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SEAPP: Android-Based Science Learning Innovation for Middle School Students in Supporting Project-Based Learning

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Abstract

This research aims to develop Android-based learning media, SEAPP, to support the Project Based Learning (PBL) approach in Natural Sciences (IPA) subjects at SMPN 4 Pasuruan. Information and communication technology development has made it easier to access learning, but implementing the 2013 Curriculum requires thorough preparation. Based on needs analysis through observations, interviews, and questionnaires, the SEAPP application was developed to increase students' motivation and activeness in learning science. The participants in this research were randomly selected students in grades VII, VIII, and IX. Data was collected and analyzed to design the SEAPP application, which was validated and tested. The research results show that SEAPP significantly increases students' motivation, activeness, and digital skills, creating a more dynamic and interactive learning atmosphere. This research guides teachers and stakeholders in developing effective technology-based learning media. Limitations of this research include the limited sample of one school and the study's relatively short duration. Further research is recommended to expand the sample range and duration of the study and explore similar applications in other subjects. This research proves that integrating technology in education, primarily through Android-based applications such as SEAPP, can positively impact the teaching and learning process. Thus, this application is hoped to be widely adopted and adapted to learning needs in various educational contexts.

INTRODUCTION

Technological advancement is rapidly reshaping all aspects of human life, fostering creativity, independence, competence, and critical thinking (Magara et al., 2021; Sari et al., 2019). The quality of education is continually evolving with increasing specifications and qualifications (Rokhim et al., 2022). Technology is a catalyst for various aspects of life, including education, supporting both indoor and outdoor learning (Saenab et al., 2016; Rokhim et al., 2021; Tardian, 2019). The fifth Industrial Revolution is an era of rapid innovation that can adapt to new and advanced technology. Information and communication technology used in education, such as mobile learning (m-learning), is part of e-learning that leverages mobile devices like cell phones and tablets (Astra et al., 2012; Saputra & Kurniawati, 2021). Innovation is a necessity to address educational challenges and make learning

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more accessible (Saputra & Kurniawati, 2021). Educators must possess the necessary skills to promote digital participation and develop students' digital skills (Carrier et al., 2017; Starkey, 2020; Tondeur et al., 2017). The implementation of the 2013 Curriculum in Indonesia still requires comprehensive preparation, underscoring the need for continuous innovation in education.

Based on searches, many researchers have discussed the development of teaching materials. According to Fajri (2018), teaching materials are essential as a source of student knowledge. Initial surveys show that Android phones are the most common devices owned and used by students every day. However, its less-than-optimal use in learning has encouraged the development of Android applications to support science learning at SMPN 4 Pasuruan. Android, a mobile operating system modified from Linux (Wahana Computer, 2013), was adapted into an application that is expected to help students gain knowledge quickly, especially in chemistry, physics, biology, and science. Chemistry studies substances' composition, structure, and relationships (Syukri, 1999; Wijaya et al., 2023). Learning media can generate new interest, motivation, and innovation, and it can help the effectiveness of learning through repetition of material (Warih et al., 2015). Science plays a vital role in improving the quality of science education to solve life problems (Hakim & Windayana, 2016; Kurniawati & Nita, 2018; Madden et al., 2013; Perignat & Katz-Buonincontro, 2019; Thuneberg et al., 2018). To support learning and facilitate students' enthusiasm for learning, it is necessary to develop exciting learning media that can enliven discussions in class (Paige et al., 2017). This research examines the development of Android-based learning media in science learning to increase learning motivation and student activity in educational institutions.

Based on the problems above, this research aims to design and assist teachers' needs in using digital teaching materials for science learning and implementing special Android-based learning media in science learning with a focus on fundamental understanding of science (Utami et al., 2021). Using Android-based technology, learning media can create a more dynamic learning atmosphere, make learning more alive in discussions, solving problems or case studies, and contribute to more exciting learning to increase student interest and involvement in understanding basic science concepts. (Alfiyah et al., 2024). This research also recommends that all stakeholders in the education sector map the need for using digital teaching materials in science learning in junior high schools (SMP). Thus, this research is hoped to provide practical guidance for teachers and policymakers in developing and implementing effective and efficient technology-based learning media.

Building on preliminary studies, the hypothesis of this research is that the use of Android-based learning media can significantly enhance students' learning motivation and engagement in science education at SMPN 4 Pasuruan. The implementation of Android-based learning media is expected to not only deepen students' understanding of basic science concepts, including chemistry, physics, biology, and science, but also empower teachers to enhance learning effectiveness. Moreover, it is hypothesized that the use of Android-based digital teaching materials can boost students' digital participation and skills, thereby fostering a more dynamic, interactive, and engaging learning environment. The ultimate aim is to develop and implement Android-based learning media that can provide practical guidance for teachers and education stakeholders, thereby improving learning outcomes and student experiences in science education at the junior high school level.

METHOD

This research uses a case study method with a qualitative descriptive approach and quantitative data analysis. Research surveys involve individuals answering several questions through observations, interviews, questionnaires, and tests (Rokhim et al., 2020; Sugiyono, 2017). This research aims to develop learning software by collecting data through observation, interviews, questionnaires, and literature studies. This data collection stage is a critical first step, providing an important foundation for software development that meets user needs and current knowledge. With this method, researchers can develop optimal software for solving educational problems. The data source was obtained from a group of KIR (Youth Scientific Group) extracurricular students consisting of 16 students in grades VII, VIII, and IX selected by random sampling. Random sampling is taking

samples randomly without paying attention to strata in the population (Sugiyono, 2017). In the random sampling technique, all individuals have the same opportunity to participate (Noor et al., 2022). This research was conducted at SMPN 4 Pasuruan in January-June 2024. SMPN 4 Pasuruan was chosen because it has yet to implement online-based science learning to advance science at the school.

Data collection techniques in this research were carried out through open questionnaires (offline and online) and interview guides. The question instrument covers aspects of basic science and the ability to innovate in digital transformation in science learning based on prototypes, products, and information obtained, as well as several phenomena that support in-depth science learning. The output of this qualitative research will be presented in the form of a written research report (Kolb, 2012; Niqmah, 2019; Sajiman, 2023). Data was collected through observation, interviews, questionnaires, and literature studies. Observations at SMPN 4 Pasuruan show that the school has adequate facilities, such as computer laboratories and classrooms that support using Android applications for science learning. Interviews with several science teachers were conducted to identify problems and find solutions to improve the quality of learning through Android-based applications. A questionnaire distributed to students revealed that 50% needed interactive learning media to avoid boredom.

In comparison, the other 50% felt the lecture method was quite effective if the teacher could interactively deliver the material. Even though the school facilities are complete, no interactive applications are used in science learning. Therefore, researchers conducted literature studies from relevant journals to find alternative solutions and develop practical learning applications. This research will potentially improve the quality of science learning at SMPN 4 Pasuruan through Android-based learning media. Developing science learning media for the junior high school level uses quantitative and qualitative approaches (Riadi et al., 2020). The research method used is Research & Development with the Lee and Owens model, which includes five stages: analysis, design, development, implementation and evaluation (Akramunnisa et al., 2024):

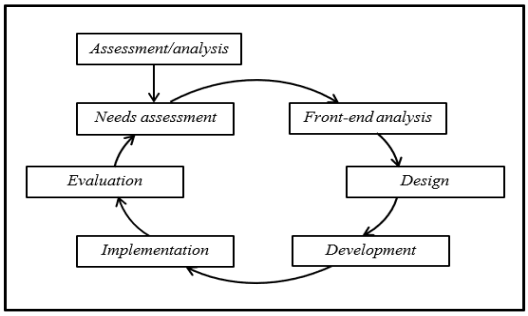


Figure 1. Lee and Owens Development Model (Source: Shufya and Pribadi, 2023)

RESULTS AND DISCUSSION

Results

In finding the problem that is the topic of this research, researchers used several stages to identify the problem comprehensively. This detailed analysis makes it easier to understand the context of the issues and needs and determine interactive multimedia suitable for development (Shufya and Pribadi, 2023). This stage includes identifying problems through initial observations to identify school science learning obstacles. Next, researchers conducted a needs analysis to understand the needs of teachers and students regarding digital teaching materials and learning tools that can support the science learning process effectively. Data is collected through various methods such as observation, interviews, questionnaires, and literature studies to understand problems and learning needs clearly. Based on the data collected, researchers designed a solution in interactive multimedia that can be used for science learning. The solutions created are then validated and tested to ensure their effectiveness and suitability to learning needs. The results of the trials are evaluated, and if necessary, revisions are made to perfect the interactive multimedia being developed. With these

stages, research procedures can be carried out in a more structured and systematic manner, ensuring that the solutions developed are genuinely able to overcome the problems identified.

Needs Analysis

This development needs analysis was carried out. On January 2 2024, observations were carried out to analyze needs at SMPN 4 Pasuruan, involving classes VII, VIII and IX Science/IPS. The method used was interviews with science teachers and distributing questionnaires to science students regarding the development design of Android-based learning media. The following are the results and analysis of questionnaire data obtained from students.

Table 1. Results of Student Opinion Questionnaires Regarding the Development of SEAPP

No.	Statement	Evaluation (%)				
		Strongly agree	Agree	Fairly	Somewhat Agree	Disagree
1.	PjBL mode integrated with SEAPP makes learning more enjoyable.	73%	27%	0%	0%	0%
2.	SEAPP helps me understand the learning material better	61%	36%	3%	0%	0%
3.	Integrating SEAPP in learning makes you more confident in learning science.	58%	39%	3%	0%	0%
4.	Motivated to learn through the PjBL model integrated with SEAPP	67%	33%	0%	0%	0%
5.	Projects carried out using the PjBL model helped me develop science skills.	58%	42%	0%	0%	0%
6.	I recommend using the PjBL model integrated with SEAPP for other students.	64%	25%	11%	0%	0%

*Note: The number of students in 1 class is 36 students

The questionnaire results show that most students feel significant benefits from integrating SEAPP (Science Education App) in the project-based learning (PjBL) model. As many as 73% of students strongly agree, and 27% agree that the PjBL mode integrated with SEAPP makes learning more enjoyable. This shows that all students find learning with this technology more attractive than conventional methods. In addition, 61% of students strongly agreed, and 36% agreed that SEAPP helped them understand learning material better, which means that almost all students felt an increase in their understanding of the material by using this application. SEAPP integration also increases students' confidence in science learning, with 58% strongly agreeing and 39% agreeing that they feel more confident. As many as 67% of students strongly agree, and 33% agree that they are motivated to learn through the PjBL model integrated with SEAPP, indicating that this technology positively impacts student learning motivation.

Additionally, all students agreed that projects implemented in the PjBL model helped them develop science skills, with 58% strongly agreeing and 42% agreeing. Finally, as many as 64% of students strongly agreed, and 25% agreed to recommend using the PjBL model integrated with SEAPP to other students, indicating that most students recognize the benefits of this learning method and feel that it is worthy of broader application. Overall, this questionnaire's results show that students received the use of SEAPP in the PjBL model. The use of this technology not only makes learning more exciting and practical but also increases students' self-confidence, learning motivation, and science skills. Most students also recommended this method to their friends, showing great potential for broader school applications.

Table 2. Interview results

Informant	Description of interview results
LAS	This digital learning tends to support science learning in practice, theory, and implementation. It also helps me to expand my understanding of science learning.
MEF	This digital learning actively explores science learning to support learning with the SEAPP learning media, which can understand practical and theoretical understanding.

QLR	Digital learning is challenging to interact with due to limitations in technology, which tend to make it difficult for students to apply learning applications. Therefore, I also have reservations about switching to the world of technology.
MM	In my opinion, digital learning needs to be supported by mature development and move to the world of technology. Also, in terms of facilities and means to support education, science learning must also be met.
KAS	For me, digital learning supports the search for ideas, studies, and several applied examples, which are theoretically supported by the presence of digital learning, which also transforms digitally with the support of adequate facilities.
MNI	Digital learning also needs to be directed at accessing science learning literacy in terms of facilities, means, and infrastructure to support digital learning.

Based on interviews with teachers and students at SMPN 4 Pasuruan, researchers carried out a needs analysis with several stages. First, researchers found conditions where cognitive and practical learning could have been more optimal. Second, the researcher defines the task with a solution: developing SEAPP in Smart Application learning media with a STEAM-based bilingual class system. Third, researchers sort the objectives based on importance, where the current redox reaction learning media is less representative and makes things difficult for students. Fourth, researchers identified discrepancies, finding that the current learning media consists of formal explanations and group discussions without practicum. Fifth, the researcher determined a positive direction by identifying the main problems in the MIPA class at SMPN 4 Pasuruan. Finally, researchers set implementation priorities by developing SEAPP to improve learning outcomes and student retention. With these steps, the research aims to overcome science learning problems and improve the quality of education at SMPN 4 Pasuruan.

Analysis of the Beginning and End of Media Development

Front-end analysis aims to obtain detailed information about problems in the learning process, which is used to determine interactive multimedia suitable for development. This analysis process includes several aspects, as in the table below:

Analysis 1	Classroom facilities with LCD projector and computer laboratory, as well as student smartphones and laptops for learning activities
Analysis 2	High interest of students and science teachers in the use of technology
Analysis 3	SEAPP media development based on Smart Application and Bilingual Class System
Analysis 4	Development of effective media in improving cognitive learning outcomes and retention of MIPA class students
Analysis 5	The implementation of virtual reality-based media at SMPN 4 Pasuruan has never been done before
Analysis 6	implementation of SEAPP in Smart Application learning media
Analysis 7	Selection of Smart Application and Bilingual Class System model strategies to deliver learning media
Analysis 8	Cost and benefit analysis (cost-benefit analysis)

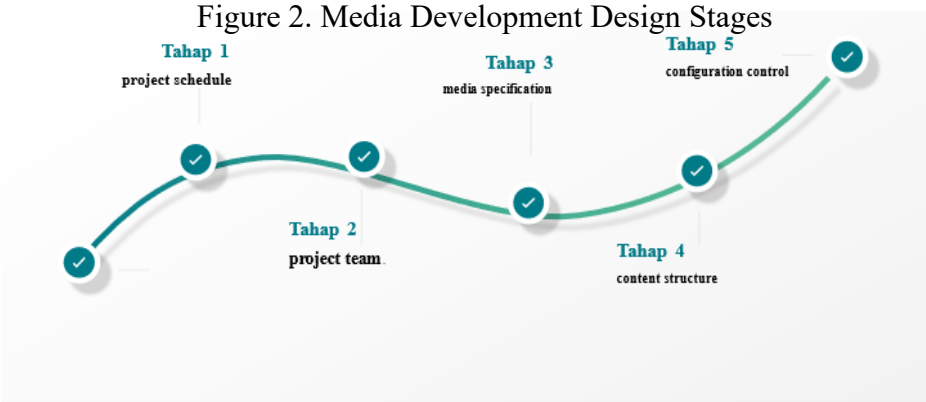
Based on the table above, media development analysis was carried out in several stages, namely: First, user analysis (audience analysis) shows that each class is equipped with an LCD projector and computer laboratory, and students are allowed to bring smartphones and laptops in learning activities. Second, technology analysis reveals the high interest of students and science teachers in the use of virtual reality technology in learning. Third, the required task analysis (task analysis) includes the development of SEAPP media based on the Smart Application and Bilingual Class System, which will be implemented in the science laboratory. Fourth, critical incident analysis is expected to be able to develop effective media in improving cognitive learning outcomes and retention of MIPA class students as a whole. Fifth, situation analysis shows that the implementation of virtual reality-based media at SMPN 4 Pasuruan has never been done before, so there will be initial obstacles to its use. Sixth, objective analysis states that the implementation of the SEAPP in Smart Application learning media will be assisted by teaching assistants from the chemistry education study program. Seventh, media analysis chooses the Smart Application and Bilingual Class System model

strategy to deliver learning media. Finally, the cost-benefit analysis shows the media implementation cost of Rp. 5,000,000.00 is expected to provide an exciting experience in science learning in junior high schools.

Design

The design stage aims to design the display and interactive multimedia content being developed. This stage includes several processes that produce schedules, job descriptions, media specifications, media materials, storyboards, and user interfaces. First, the interactive multimedia development schedule (project schedule) starts on June 12, 2023, to develop innovative application and bilingual class system media, with observation activities on June 15, 2023, and media implementation on June 20, 2023. Second, the project team coordinates the role and responsibility for working on interactive multimedia, including designer by Ulfa Rahmawati, developer by Dika Putra Wijaya, and material compiler by Shefira Salvabila Safitri. Third, the media specification includes a virtual reality box application with instructions for using the application. Fourth, the learning structure (content structure) contains material from each KD sample for each SMP Science level. Fifth, configuration control and arrangement (configuration control) explains the media control and design mechanisms in preparing media, which are arranged in storyboards and user interfaces. With these processes, the design stage is expected to produce interactive multimedia that is effective and by learning needs.

Figure 2. Media Development Design Stages



Discussion

Identify Potential Problems in Learning

The research results show that learning at SMPN 4 Pasuruan still uses the lecture method. This method, which involves teachers' verbal narratives to students, is often less effective in improving the quality of education. To overcome this, Android-based interactive media is proposed as an alternative to enhance and increase students' understanding of science learning. Information obtained from observations and interviews indicates that measurements, body organs, and the respiratory system can be taught more effectively through interactive media. Data from the questionnaire shows that students can describe basic science knowledge and the latest news related to science learning, which includes the ability to understand basic concepts, search for information, and solve problems with a systematic and logical approach (Herak et al., 2019; Rusilowati, 2018).

Personal Experience and Development of Science Learning

Students' personal experiences, based on interviews with teachers, reveal that applying scientific methods in learning often becomes a stepping stone for students in understanding and solving problems in a structured manner. Interviews show that students are interested in asking questions about the implementation, use, benefit, and content of the material studied procedurally and systematically. Knowledge about scientific methods applied systematically and logically has begun to develop in students through digital technology. The constructivism theory proposed by Jean Piaget and Lev Vygotsky emphasizes that learning is an active process in which students build new knowledge based on their previous experiences (Piaget, 1952; Vygotsky, 1978). In this context, using scientific methods in learning allows students to connect new knowledge with existing understanding, thereby strengthening their knowledge through experimentation and reflection.

In addition, problem-based learning (Problem-Based Learning) stimulates students' creativity, critical thinking, and logic, helping them solve problems structurally and systematically (Sani, 2015). Social learning theory by Albert Bandura states that learning occurs in a social context and through observation, which means using digital technology and science laboratories allows students to learn from observations and interactions with classmates and teachers (Bandura, 1977). Teacher support in the form of laboratory facilities for practical work and making science products is highly expected to encourage the development of ideas related to science learning. The integration of technology in education has also been proven to increase student engagement and understanding, where using digital tools for science experiments increases students' ability to answer questions related to science knowledge and information (Herak et al., 2019; Rusilowati, 2018). This research shows that students can answer questions related to science knowledge and information well. It encourages teachers to better support students in developing ideas or thoughts related to science learning by providing adequate facilities and appropriate guidance.

Students' Science Literacy in Product-Based Science Learning

The decline in science learning outcomes is often caused by students' need for more experience exploring research results for science learning. Students only listen, take notes, and observe the teacher's explanation. The 2013 curriculum in Indonesia emphasizes the development of critical and creative thinking and the application of science in everyday life, but often needs more interest, a shallow understanding of basic science concepts, and limited critical and creative thinking skills. To overcome this, there needs to be a balance in the science curriculum that maintains the basic concepts of science, the scientific process, and the application of science (Fauziah et al., 2022; Pariatno et al., 2021). Students at SMPN 4 Pasuruan developed products such as facial cleansing soap, cream scrub, and eco-enzyme as part of product-based science learning. The aim of creating this product is to study science in depth and apply it in a natural context. With the proper guidance, students have the potential to become skilled entrepreneurs and be open-minded to basic scientific concepts (Marwah & Pertiwi, 2024). This research underlines the importance of interactive and product-based learning media in improving students' learning outcomes and interest in science.

Applicational Learning Media Development

The flow chart for developing media (Android-based application) to support students' interest in learningveness in learning Natural Sciences (IPA) is as fo:

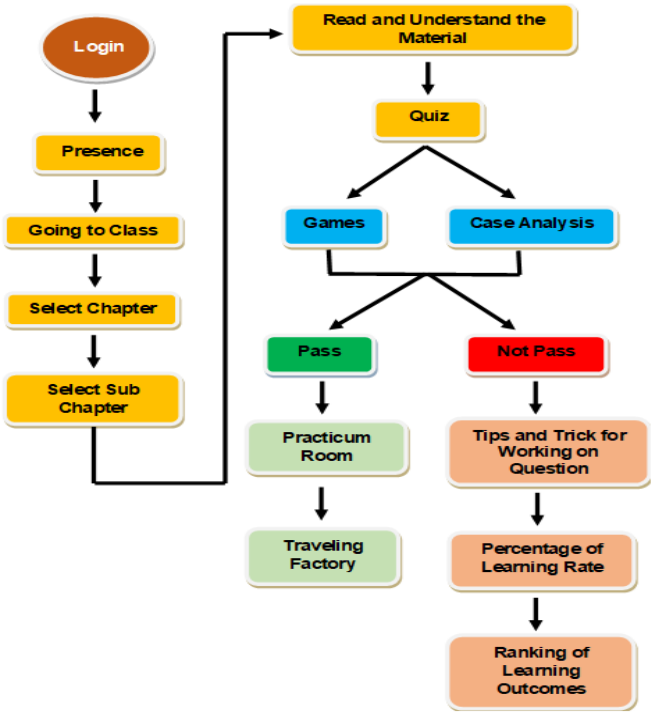


Figure 3. SEAPP programming in Smart Application

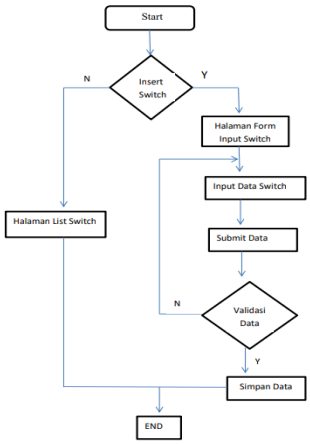


Figure 4. *Flowchart Switch*

Figure 3 (switch flowchart) shows that data validation includes several essential steps to ensure input integrity and accuracy. First, validation is carried out to ensure that the data meets the requirements, such as the correct format and allowed value range, and is free from invalid characters. Validation also provides the data that does not exist in the database to avoid redundancy. After successful validation, valid data is stored in appropriate tables in the database, ensuring the data is organized and easy to access. If validation fails, the user is given feedback to correct the input. If successful, the data is saved, and confirmation is provided to the user. Data maintenance includes regular backups to prevent data loss and recording changes for audits. These steps ensure that the data validation and storage process runs smoothly, resulting in accurate and redundancy-free data in the database.

In the context of data validation, theories such as database normalization, integrity constraints, human-computer interaction (HCI), data backup and recovery, and audit trails play a crucial role. These theories are not just theoretical concepts, but practical tools that ensure the effectiveness and efficiency of data validation and storage processes. Database normalization, for instance, organizes data attributes into tables to reduce redundancy and improve data integrity (Codd, 1970). Integrity constraints such as primary key, foreign key, unique, not null, and check constraints ensure that the data entered meets the requirements and is free from errors (Elmasri & Navathe, 2011). HCI principles are applied by providing feedback to users to improve input, ensuring effective interaction between the system and users (Preece et al., 2015). Data backup and recovery is the practice of periodically making copies of data to prevent data loss and ensure recovery in the event of damage (Wiederhold, 1980). Audit trails record all changes that occur to data in an information system, which is important for tracking user activity and detecting errors or suspicious behavior (Bishop, 2003). By applying these theories, data validation and storage processes become more effective and efficient, ensuring accurate, redundancy-free, and reliable data, supporting better data-driven decisions.

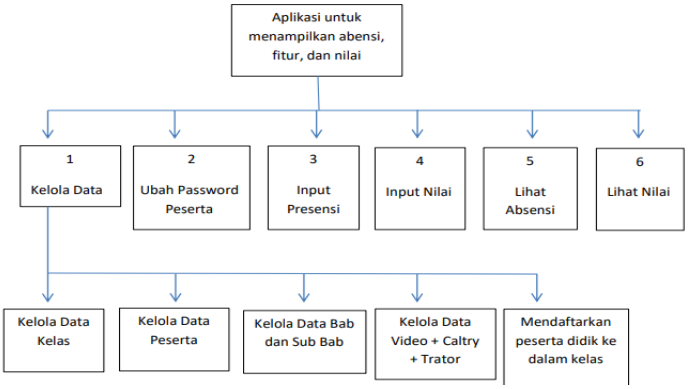


Figure 5. Decomposition diagram

Based on the decomposition diagram, the aim is to make it easier for students to use the SEAPP In Smart Application to solve or study science material well and structure. Apart from that, there is an application of this diagram to solve problems, especially in science learning, which are considered problematic, so that they can be easily understood through this application.

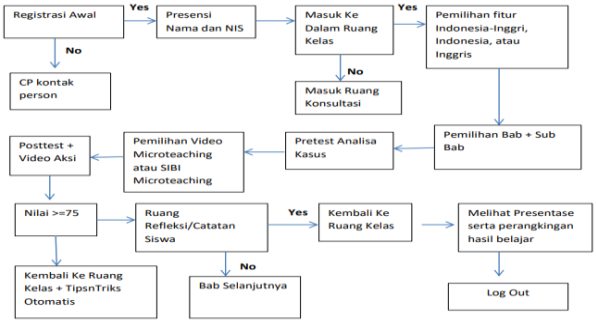


Figure 6. Flowchart of Participants in the Smart Application

Based on the flowchart, SEAPP In Smart Application helps students process data when using the application so that students who use it for the first time feel clear. SEAPP In Smart Application is a technology-based interactive learning application designed to resemble an international class, especially in science, to form an intelligent, active, and responsive generation in facing global challenges. This application supports the achievement of the 2030 Sustainable Development Goals (SDGs) by providing theory and application concepts and introducing local Indonesian wisdom in interesting science material, as illustrated in Figure 5 and Figure 6.

The integration of technology in education has been shown to enhance the learning process. As Mayer (2009) suggests, multimedia learning that incorporates text, images, and interaction can significantly improve students' comprehension of the material. Applications like SEAPP create a dynamic and interactive learning environment, empowering students to learn at their own pace and deepen their understanding through practical experiences. Project-Based Learning (PBL) is a potent method for cultivating 21st-century skills, such as critical thinking, collaboration, and problem-solving. PBL enables students to work on real projects that are pertinent to their lives, thereby boosting their motivation and engagement (Thomas, 2000). SEAPP In Smart Application leverages PBL principles in the development of science content, enabling students to apply theory to real-world scenarios. The application's design, reminiscent of an international classroom, is geared towards preparing students to confront global challenges. According to UNESCO (2017), education that supports the SDGs must encompass learning about sustainability, intercultural understanding, and the practical application of scientific concepts. SEAPP equips students with the knowledge and skills necessary to contribute to environmental and societal sustainability. With this approach, SEAPP In Smart Application not only enhances students' grasp of science material but also fosters a generation that is equipped to tackle global challenges with comprehensive knowledge and relevant skills. The application fosters continuous learning that aligns with the SDGs 2030 goals, creating an interactive, dynamic, and project-based learning environment.

CONCLUSION

This research delves into the development and implementation of SEAPP, an Android-based learning media designed to support Project Based Learning (PBL) on science material at SMPN 4 Pasuruan. The research findings demonstrate that SEAPP significantly boosts students' motivation and activeness in learning science. Rigorous data validation ensures the integrity and accuracy of input, while technological support such as data backup and audit trails maintains information security and reliability. The implementation of SEAPP not only aids students in grasping basic science concepts but also enhances their digital skills, thereby making the learning process more dynamic and interactive. The innovative use of SEAPP in science education provides practical guidance for teachers and stakeholders, enabling them to create effective and efficient digital teaching materials that align with the educational needs of the digital era. Thus, SEAPP stands as a beacon of educational

innovation, inspiring and exciting educators and stakeholders with its potential to revolutionize science education through the adaptive use of information and communication technology.

This research provides theoretical and practical implications. Theoretically, this research supports constructivism theory, which emphasizes active learning, where students build new knowledge based on previous experiences. SEAPP helps students connect new knowledge to existing knowledge through experimentation and reflection, supports Problem-Based Learning (PBL), and increases digital literacy according to 21st-century needs. Practically, the implementation of SEAPP at SMPN 4 Pasuruan increases science understanding and student engagement, reduces dependence on lecture methods and increases class interaction. SEAPP also guides learning media developers for other subjects with data validation features, periodic backups, and audit trails that maintain data integrity and security. This research encourages educational innovation with new technology to improve the quality of learning in the digital era.

This research has several limitations, including the sample being limited to students at SMPN 4 Pasuruan, the use of a case study approach, the short duration of the research, and reliance on technology and specific school infrastructure. In addition, aspects of implementation costs and teacher training needs should have been explored in depth. For future research, it is recommended that the sample be expanded to various schools and a longitudinal study be conducted to observe the long-term effects of SEAPP. Research could also explore the effectiveness of SEAPP in other subjects, the cost-benefit analysis and teacher training needs. Comparative studies with other Android-based learning media are also recommended to provide additional insights.

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AUTHOR CONTRIBUTION STATEMENT

DP was responsible for conceptualization, design, analysis, and writing. SS was responsible for data analysis. UR was accountable for interpreting the study results. DP and DD were responsible for collecting data at SMPN 4 Pasuruan and editing and reviewing the manuscript.

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