is not challenging. It is hoped that the development of the SARITHA-Apps mobile learning application product will increase students' motivation and enthusiasm in studying environmental subjects.

Research questions can be formulated: (1) what are the results of the Expert Team's assessment of the suitability of the SARITHA-Apps Mobile-Learning Application instruments and products; (2) Can the SARITHA-Apps

Mobile-Learning application be used as a learning medium to improve learning achievement? (3) How do students respond to using the SARITHA-Apps Mobile-Learning Application? Research is very important to carry out considering that there are still limited applications for application-based environmental learning [10]. The majority of applications are in social learning, mathematics, natural sciences, not environmental sciences [11]. Apart from that, efforts to protect the environment from damage are very important [11]. Especially for students, it is necessary to increase awareness of the importance of increasing awareness of the importance of environmental sustainability for all living things living on earth [12].

II. Literature Review

A. Learning Management System (LMS)

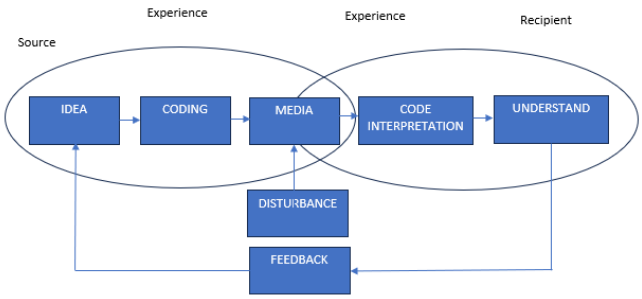

Fig. 1. The position of the media in the learning system [13].

Significant changes resulting from the recent COVID-19 pandemic include a shift in the learning paradigm from face-to-face tutorials to online learning, encompassing both blended and fully online formats, which has triggered an increase in the need for synchronous and asynchronous learning platforms [14, 15]. Online learning is not only learning using the web but also utilizing the Learning Management System (LMS). Learning in the current era is characterized by research, relevance, rationality, reflex in learning, and the presence of report cards that provide feedback between students and tutors, lecturers, or teachers [16]. Online learning provides breadth in learning, where tutors can set the time to upload learning materials while students can open learning materials without a time limit [17]. Medium (in plural "media") is an instrument that is used to change messages or information from "source" to "recipient" which generally refers to something that is used as a container, tool, or means of communication [13]. In general, the medium has a function, among others, to express ideas, opinions, and ideas to recipients with a feedback response in the process cycle (Fig. 1). Learning with mobile learning is designed by considering what material needs to be delivered, how it will be done, and how the delivery structure is based on "the real needs of instructors and students" [18]. Mobile learning is a combination of mobile technology and efforts to create a learning environment that has unique opportunities without being limited by time and place, where the learning process takes place anytime, anywhere when we are moving in our environment. In simple terms, mobile learning can be defined as E-learning through mobile computing devices such as cell phones, tablets, and similar handheld devices [19].

B. Mobile-Learning (M-Learning)

The research results of [20] explain that smart phone-based learning is still very relevant for use in learning in teacher slichools, including analysing various assignments from lecturers, including systematically reviewing literature. The research results of [21] found that learning using digital game design has enormous benefits in improving the quality of learning.

According to Bora and Dhumane [19], the advantages of mobile learning include (i) Portability, where mobile devices can be carried from class to class or wherever people go and information can be obtained when interacting with peers. Portability can make a difference in a variety of settings, i.e. classrooms, field trips, or outside the school setting. Mobile learning is more portable so that support is available in more places and more time for students; (ii) Collaboration, where mobile devices enable groups of students to easily distribute, collect, and share information, resulting in more successful collaborations. Wireless technology, especially PDAs has been shown to benefit family learning because students can use them for various literacy tasks, take notes, read electronic books, and then take them home to continue working on them with their parents [4]; (iii) Motivation, where wireless technology plays a role in increasing enthusiasm and autonomy in learning, as students show increased self-regulation in learning and take initiative in finding ways to use handheld devices for learning; (iv) In general, it is cheaper than PCs and laptops, so it is more likely to be affordable and is personal in use, so students do not need self-image.

This research aims to develop a biology learning medium by using mobile technology for environmental science materials. This involves identifying and designing environmental science learning materials or content within a mobile learning medium, testing its use with biology education students, and analyzing the learning outcomes for students utilizing the mobile learning medium. The goal is to bring about innovations in environmental science learning materials based on mobile .learning.

C. Environmental Science

Environmental Science was born because of the challenges faced by humans to be able to continue activities on earth as the only place in the solar system whose environmental conditions allow it to be inhabited by humans and other living creatures. The Indonesian government defines the environment under Law no. 32 of 2009 as the unity of space encompassing all entities, including humans and their behavior. The learning materials for this research aim to promote understanding of environmental topics such as ecology, carrying capacity, health, pollution, management, and sustainable development [22]. These materials are materials given to students in the Biology Education Study Program, FKIP, Palangka Raya University in Environmental Knowledge courses and other related courses such as General Biology, Ecology and Biodiversity.

In teaching, environmental knowledge carries a mission so that students have an attitude of awareness of problems and improve attitudes and behavior to be able to face challenges and the importance of environmental problems appropriately, responsibly and wisely so that in the end they have

responsibility for the future nation based on environmental sustainability. Students are expected to be able to apply logical thinking critically, systematically and innovatively in the context of developing or implementing science and/or technology according to their field of expertise based on environmental sustainability. Providing environmental science material is currently seen as very relevant, especially in relation to challenging problem conditions. Environment and health due to the COVID-19 pandemic. Environmental knowledge will provide an understanding of the importance of maintaining personal health and the environment as well as mastering the principles and current issues in economics, social, health and ecology in general [14, 23]. Apart from that, it is hoped that the use of M-learning media in delivering Environmental Science material will be able to support government programs in the education sector, namely those related to the Independent Learning and Independent Campus (MBKM) programs for students to have freedom in carrying out their learning. This M-learning media innovation in Environmental Science material is also used to support the achievement of UPR's vision and mission related to environmental sustainability and peat ecosystems.

D. The Hannafin and Peck Model

Hannafin and Peck Model consists of 3 (three) phases [24], namely:

1) The Needs Analysis Phase to identify the needs in developing a learning medium including the goals and objectives of the learning medium created, the knowledge and skills needed by the target group, the equipment, and the needs of the learning medium;
2) Design/Design phase to identify and document the best method to achieve the goal of making the learning medium in the form of a Storyboard (scenes, audio, and visualization with information about the content and visualization used for the production of a product);
3) Development and Implementation Phase to produce products, as well as formative assessment and summative assessment. In each phase, an assessment and repetition process is carried out to test and assess the learning medium throughout the medium development process and after the medium has been developed.

The storyboard design of this mobile learning application as an online-based learning medium for environmental science material includes components: homepage, modules, learning videos, learning audio, quizzes/quizzes, and manuals; named the SARITHA-Apps which is an abbreviation of sistem aplikasi mobile learning materi ilmu pengetahuan lingkungan (Fig. 3).

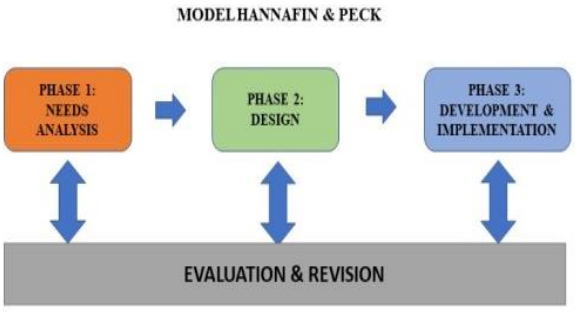

Fig. 2. The Hannafin & Peck model [24].

Fig. 3. Storyboard Design of the SARITHA-Apps mobile learning application.

III. Research Methods

A. Research Approach

The total sample of all third semester students from three departments was 243 students, 24 students were selected by sampling as respondents. The sample from the Biology Education Study Program was 8 students, from Mathematics Education there were 8 students, and from the Science Study Program there were 8 students, so that the total number was obtained, as shown in Table 1.

Table 1. Population and sample

No	Subject	N	n
1	Biology Education Study Program	81	8
2	Mathematics	82	8
3	Natural Sciences Education	80	8
	Total	243	24

This research was carried out at the Biology Education Study Program, Mathematics and Natural Sciences Education Department, Faculty of Teacher Training and Education (FKIP), Palangka Raya University in Central Kalimantan Province. This research was carried out and tested in accordance with the program of teaching and learning activities for Environmental Knowledge material in the Biology Education Study Program, namely in the odd semester of the 2021-2022 academic year.

B. Questionnaire Used

1) The questionnaire used to determine students' competency level is a multiple-choice test to determine improvements in cognitive, affective and psychomotor aspects. The pretest and post-test models used are the same test model, so that the Gain-score can be obtained. This G-S value is used to determine the level of improvement or increase in students' understanding of environmental material.
2) The measuring tool to determine the validator's response to the feasibility of Mobile-Learning learning media products uses a rating scale score of 1, 2, 3, and 4. Validity testing by means of judgment is carried out, to obtain the validity of the judgment. Assessment examines test items to gain confidence that the test obtained has empirical validity
3) Measurement of learning interest is carried out based on a rating scale consisting of 4 categories, namely strongly agree (SS), agree (S), disagree (TS), and strongly disagree

(STS). Response results are calculated using formulas and interpretations.

The type of exam used is a multiple choice written test with five alternative answers whose validity and reliability have been tested. The results of the validity test using Product moment correlation, all items are said to be valid so they can be used in the research process. The reliability test uses Kuder-Richardson Formula 21 (KR 21) and the results can be said to be reliable.

Expert participants who were asked to approve the research model were: environmental science experts, media experts (Prof. Dr. Teguh Budiharjo, Surokarto State Islamic University, Indonesia), curriculum experts (Dr. Siskandar, PTIQ University, Indonesia), and various mobile learning experts learning (Dr. Basrowi, University of Bina Bangsa, Indonesia).

Participants include students from the Biology Education Study Program, namely in the odd semester of the 2021–2022 academic year. The characteristics of the participants can be explained as students who are taking environmental education courses in semester 3, and they have taken the basic environmental science objectives.

IV. Results and Discussion

A. Result

Based on Table 2, it can be concluded that the number of students in the third semester of Biology education is 24 students, 11 male students (45.8%) and 13 female students (54.2%). All of the students could follow all of the set activities that have been decided, so all data from them can be used in this research and can be used to analyze and answer the research question.

Table 2. Demographics of the sample

No	Sex	N	%
1	Male	11	45.8
2	Female	13	54.2
	Total	24	100

1) The development of mobile Apps

The development of mobile apps for environmental science material needs to be encouraged to improve the quality of environmental biology learning. This is very important, because the environment is where all creatures live, so it must receive serious attention by improving biology learning performance. Apart from that, environmental science is very important for the sustainability of the earth which will be occupied by future generations. The gaps and challenges in environmental science learning so far have only been theoretical and not yet practical at a practical level using smartphone-based methods. Mobile applications are crucial because it is on mobile devices that all applications can be developed, downloaded, utilized and used not only for communication but must also be used for the development of science, including the science of preserving the earth.

The SARITHA-Apps has components including homepage (start page and menu page), learning objectives, learning materials, learning videos, learning audio, instructions for use, quizzes, and about; with the following user interface:

1) Homepage: consists of several menus, namely the start page which contains the name of the learning medium and the features continue to the Menu page which contains the features of learning objectives, learning materials, learning videos, learning audio, instructions for use, quizzes, and about (Fig. 4).
2) Learning Objectives: Explain the objectives of learning Environmental Science (Fig. 5).

Fig. 4. User Interface of Homepage in the SARITHA-Apps.

Fig. 5. User interface of learning objectives in the SARITHA-Apps.

3) Learning Materials: contains learning modules 1 to 5 with material namely Module-1 Introduction to Environmental Science; Module-2 Problems and challenges faced and human population growth; Module-3 Ecology as a Basis for environmental knowledge; Module-4 Environmental Pollution; and Module-5 Air, water and soil pollution. Fig. 6 presents the user interface of the learning materials.

Fig. 6. User interface of learning materials in the SARITHA-Apps.

4) Learning Videos: contains 5 learning videos, namely: Video-1: Introduction to Environmental Science; Video-2: Problems and challenges faced and human population growth; Video-3: Ecology as a Basis for environmental knowledge; Video-4: Environmental Pollution; and Video-5: Air, water, and soil pollution. (Fig. 7). Learning Audios: contains 5 audio learning, namely: Audio-1: Introduction to Environmental Science; Audio-2: Problems and challenges facing and growing human population; Audio-3: Ecology as a basis for environmental knowledge; Audio-4: Environmental Pollution; and Audio-5 Air, water and soil pollution (Fig. 8).

Fig. 7. User interface of learning video in the SARITHA-Apps.

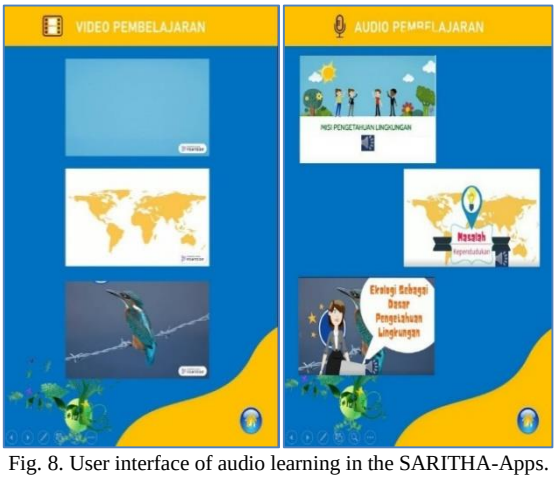

Fig. 8. User interface of audio learning in the SARITHA-Apps.

5) Instructions for use: contains instructions and explanations for the use of each feature contained in this SARITHA-Apps application. Fig. 9 is the interface of instructions for use

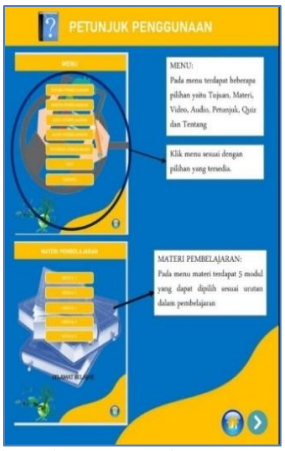

Fig. 9. User interface of instructions for use in the SARITHA-Apps.

6) Quiz: contains practice questions based on modules 1 to 5, i.e. Quiz Module-1: Introduction to Environmental Science; Quiz Module-2: Problems and challenges faced and the Growth of the human population; Quiz Module-3: Ecology as a Basis for Environmental Knowledge; Quiz Module-4: Environmental pollution; and Quiz Module-5: Air, water and soil pollution (Fig. 10).

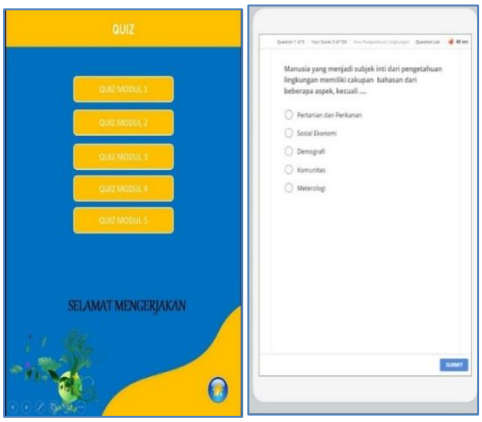

Fig. 10. User interface of quiz in the SARITHA-Apps.

7) About: Explaining the purpose of designing the SARITHA-Apps as a medium for studying Environmental Sciences materials (Fig. 11).

Fig. 11. User interface of about in the SARITHA-Apps.

2) Expert validation on the feasibility of the mobile learning product

The data obtained from the Validator's responses were analyzed to determine the feasibility of the use of the mobile learning product as a learning medium of environmental sciences materials. Obtaining questionnaire data was carried out based on rating scale scores 1, 2, 3, and 4, using the Eq. (1) and interpretation in Table 3.

$$NP = \frac{\mathrm{R}}{\mathrm{SM}} \times 100\% \quad (1)$$

in which:

NP = Percentage value (%)

R = Score obtained

SM = Maximum Score

Example

R: 30

SM: 60

$$NP = \frac{30}{60} \times 100\%$$

NP =50%

Table 3. Interpretation of the validator's assessment

Intervals (%)	Qualification
0–20	Not feasible
21–40	Less Eligible
41–60	Decent Enough
61–80	Worthy
81–100	Very Worthy

Based on Table 4, the Kolmogorov Smirnov Z value of the pre-test data is 0.717 with a probability of 0.683. A p-value above the constant value α = 0.05 indicates that the data is normally distributed. The Kolmogorov Smirnov Z value of the post-test data is 0.783 with a probability of 0.815. The p-value above the constant value α = 0.05 indicates that the data is normally distributed.

Table 4. Normality test of variable

		Unstandardized Residual Pre-test	Unstandardized Residual Post-test
N		400	400
Normal Parameters [a,b]	Mean	0.000	0.00000
	Std. Deviation	2.510	2.523
Most Extreme Differences	Absolute	0.045	0.054
	Positive	0.034	0.032
	Negative	−0.045	−0.044
Kolmogorov-Smirnov Z		0.717	0.815
Asymp. Sig. (2-tailed)		0.683	0.783

[a]. Test distribution is Normal.

[b]. Calculated from data.

In statistical analysis, H_0 (null hypothesis) and H_a (alternative hypothesis) are used to formulate statements about the presence or absence of an effect or change in a population. H_0 asserts the absence of a difference or effect, while Ha states the presence of a significant difference or effect. The process of hypothesis testing involves collecting data to assess whether there is enough evidence to reject Ho. If the evidence is significant, H_0 is rejected, and H_a is accepted, indicating the presence of a identifiable change or observable effect in the tested population. This approach is widely applied across various research fields and disciplines, aiding in decision-making based on objective statistical analysis.

From Table 5, the t test is said to be different if the t_{count} value is greater than $t_{table} > 1.65336$, whereas if the t_{count} value is smaller than $t_{table} < 1.65251$ then the t_{test} is said to be no different. Based on the table above, it can be seen that the t_{count} for the pre-test and post-test is 1.356. This means that t_{count} < t table 1.65251, so H_0 is accepted and H_a is rejected. This means that the data is homogeneous.

Table 5. t test result of study

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	9.929	1.562		1.356	0.075
Pre-test	0.451	0.063	0.391	1.152	0.064
Post-test	0.404	0.058	0.377	1.409	0.076

3) Student learning outcome data

Data on student learning outcomes were obtained from the results of the pre-test and post-test using the pre-test and post-test instruments. Data were analyzed with statistical parametric through pre-test and post-test data normality test, data homogeneity test, two variance similarity test (t-test), and Normalized-Gain test (N-Gain). The tests aim to determine the influence and how greatly influence the use of the product has on student learning outcomes in Environmental Science materials with the final formulation of N-Gain (Eq. (2)) and score interpretation (Table 6).

Table 6. Interpretation of average normalized gain (N-Gain) scores

N-Gain value	Category
N-Gain > 0.70	High
0.30 ≤ ***N-Gain*** ≤ 0.70	Medium
N-Gain < 0.30	Low

$$NG = \frac{\mathrm{Spost} - \mathrm{spre}}{\mathrm{S\,max} - S\,pre} \quad (2)$$

in which

NG = Normalized Gain (N-Gain)

S_{pre} = pre-test score

S_{post} = post-test score

S_{max} = maximum score

4) Student learning interest

Obtaining questionnaire data was carried out based on a rating scale consisting of 4 categories i.e. strongly agree (SS), agree (S), disagree (TS), and strongly disagree (STS). Response results are calculated using Eq. (3) and interpretation in Table 7.

$$Percentage\ (\%) = \frac{\text{Number of respondents with the same answer}}{\text{Total number of respondents}} \times 100\% \quad (3)$$

Table 7. Interpretation of student learning interest assessment

Intervals (%)	Qualification
0–20	Very Weak
21–40	Weak
41–60	Enough
61–80	Strong
81–100	Very Strong

Based on the results of the needs analysis, it was found that the availability of alternative learning media that can be accessed directly is needed to be able to overcome the problem of geographic location (the location of many students from outside the region) and lecture time. In addition, it was also found that 72% of students owned and used cell phones/tablets during online lectures, with constraints including weak internet networks, internet quota which was spent a lot during lectures (generally when face-to-face with Zoom platform), and unfavourable environmental conditions which is less conducive (Fig. 12.). The results of this need analysis form the basis for developing the use of an online-based mobile learning medium in this study.

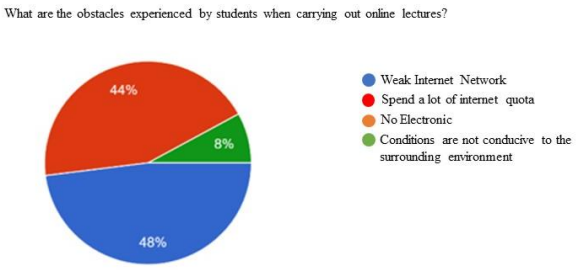

Fig. 12. Results of Needs Analysis for the basis of mobile learning development.

a) Results of the Assessment Team of Experts

The Expert Team provides an assessment of the SARITHA-Apps as an online-based learning medium for environmental sciences material on 4 (four) feasibility aspects, namely the feasibility of questionnaires and the eligibility of test questions, the feasibility of learning materials, and the feasibility of the product.

1) Eligibility of Questionnaire and Eligibility of Test Questions

The results of the Expert Team's assessment of the Feasibility Questionnaire based on the average percentage value of the 3 (three) feasibility aspects was 91% which after being converted with Table 1 Interpretation of the Validator's Assessment, the average percentage of 91% was in the Very Eligible qualification. The results of the Expert Team's assessment of the Feasibility of Test Questions were 88% which is the average percentage value for the 3 (three) aspects of the eligibility, after being converted with Table 1 Interpretation of the Validator's Assessment, the average percentage of 88% is in the Very Eligible qualification. Details of the results of the Expert Team's assessment of the feasibility of the questionnaire and the feasibility of the test questions are shown in Table 8 below.

Table 8. Questionnaire eligibility results and test question eligibility

No	Aspect	Eligibility of Questionnaire		Eligibility of Test Questions	
		Score	Value (%)	Score	Value (%)
1.	Clarity	24	100%	22	92%
2.	Conformity Statement	14	88%	15	95%
3.	Language	13	81%	12	74%
	Average		91%		88%
	Qualification		Very Worth it		Very Worth it

2) Feasibility of Learning Materials

The assessment aspects used to evaluate the learning materials displayed in the SARITHA-Apps include 3 (three) aspects, namely: (1) Material Substance, (2) Material Structure, and (3) Clarity. The substance aspect of the material includes 3 (three) indicators: (1) the relevance of the material to the expected competencies, (2) the clarity and ease of understanding the material and language by users/students, and (3) the suitability of the proportion of questions with the material that must be mastered by the participants educate. The Material Structure Aspect includes one indicator that the existing material has been prepared based on the stages of mastery of the material and the language used effectively, while the Clarity Aspect includes 2 indicators: (1) the material displayed in the SARITHA-Apps has been arranged sequentially and clearly, and (2) the material displayed supports the achievement of learning objectives. The results of the Expert Team's assessment of the Feasibility of Learning Materials based on the average percentage value of the 3 (three) feasibility aspects is 92% which after being converted with Table 1 Interpretation of the Validator's Assessment, the average percentage of 92% is in the Very Eligible qualification. The details of the results of the Expert Team's assessment of the feasibility of the learning materials displayed in the SARITHA-Apps are presented in Table 9 below.

Table 9. Results of the expert team's assessment of the feasibility of learning materials displayed in the SARITHA-Apps

No	Aspect	Score	Value (%)
1.	Material Substance	22	92%
2.	Material Structure	6	75%
3.	Clarity	16	100%
	Average		92%
	Qualification		Very Worth it

b) Product feasibility

The assessment aspects used to evaluate the SARITHA-Apps product include 4 (four) aspects, namely: (1) Learning Material Content, (2) Linguistics, (3) Presentation, and (4) Graphic. The content aspect of learning materials includes 4 (four) indicators: (1) compliance with basic competencies, indicators, and learning objectives, (2) the correctness of the substance of learning materials, (3) conformity with literature, and (4) benefits for broadening insight. The linguistic aspect includes 5 (five) indicators: (1) readability in the media, (2) information clarity, (3) conformity with good and correct Indonesian language rules, (4) the language in the media is adjusted to the developmental stages of students, and (5) the use of language effectively and efficiently. Presentation Aspects include 5 (five) indicators: (1) clarity of goals to be achieved, (2) ease of mobile learning media to study and use, (3) clarity of presentation order, (4) media material presented relates to and supports clarity of material, and (5) material completeness. Graphic aspects include 4 (four) indicators: (1) use of colour, type, and size of letters, (2) layout or layout, (3) media (video, audio, etc.) describing the content of the material presented, and (4) the attractiveness of the display design. The results of the Expert Team's assessment of the Feasibility of the SARITHA-Apps product based on the average percentage value of the 4 (four) feasibility aspects is 90% which after being converted with Table 1 Interpretation of the Validator's Assessment is in the Very Eligible qualification. Details of the results of the Expert Team's assessment of the feasibility of the SARITHA-Apps product are presented in Table 10.

Table 10. Assessment of the expert team on the feasibility of the SARITHA-Apps

No	Aspect	Score	Value (%)
1.	Content of Learning Materials	28	88%
2.	Language	38	95%
3.	Presentation	33	83%
4.	Graphics	30	94%
	Average		90%
	Qualification		Very Worth it

c) Student learning outcomes

Based on the results of the implementation of the SARITHA-Apps product by conducting a pretest and post-test on 30 students, it was obtained, namely: (1) Students have an average pre-test score of 18.5 (average value of 74), the average post-test score of 21.0 (average value of 84), and N-Gain of 0.4 (average value of progress 10); (2) The average pre-test score before using the SARITHA-Apps product (average score 74), is not the same as the average post-test score after using the SARITHA-Apps product (average value of 84); (3) From the results of the N-Gain calculation with a value of 0.4 after being converted with Table 2. Interpretation of the Average Normalized-Gain Score is in the Medium category (4) Based on the learning outcomes of students according to the level of the cognitive domain of the questions given found that the ability level C4 (analysis) has the highest percentage increase value compared to the percentage increase at other cognitive domain ability levels, (5) From the results of the analysis of student learning outcomes it can be concluded that the SARITHA as a mobile learning medium for environmental sciences materials can improve student learning outcomes, especially in the cognitive domain for environmental science materials. Table 11 displays student learning outcomes based on N-Gain calculations, while Table 12 displays student learning outcomes based on cognitive domain levels.

Table 11. Student learning outcomes based on normalized-gain

Information	Average Score
Pre-test	18.5
Post-test	21.0
N-Gain	0.4
N-Gain category	Medium

Table 12. Student learning outcomes are based on the level of the cognitive domain

Cognitive Realm Levels	Question number	Percentage of Number of Correct Answers		Description of Percentage of Increase
		Pre-test	Post-test	
C1 (Knowledge)	7, 8, 9, 11, 25	71%	82%	11%
C2 (Understanding)	1, 10, 12, 13, 14	76%	83%	7%
C3 (Application)	17, 18, 19, 21, 23	64%	69%	5%
C4 (Analysis)	2, 3, 4, 5, 6	63%	80%	17%
C5 (Synthesis)	15, 16, 20, 22, 24	72%	81%	9%

d) Results of the student response assessment

Analysis of the assessment of Student responses found that the highest average percentage value of the 4 (four) aspects of Student responses to the use of the SARITHA-Apps was the highest in the "Agree" response, which was as much as 73% of the total Student responses, where the value of 73% is after being converted with Table 3. Interpretation of the Assessment of Student Learning Interest is in the Strong qualification, which means that the use of the SARITHA-Apps has a strong impact on Student learning interest. Details of the results of the assessment of Student responses in using the SARITHA-Apps are presented in Table 13.

Table 13. Percentage of student response results to the use of the SARITHA-Apps

No	Aspect	SS	S	TS	STS
1.	Motivating the ability to learn	40%	60%	-	-
2.	Ease of understanding learning material	20%	80%	-	-
3.	Ability to practice self-skills	18%	82%	-	-
4.	Ability to create a conducive learning environment	30%	70%	-	-
Average		27%	73%	-	-
Qualification		Strong			

B. Discussion

The syntax of the mobile learning model includes 5 stages, namely: (1) The stage of delivering goals and motivating students where the educator (lecturer) conveys all the learning objectives to be achieved and motivates students to learn environmental science material using the SARITHA-Apps application that are tailored to the basic competencies and core competencies listed in the learning/lecture plan, (2) The stage of presenting information on the use of the SARITHA-Apps where educators (lecturers) demonstrate how to use the application to students, and students install the application and try to operate the application, (3) the stage of organizing students into the learning process independently using the application, where the educator guides students to study independently efficiently without being bound by place and time [25], (4) the evaluation stage where the educator evaluates student learning outcomes at environmental science material that has been studied using the SARITHA-Apps with reference to the Minimum Completeness Criteria (KKM) (e.g. Completed if with a Score ≥ 55), (5) The award stage where the educator gives praise and applause as a form of appreciation both effort and learning outcomes obtained by individual students [26].

The results of this research show that SARTHA-Apps can gain many advantages. firstly, it is very suitable for use by students not only during the Pandemic but also in normal situations. Second, each student shows his motivation, third, the student's performance gets the highest position. The SARITHA application can also help students compile their reports when carrying out activities in laboratories or outbound laboratories because this application is very suitable to be applied in any situation, any condition, and any position.

The results of the validation by the Expert Team with an average score of 90% stated that the mobile learning medium application that had been developed, namely the SARITHA-Apps, already had a "Very Eligible" quality for use in environmental science material learning activities. However, based on the Hanaffin & Peck Model approach, there is a percentage deficiency in the validation of the assessment that has been carried out (where the maximum value is 100%) is corrected according to the Evaluation and Revision phase [21]. In the Evaluation and Revision phase [27], the assessment and repetition processes are carried out to test and assess learning media [28] throughout the media development processes and after the media have been developed [24].

Differences in student learning outcomes before and after using the SARITHA-Apps show the effect of using the SARITHA-Apps on individual students. Overall, there is an increase in student learning outcomes after using the application. The "moderate" category indicates that student learning outcomes are still at a moderate level or not excessive. However, it was found that as many as 10% of students who had an "Incomplete" category score from their pre-test results, got a "Completed" category score from their post-test results. This shows that there is an effect of using the SARITHA-Apps on student learning outcomes. Furthermore, the highest score is at the percentage increase from the percentage of the number of correct answers based on the Cognitive realm criteria, namely at level C-4 (Analysis), indicating that this application may have great potential to improve students' analytical abilities. Analytical ability, namely the ability to decompose a material into clearer components, and determine the relationship between these components and the relationship between these components and the overall structure or purpose. In this case, students are asked to decompose information into several parts/elements, find assumptions, distinguish opinions and facts, and find causal relationships [29].

The results of the analysis of Student responses to the use of the SARITHA-Apps generated only 2 (two) respondents' opinions, namely "Agree" and "Strongly Agree", with the highest percentage being in the "Agree" opinion. This shows that the use of the SARITHA-Apps product only responds to positive attitude statements and perceptions for all respondents. The results of the analysis of student responses also showed that 40% of the total respondents stated that they strongly agreed that the use of the SARITHA-Apps was able to motivate respondents to learn. Furthermore, as many as 30% of the total respondents stated that they strongly agreed that the use of the SARITHA-Apps was able to make the learning environment conducive, namely more fun, more effective and efficient, and assisted in learning than before. This means that it also shows that the effect of using the mobile learning application in teaching and learning activities can generate new motivation and interest, create stimulation in learning activities, and can have a positive influence on the psychology of students [16, 24].

This study also obtained the results of an analysis of the advantages and disadvantages of the SARITHA-Apps product. The advantages of using the SARITHA-Apps based on student opinion that the product include: (1) the cost of mobile learning media will be relatively cheaper because the cost of mobile devices is much lower than PCs and laptops. This is in accordance with the opinion of [30] who said that this application can be operated without electricity.

SARITHA App also has another advantage, namely the cost of the learning process is reduced. This certainly greatly reduces the costs that students have to incur, especially in the midst of limited school fees for their parents. This is in accordance with the opinion of [31] who says that students should be able to take part in online learning without internet quota fees, this is done by downloading lesson materials which only require a small quota so it is more economical [32].

SARITHA App also has the advantage that, the use of learning applications is not limited by space and time. This is reinforced by Benali and Ally [33] who explain that application use is not bound by place and time. Learning activities can be carried out anywhere, anytime and anything [34].

SARITHA App also has other advantages, namely always encouraging students to carry out independent and sustainable learning, and has better potential in providing learning experiences. This is in accordance with the opinion of [35] who explain that students can learn independently without depending on the teacher.

Based on the teacher opinion, the advantage for this apps are the delivery of material learning will be more diverse and have many choices/alternatives, increase the level of literacy, increase the number of one's participation in education, a greater learning communication feature, because it can send

text, audio, audio-visual between cell phones, will increase learning motivation, understanding, and Student skills, being able to make the learning environment conducive that is more fun, more effective and efficient. Conditions like this are in accordance with the opinion of [36] that learning with applications provides many choices, Brundiers *et al*. [25] is able to contribute to increasing literacy, the number of participants in a learning activity, and can be used for teaching and learning. direction, as well as being able to provide encouragement to increase student motivation, understanding and skills [37].

Based on judgement opinion, the advantage for this App are very flexible for student, the content of this App is very representative, it's very comfortable for anytime, anyplace, any partner. This is in accordance with the opinion of Diacopoulos and Crompton [38] who say that with application, learning methods become more varied, students do not get bored, and students' level of understanding increases.

The disadvantages of using the SARITHA-Apps product include based on student, teacher and judgement are it is only designed for online learning so the use of this application in places where the internet network is weak will be an operational obstacle, the mobile learning application product, SARITHA-Apps, still requires a large enough memory capacity to be installed on mobile devices, especially when using a lot of video and audio media in operations. This is in accordance with the opinion of Fia *et al*. [39] who say that learning with web-based applications is sometimes very dependent on quotas, and students become easily bored, easily overworked, and less motivated to progress because there is no teacher to guide them [40].

SARITHA-Apps product cannot stand alone as the learning medium due to its limited capabilities device capacity. Educators and students may use other learning sources and teaching materials to strengthen and complement to achieve the learning objectives, there will be the possibility of interference from parties who are not responsible for infiltrating the system (informed consent) of this learning media product (welfare); and requires continuous upgrading of the application system which must always be done continuously. This is in accordance with the opinion of Guan *et al*. [41] who clearly states that application-based learning will have a less good impact on students because students tend to be individualistic, and do not understand how helping other students can occur.

Šramová [42] concluded that cell-phones have many functions, especially during the COVID-19 pandemic. All students at universities are greatly helped by the Zoom, Google Meet, etc. applications. Diacopoulos and Crompton [38] found that mobile learning in social studies subjects is very important to help students achieve maturity in their learning, especially in efforts to achieve higher achievements. Duriez *et al.* [43] concluded that students really hope to get their learning material via telephone, so it is very important to get maximum performance in their learning. Fia *et al*. [39] also explained that higher education institutions have found that mobile applications in education are synonymous with teachers. It could describe their predicament, but it could be described by his heart and not being able to understand his cousin disciple's mistakes. Guan *et al*. [41] in their research concluded that students can summarize all material from their teacher, especially regarding difficult aspects and essay aspects [44]. However, the students said that the mobile application had many limitations due to the different characteristics of the number of students. Teachers must provide support to their students so that they can increase their learning motivation to achieve their goals. In contrast to Guan, Hoi and Mu [6] stated that games based on mobile applications can attract students' motivation to achieve the highest achievements.

V. Conclusion

The results of the analysis of the mobile learning application SARITHA-Apps and its use show: (1) The average result of the Expert Team's assessment of the feasibility of the SARITHA-Apps instrument and product is 91%, which means it is in the "Very Eligible" qualification; (2) The SARITHA-Apps as an online-based learning medium for environmental science material can improve student learning outcomes, especially in the cognitive domain for environmental science material, namely with an N-Gain of 0.4 which means it is in the "Moderate" category. "; (3) Student responses to the use of the SARITHA-Apps resulted in only 2 (two) opinions, namely "Agree" and "Strongly Agree", with the highest percentage being in the opinion "Agree" (73%), which means they are in Strong qualification, namely that the use of the SARITHA-Apps has a strong impact on students' learning interest.

The SARITHA-Apps product has 11 advantages and 5 disadvantages. The main advice related to overcoming product weaknesses is that because the SARITHA-Apps is designed for the online learning system, it is expected that application users when they get a strong internet network immediately download materials so they can still study the materials offline. In addition, it is necessary to carry out further research related to the development of offline-based mobile learning.

A. Research Recommendations

Teachers who want to improve students' learning achievements in teaching environmental knowledge can use the SARITHA-Apps Mobile Learning Application. By using this application, it is hoped that learning motivation, level of understanding and learning outcomes will increase.

B. Weaknesses

The disadvantages of using the SARITHA-Apps Mobile-Learning Application product include: (1) it is only designed for online learning, so that using this application media in places where the internet network is weak will be an operational obstacle, (2) the Mobile-Learning Application product SARITHA-Apps still requires a large enough memory capacity to be installed on mobile devices, especially when using quite a lot of video and audio media in operations, (3) SARITHA-Apps Mobile-Learning Application products cannot yet be the only learning media due to limited capabilities device capacity, so that educators (lecturers) and students still have to use other sources and teaching materials to strengthen and complement each other in achieving learning goals, (4) there will still be the possibility of interference (ware) from irresponsible parties responsible for

infiltrating the system (informed consent) of this learning media product. (5) requires continuous upgrading of the application system which must always be carried out continuously.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Saritha Kittie Uda, first and corresponding author, SARITHA-Apps designer, concept writer, and main contributor to the article. Dwi Prasetyo - Contributor in SARITHA-Apps development, data collection and analysis, and article composition. Elda Susanti E. B. Dopo - Involved in SARITHA-Apps development, data collection, and contributed to result analysis and article composition. Subrata Aditama K. A. Uda - Contributor in SARITHA-Apps design, research protocol development, and data collection. Basrowi - Involved in the design and development of SARITHA-Apps, and contributed to data analysis and article composition.

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