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The Android-based Interactive *Pop-Up* Multimedia Development to Improve Environmental Literacy, Learning Autonomy, and Learning Outcomes

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Abstract

The innovation of this research developed the android-based pop-up multimedia that can help students use Android as an interactive learning medium during the learning process and interactive multimedia can be tested for feasibility. This research is an important step in providing innovation in the development of interactive pop-up multimedia based on Android and shaping changes in the form of increasing students' the environmental literacy, learning autonomy, and learning outcome of learners. The applied research type was Research & Development with the ADDIE method. The researchers promoted the research for the fifth graders of Public Primary School Sumber and MIM Tumpuk in the academic year 2021/2022. The technique for collecting data was an interview, test, questionnaire, and observation. The results showed that 1) the characteristics of the android-based pop-up interactive multimedia were the one-application packaging, the material about the water cycle, and the modest and understandable language; 2) the android-based pop-up interactive media practicability reached a percentage of 97.49% with a high criterion, 3) the android-based interactive pop-up multimedia reached a percentage of 99% with valid criterion, and 4) the android-based interactive pop-up multimedia effectiveness influenced the improvement of environmental literacy based on questionnaire data, learning autonomy based on the questionnaire and learning outcome based on test and classical accomplishment calculation with a percentage of 94%, the N-Gain score of 0.69 with moderate category. It can be concluded that the development of the android-based pop-up interactive multimedia was effective to improve the environmental literacy, learning autonomy, and learning outcome of learners.

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INTRODUCTION

The roles of educators are important to realize qualified humans (Lestari et al., 2015). In the current 21st century, science and skill determine the national life quality (Parasamaya & Wahyuni, 2017). In learning, the implementation of learning media is important to create effective learning (Tafonao, 2018). One of the applicable media for learning istechnology-based media (Sujono, 2020). The use of learning media could realize effective learning, accelerate learning, and facilitate learners to understand the delivered materials (Dewanti et al., 2018). Therefore, interactive multimedia implementations are useful as the current learning media innovation. The most common technology-based learning media is a computer (Akhmadan, 2017). The applied learning in this research was learning for primary school learners.

Supportive learning media for learners should be based on their needs. One of them is the use of interactive multimedia pop-up learning. Pop-up media is a media with paper engineering in the form of a pop-up book. This book has some movable parts with a three-dimensional object to provide interesting visualization of the presented story. The object will move once the book is opened (T. Ningtiyas et al., 2019). A pop-up book is a three-dimensional book made from paper. These papers will move once the book is opened and folded or closed (Jr et al., 2014).

The developed android multimedia pop-up in this research used the Science and Technological Development. One of the most applied matters in daily life is - a mobile device with an android operational system. This matter becomes the potential matter of an android as a device to develop learning media based on the technology development. The android-based pop-up media development used a mobile device to display the application (Lan, 2012). Mobile learning is a solution to deal with an educational challenge. With various devices and resources, cellular learning provides more options to personalize the learning (Mehdipour & Zerehkafi, 2013).

Literacy has an important role to improve human resource quality and broadening insight. Environmental literacy refers to the skill to understand the environmental condition and keeping and to improve the environmental condition (Kusumaningrum, 2018). One of the environmental literacy is water-cycle. The water cycle is a cycle from the Earth, to the atmosphere, and returns to the Earth continuously. These patterns create a continuous circular rotation that causes water to be available eventually.

Learners must also improve their learning autonomy along with literacy. Learners with high learning autonomy and responsibility to improve their learning quality would influence their learning achievements. Learning autonomy of learners demands great responsibility for learners to influence the learners. Thus, the learners will promote activities to reach the learning objectives (Sahade, 2020). The learning autonomy is influenced by some factors, such as environment and family. Learners in a less conducive environment will have their learning process influenced (Asmar, 2018).

Successful learning is a learner that can reach the learning objective. The other important factors in achieving the learning objective are using the learning media, implementing the learning media to teach, and communicating the learning materials via the media (Pingge, 2018). Therefore, teachers must create interesting and innovative learning media to encourage optimal learning and develop cognitive capacity (Emda, 2017).

Science and technology development becomes a real challenging demand by the educators to be more creative in using science and technology development. Then, by combining science and technology into a method and interesting learning, teachers can develop the learning potentials of the learners. From the background, the researchers developed the android-based pop-up interactive media to improve the environmental literacy and learning autonomy of learners toward the fifth graders' learning outcomes.

This research aims to 1) analyze the learning media characteristics of water cycle

material applied in primary school; (2) analyze the practicability of the developed learning media, (3) analyze the effectiveness of the develop learning media, and (4) analyze the reliability of the developed learning media.

The theoretical framework of this research could be applied for reference to develop the android-based pop-up interactive media for water cycle material at primary school to realize efficient and effective learning. On the other hand, the practicability for the teachers is to use the results as the reference and recommendation to optimize science learning. For the learners, the results of the development, the android-based pop-up interactive media will be useful to improve the learners' learning autonomy and learning outcome.

METHOD

The applied research type was Research & Development with the ADDIE method. The research stages were analyzing, designing, implementing, and evaluating.

The analysis stage is a stage to collect the information for reference to create the product. In this case, the developed product was the android-based pop-up interactive multimedia. The collected information included the data analysis and the software analysis to create the product.

This research design facilitates the process' developing the pop-up learning media. The design stage consisted of data collection. The development process of the android-based pop-up interactive media required some collected data. The required data included the predetermined data in the analysis stage, the test and pretest questions in the form of exercise, and games and learning videos to support the learning process.

The development process of the media was useful to realize the design into a product. Then, the final result in this stage was the product to test. The development of the product was the android-based application. The result of the development was packaged into a downloadable application on a smartphone device.

In the implementation stage, the preview of the android-based pop-up interactive multimedia involved media experts and practitioners. The small-scale product implementation involved the fifth graders of MI Muhammadiyah Tumpuk at Trenggalek districts, consisting of 20 persons. The test was useful to examine the practicability of the developed product and to validate the questions. The next stage was the product revision. This stage was useful to refine the android-based pop-up interactive multimedia. The larger-scale implementation stage involved 36 participants from the fifth graders of Public Primary School Sumber Karangan at Trenggalek districts, 16 persons; and fifth graders of MI Muhammadiyah Tumpuk at Trenggalek districts, 20 persons. The test question examination was useful to find out the learning outcome results of the learners.

In the evaluation result, the researchers measured the learning objective achievement by determining the effectiveness of the developed learning media. Then, the researchers revised the product based on the criteria, the needs, and the responses of the teachers and the learners toward the android-based pop-up interactive product.

The applied techniques of collecting the data were interviews to obtain the initial data of the problem identification process, documentation to observe the applied media before developing the android-based interactive pop-up multimedia, tests to find out the learning outcome improvement, observation to observe the learners' autonomy, and questionnaire to obtain the data about learning autonomy, environmental literacy, and android-based interactive pop-up multimedia. The obtained data included quantitative and qualitative data.

The researchers analyzed the data descriptively. The researchers classified all collected data. The researchers stated the qualitative data with words while the qualitative data with numbers. The qualitative data was useful to complement and entail the presented figures. Then, the quantitative descriptive data was useful to process the data from the observation sheet and the total scores from the questionnaire. The other way to promote quantitative descriptive analysis was by grouping the data based on the instrument in the form of a

descriptive percentage. The applied quantitative data analysis included the validity of the android-based interactive pop-up multimedia, practicability analysis, reliability analysis, and effectiveness analysis.

RESULTS AND DISCUSSION

The Android-based Interactive Pop-up Multimedia Characteristics

The developed Android-based interactive multimedia characteristics were based on the obtained interview results about the needs of the media. Then, the researchers arranged the android-based interactive pop-up multimedia characteristics. The developed materials in the developed product were the water cycle. The characteristics of the android-based interactive pop-up multimedia were: 1) The developed media were packaged in an android application to allow the learners to learn autonomously. The media consisted of core competence, basic competence, learning objective, instruction to use the media, learning material, quizzes, and questions. 2) The media had the implementation of water cycle material. 3) The media used simple and understandable language for the learners.

The android-based interactive pop-up media was the interactive media that elaborated various types of figures, animations, and learning videos of the water cycle. (Novitasari, 2016) explain that the combination of figures, animations, and interesting sounds will lose the learners' boredom because the learning is interesting and not monotonous. Thus, the learners are motivated the learn. Table 1 shows the previous studies about android-based interactive pop-up media.

Table 1 The Previous Studies about the Android-based Pop-up Media

Andrianto et al, (2020)	Baiduri et al, (2019)	Jazuli et al, (2018)
Home page	Cover	Instruction
CC and BC	CC and BC	Indicators
Materials	Table of Contents	Materials
Material Contents	Question	Autonomous Experiment
Material Videos	Audio Materials	Reference
Quiz		Developers
Question Exercise		Evaluation Test
		Quit Menu

The arrangement of the android-based interactive pop-up multimedia included: 1) Cover, 2) Instruction to use, 3) Home Menu, 4) Core Competence and Basic Competence, 5) Material, 6) Evaluation/Test, and 7) Game The differences of the current research from Andrianto et al., (2020); Baiduri et al., (2019); Jazuli et al., (2018) was about the display. In this research, the display was simple, attractive, and colorful. Thus, the product was relevant to the primary school learners' characteristics.

Here are the results of the developed Android-based interactive pop-up multimedia.

Figure 1 the Cover of Interactive Multimedia

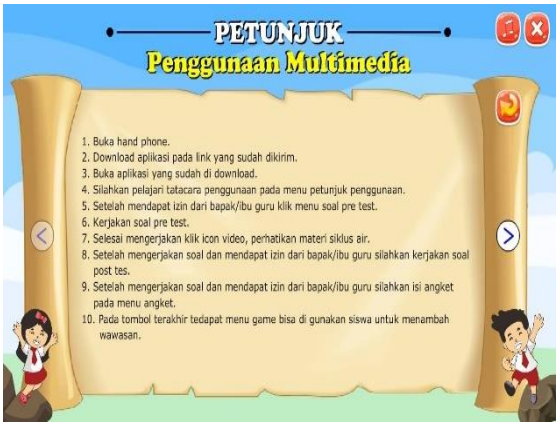

Figure 2 the Instruction to Use the Media

Figure 3 the Home Menu

Figure 4 the Core Competence and Basic Competence

Figure 5 the Material of the Water Cycle

Figure 6 the Evaluation/Test

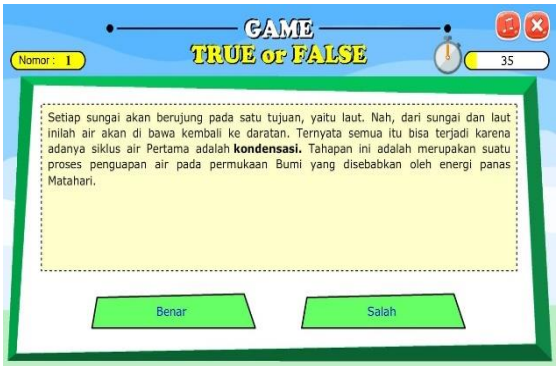

Figure 6 the Game

The components of the android-based interactive multimedia were: 1) The cover of the android-based interactive multimedia presented the learning title with an animation of the water cycle process. 2) The instruction of using the media facilitated learners to operate the android-based interactive multimedia. 3) The home menu had figures and remarks to facilitate the learners in using the media based on the presented activities. 4) The core competence and basic became the guidelines to develop competence during the learning process with the implementation of the android-based interactive multimedia. 5) The materials became an important matter in the learning process. In the android-based interactive multimedia, the materials were made into video animation entailed with the process of the water cycle. 6) The evaluation used a question about the water cycle. It consisted of 20 questions with C1-C6 cognitive levels. 7) The applied game as the final learning process made the learners active and felt enjoy. The game was guessing the correct answers.

The android-based interactive pop-up media had an accessible android package by mobile phone. The media had kinds of music to facilitate learners' concentration in their learning. The implementation of the media was joyful during the classroom learning. Handayani et al., (2013) explained that learners required concentration to think before writing, speaking, and promoting actions.

The instruction button had some remarks to facilitate learners in using the media. The symbols of the media were made consistent to

avoid ambiguity for the learners. The cover of the developed media had bright colors and used cartoon figures. Thus, the primary school learners liked the cover design. The bright colors of the android-based interactive pop-up media were useful to attract the learners' attention. Thus, the learners were motivated to read and use the media. Mabruri et al., (2019) explain that the science learning mobile media has some strengths if the media has various colors. Thus, the learners would be more attracted to using the developed media.

The android-based interactive pop-up media had some learning materials, such as animation and videos to facilitate learners' understanding of the material about the water cycle. The android-based interactive pop-up multimedia also had joyful quizzes for the learners. Nurrita (2018) explains that the arrangement of a learning material must be interesting to attract the learners and must be valid. The developed media also had multiple choice questions, consisting of 20 items to measure the capabilities and learning outcomes of the learners after being taught by the android-based interactive pop-up multimedia.

The Practicability of the Android-based Interactive Pop-up Multimedia Characteristics

The practicability value of the android-based interactive pop-up multimedia was based on the learners' answers to the questionnaire. Table 2 shows the practicability calculation based on the questionnaire results.

Table 2 The Result of the Practicability Questionnaire

Criteria	Score Total	Percentage	Criteria
Instruction Clarity	104	96.29%	Very High
Promotion	214	99.07%	Very High
Time Allocation	34	97.12%	Very High

Table 2 shows the practicability results from the learners' responses were high. The researchers conducted a limited-scale test in the initial stage of the product development to determine the practicability of the android-based interactive pop-up multimedia. This limited test involved the learners. They judged the product by filling out the given questionnaire. The assessment of the learners consisted of instruction, promotion, and time allotment. The results became the reference to revise the android-based interactive pop-um multimedia.

The obtained results from the questionnaire showed that the developed product could be used autonomously and practically. The product had buttons and instructions to use so that the product facilitated the learners at school and home by using mobile devices autonomously.

The learners could access the learning materials every time and repeatedly. They could also join the lesson if the learners could not attend school because they were sick or taking a leave. They could still learn the materials with the developed media. Jazuli et al., (2018) Found that learners could ensure their mastery of using the learning materials. On the other hand, the teachers could use the android-based interactive pop-up multimedia to share abstract materials with some visualizations, such as figures and clear and attractive videos with a mobile device.

The applied language of the developed product used consistent, communicative, and understandable terms and dictions based on the learners' levels. Sutiyanto et al., (2017) explain that understandable language use allows learners to learn autonomously. The arrangement of the sentence in the teaching material adhered to the General Guideline of Indonesian Language Spelling, PUEBI. The developed teaching material used the standardized, communicative, and understandable Indonesian language to learn the presented material with the developed product.

The consistency of the term uses was useful to avoid misinterpretation by the learners while they were reading passages in the developed product. For example, the android-based interactive pop-up media used capital letters, accurate punctuation marks, and italic letters to

indicate foreign or scientific terms. The grammatical rules of the android-based interactive pop-up media obeyed the writing guideline of written language. The remarks on the developed media were brief so that the learners could read the remarks conveniently (Fajarini et al., 2016).

The Reliability of the Android-based Interactive Pop-up Multimedia

In the beginning, the researchers created a draft to be validated by experts before involving learners in the trial run test. The validation of the android-based interactive pop-up media was specifically done for the aspects of the home menu, core competence, basic competence, introduction, material, and evaluation. Table 3 shows the calculation result of the android-based interactive pop-up multimedia reliability**.**

Table 3. The Reliability of the Android-based Interactive Pop-up Multimedia Aspects

Assessment Aspect	Total Score	Maximum Score
Home Menu Aspect	72	72
Core Competence and Basic Competence	83	84
Introduction Aspect	96	96
Material Aspect	119	120
Evaluation Aspect	84	84
The Score Total	454	452
Percentage	99%	
Criteria	Very Valid	

The initial design of the android-based interactive pop-up multimedia was validated by media experts. The results obtained a percentage of 99%, categorized as very valid. This result indicates that the developed media could be applied excellently, especially on the aspects of the home menu, core competence, basic competence, introduction, material, and evaluation. The initial design of the product had bright colors to attract the learners so that they learners with the developed media. The content design of the developed multimedia used buttons and figures with some remarks to facilitate the learners in using the android-based interactive pop-up multimedia. The instruction of the android-based interactive pop-up media also had relevant figures with the written remarks. Thus, the learners could understand the remarks in the android-based interactive pop-up multimedia. The promoted validation was useful to realize excellent and relevant teaching material as the theoretical principle of the development (Yudiyanto et al., 2020). Table 4 shows the revision result of the android-based interactive pop-up multimedia.

Table 4. The Revised Version of the android-based interactive pop-up multimedia.

Number	Revised Version	The promoted revisions
1		Adding the core competence
2		Adding the core competence and learning objectives
3		Adding the profiles of the supervising lecturers

In general, the developed media was valid but the researchers revised some elements of the android-based interactive pop-up media based on the given suggestions from the media expert and validators. The revisions included: (1) adding the core competence, basic competence, and learning objectives shown in the pop-up multimedia; (2) adding animations, figures, and materials; (3) revising the sentences based on the excellent spelling for the given material; and (4) adding the supervising lecturers in the cover of the pop-up multimedia. These revisions were useful to make the developed media applicable in learning.

The media was used to support the teaching materials. Thus, the researchers packaged the android-based interactive pop-up multimedia in an integrated application with materials, questions, and games. Thus, the teachers could use the media to reach the learning objectives. The android-based interactive pop-up media had the material of the water cycle. Thus, the media could influence the environmental literacy and the learning outcomes of the learners. Besides that, the android-based interactive pop-up media could be used at home as an autonomous learning strategy. The developed media was accessible from smartphone devices.

The developed media also had an interesting design for the learners. The media had bright colors to attract learners. Thus, learners could be motivated the use the android-based interactive pop-up media. This matter indicated that the developed media had excellent animations and figures, clear videos, and colorful and interesting designs. Handoko et al., (2016) found an excellent teaching material had to contain supportive figures to explain the material contents because these figures could attract learners and prevent the learners from boredom.

The Effectiveness of the Android-based Interactive Pop-up Multimedia Characteristics

After examining the practicability, the researchers conducted a trial run for the product. The trial run was useful to find out the effectiveness of the developed media. The examination involved the fifth graders of Public Primary School Sumber and MIM Tumpuk. The classroom learning obtained a percentage of 75% of the classical accomplishment score.

The learning outcome improvement after implementing the android-based interactive pop-up multimedia. The classical accomplishment results after the posttest reached a percentage of 94% with the accomplished criterion. The learners' learning classical accomplishment indicated that the learners had a very excellent understanding of the water cycle after implementing the android-based interactive pop-up multimedia. The result indicated that the developed multimedia could be understood by the learners excellently so they could improve their learning outcomes.

The effectiveness of the android-based interactive pop-up media was measured by the learning accomplishment of the learners. The results showed that 34 learners out of 36 learners could achieve the learning accomplishment. The classical learning accomplishment reached a percentage of 94%. The percentage indicates the achieved classical accomplishment. The Department of National Education also found that teachers knew the learners' characteristics, initial skills, retaining mastery, and other strengths of the learners. The development of the android-based interactive pop-up multimedia could answer the learning difficulties. All classical accomplishments were achieved because the learning applied the android-based interactive pop-up multimedia with autonomous learning features and environmental literacy. The pop-up media became excellent learning for learners because they could share their joyful learning experiences (T. W. Ningtiyas et al., 2019). The learning experience could improve the learners' skills.

The improved skills were observable from the pretest and posttest results. The improved skills were calculated with the N-gain formula.

The results showed an improvement in the learners' learning outcomes. The improvement was observable from the difference in pretest and posttest results after the implementation of the developed Android-based interactive pop-up multimedia. The pretest results of the learners obtained a mean of 75. The post-test result of the learners obtained a mean of 83.05. From the analysis result, the improvement of the pretest and post-test scores obtained the N-Gain score of 0.69. The score indicated a moderate improvement of pretest-posttest mean differences.

The learning outcomes refer to the achieved skills after learners learn (Nilasari et al., 2016). The learning outcomes are important in the learning process to provide valuable information for teachers about the learners' progress in learning activities. Based on the explanation, a change in the learning process is

important to motivate learners to be active during the lesson. The researchers recommended using the android-based interactive pop-up media in the learning to improve the learning outcomes.

The scores of environmental literacy skills were based on the learners' questionnaires. The

The results showed that the learning autonomy of the learners included the capability to answer without being addressed by the teachers. The learners could also create personal notes while the teachers were explaining the material about the water cycle. The learners also had the initiation to ask the teachers if they did not understand. The learners could also explain the explained water cycle material. The autonomous learning implementation allowed the learners to learn and manage their learning time autonomously. The learning process with the developed multimedia provided opportunities for the learners to train their learning autonomy. They could access the developed multimedia with a handphone. The learning activities triggered and train the skill of the learners. The use of accurate learning media could facilitate information sharing or teaching to improve the learning motivation of the learners (H. P.S. Muttaqin et al., 2021). The learning process with the developed multimedia allowed learners to apply their environmental literacy skills. Thus, they could keep the environment properly during the learning process in their daily life.

In this research, the researchers also observed the learning autonomy during the learning process. Table 5 shows the observation calculation of the learning autonomy of the learners.

Table 5. The Result of Learning Autonomy Observation

Criteria	Mean	Percentage	Criteria
Precision and Carefulness	15.27	71%	High
Tidiness and Cleanliness	16.58	83%	Very High
The presentation systematization	13.38	67%	High
Bravery	17.05	85%	Very High
Content Clarity	14.27	71%	High

The observations of the teachers during the learning process with the developed media obtained a percentage of 71% with high criteria in terms of carefulness and preciseness. The aspects of tidiness and cleanliness obtained a percentage of 83% with a very high criterion. The systematization of the presentation obtained a percentage of 67% with a high criterion. The aspect of bravery obtained a percentage of 85% with a very high criterion. The aspect of clarity obtained a percentage of 71% with a high criterion. From the results, the observation results supported the questionnaires of the learners. The results showed the learning autonomy of learners had high criterion results. The aspect of self-learning direction or self-learning autonomy applies personal motivation to master a certain competence. Thus, the individual can solve problems in the real world (Handayani et al., 2013).

The calculation of the environmental literacy calculation with a percentage of 82%, a high criterion. The result indicates the environmental literacy of the learners after learning with the android-based interactive pop-up multimedia for learning science is excellent.

The results of the environmental literacy skill were observable in various matters, such as the learners' capabilities to instill an environmental awareness attitude by saving the consumption of electricity. This attitude, using the electricity wisely and being responsible for all school facilities, could keep the environment and realize sustainable development. Besides that, the use of water also indicates an environmental awareness attitude. The attitudes to using water were observable in the learners' behaviors. They did not let the water waste away. The behavior of not littering became the attitude of the applied environmental literacy of the learners. Keeping the cleanliness and environmental preservation

should include keeping the plants and cleaning the area responsible including the classroom. Some scientific attitudes indicated improved environmental literacy after learning with the android-based interactive pop-up multimedia. Thus, the learners were more aware of the surrounding environment. Oktarina et al., (2020) also found that determining the environmental literacy skills and attitudes of learners could develop compassion feeling toward the environment and keep resource availability in Indonesia.

The researchers distributed the questionnaire to the teachers at the research sites. The results showed that all respondents, 100%, found that the developed media was very excellent. This result indicated the positive responses from the teachers toward the android-based interactive pop-up multimedia for the science learning process in the classrooms. The developed media could create an autonomous learning atmosphere and improve the learners' environmental literacy skills.

The teachers explained that the use of the android-based interactive learning media could provide a new learning experience for the learners. The learners could actively participate with the developed learning media and used various sets of activities to improve the learners' learning outcomes with various strategy implementations. The android-based interactive pop-up media could improve the learning autonomy and environmental literacy of the learners. Technology development stimulates the cognitive skills to think, create, and learn (Maria et al., 2019).

The presented materials with the developed media are assisted by videos and figures. Thus, the developed media, the android-based interactive pop-up media, could facilitate the learners' understanding and help teachers in the teaching process to reach the objectives (Nurrita, 2018). The developed media had simple language implementation and interesting figures to narrate and direct the language. The presented figures were interesting to attract the learners in understanding the materials (Setyowati et al., 2013).

In this research, the researchers also examined the reliability of the instrument based on the National Education Standards Agency (BSNP) assessment guideline. In this process, the researchers involved some experts. The researchers also examined the interactivity of the developed media based on the learners' response questionnaire. The experts considered the android-based interactive pop-up media received reliable. Thus, the researchers proceeded with the process into a trial run test of the product. In this test, the researchers involved 20 learners. Then, the researchers involved 36 learners in the implementation test. Besides those tests, the researchers also distributed a questionnaire for the learners.

The learners shared their responses about the product in terms of three aspects: presentation, ease of utilization, and benefit. The result obtained a percentage of 95%, with very excellent criteria. The result indicated that the learners had positive responses toward the developed media with material on the water cycle. The learners assumed that the android-based interactive pop-up media could attract learners with the literacy activities. The learners argued that the applied language in the media was understandable. They were also enthusiastic while learning with the android-based interactive pop-up media. The learners had the same argument that the developed media could make them interested in learning water cycle material. Febrianti et al., (2015) explain that excellent teaching material should gain positive responses from the learners, starting with the attractiveness, helpfulness, and understandability of the developed media. Dewanti., (2018) explain that the learning media utilizations include a means to attract the learners' attention, a means to share the learning material, and a means to facilitate the learners' understanding construction. The developed Android-based interactive pop-up multimedia was useful as an information resource to improve and reach the knowledge, skill, and creativity of applying effective and efficient learning media (Arip & Aswat, 2021).

CONCLUSION

The android-based interactive pop-up media about the water cycle was valid, practical, and understandable for the learners. The android-based pop-up interactive multimedia was effective to improve the environmental literacy, learning autonomy, and learning outcome of learners. The evidence was observable from the learners' and teachers' positive responses. Thus, the android-based interactive pop-up media with water cycle was reliable to use in science classroom learning.

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