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Digital Era for Quality Education: Effectiveness of Discovery Learning with Android to Increase Scientific Literacy

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ABSTRACT

Objective: This study analyzes the effectiveness of discovery learning models integrated with Android. **Method:** The method used is the literature review method. A literature review is a type of research used to collect data and information from various references. This research analyzes 20 national and international articles that can be accounted for. The articles used are articles published in 2018-2023. The steps taken in this study are identifying topics, finding and selecting appropriate articles, analyzing and synthesizing literature, and concluding. **Results:** Based on the results of research and analysis, it can be supposed that (1) the application of the discovery learning model can improve students' scientific literacy; (2) The use of Android in learning can improve students' scientific literacy. **Novelty:** This research reveals that integrating discovery learning learning models with androids can improve students' scientific literacy. This discovery invites researchers, educators, and governments to develop and facilitate discovery learning integrated with Android.

INTRODUCTION

The phenomenon of digital use in human life in the Industrial Revolution 4.0 is increasing sharply. This phenomenon can be found in various people's daily lives (Abdullah, 2019). The Industrial Revolution is closely related to the development of the 21st century. The development of the 21st-century world is marked by the use of information and communication technology in all aspects of life. Technology connects the world and transcends geographical barriers so that the world becomes borderless. One of the areas that became the foundation in realizing this was education. Education is always closely related to learning in schools. Technology develops in various fields to meet human needs in life. Everyone must have critical thinking skills, master technology, communicate, collaborate, and connect knowledge with the natural world (Anggriani et al., 2020). The World Economic Forum identifies skills required in the 21st century, including scientific literacy.

The Organization for Economic Cooperation and Development (OECD) (2019) states that scientific literacy is based on three main competencies, namely: explaining scientific phenomena or issues scientifically (explaining, identifying, and evaluating explanations of several developing technologies and natural wonders that occur); designing and evaluating scientific investigations: creating procedures for answering scientific questions, designing scientific studies, and assessing the results of such experiments; and interpret evidence and data scientifically: analyze various data presented in multiple forms such as graphs, tables, and diagrams, evaluate the correctness of information facts and data scientifically, and conclude based on the analysis of these scientific data and facts.

In line with this, the fact that Indonesia currently still has low scientific literacy. The Organization for Economic Cooperation and Development, through the Program for International Student Assessment (PISA), which conducts evaluation programs on the literacy facts of various countries, shows that the average scientific literacy in OECD countries is 486. At the same time, Indonesia has an average score of 396, ranked 69th out of 79 countries evaluated by PISA (OECD, 2019). This shows that scientific literacy skills in Indonesia still need to improve. Of course, this data is very concerning, especially for actors in education and science education. Scientific literacy must be cultivated during school learning so that students can understand science concepts and processes well and apply them to everyday life. Literacy is also a standard for a country's education quality (Zhang et al., 2018).

Research on the analysis of early scientific literacy skills at various levels of education still needs to improve. Students' initial scientific literacy skills are still in the nominal and functional categories, namely 39% and 36% of students. In the conceptual/procedural category, there are 20% of students. While in the multidimensional category, it is still 4%. 1% of students still need to give answers to the scientific literacy test given. This is because they need to be used to answering scientific literacy questions and are constantly faced with an examination system operating at that level. This is the same as Wibowo's research (2019), which shows that students' scientific literacy ability on basic biology concepts for both competencies is dominated by nominal categories with a percentage range of 62% - 80%, a small part in the functional class of 13% - 34%. The conceptual type is in the range of 4% - 7% and multidimensional by 0%. The results are from previous research stating that scientific literacy skills are primarily at low levels. At the high school level, it is also shown that scientific literacy is still down, with an average percentage of 52%. In addition, research results of scientific literacy ability were 55% and classified as low (Utama et al., 2019).

At the elementary school level, a lower analysis of students' scientific literacy skills was also obtained, especially the ability to conduct effective literature searches and indicators of inference, prediction, and conclusion drawing based on quantitative data with a percentage of 3.1% (Winata et al., 2018). This is supported by research by Fuadina et al. (2022), which shows that early studies of scientific literacy research are at a low level for junior high school level. Various studies show that students' scientific literacy is expected at all levels of education. The learning applied is still monotonous and conventional. There are no diverse methods in a learning process. Methods in the classroom are considered boring by students (Resita & Ertikanto, 2018). One method that can be used is discovery learning. Teachers do not deliver material directly through this learning model, but students are invited to explore their answers. Therefore, a learning model, including the discovery learning model, is needed to improve the learning process.

The discovery learning model makes students active and provides experience in finding and investigating their problems so that they will remember how the process is formed (Rahayu & Kuswanto, 2021). Nugroho & Subiyantoro (2018) explained that discovery learning includes several learning steps such as (1) stimulation, presentation of problems, (2) problem statements, identification activities, (3) data collection, data collection from observing objects, literature, and interviews, (4) data processing, analyzing data collection results, (5) verification in the form of evidence and (6) generalization of activities to conclude the results of observations and verification that have been carried out. Discovery learning scenarios also encourage students to solve

problems (Fadriati, 2017). Mustofa's research (2017) shows that student worksheets based on the Discovery Learning Learning Model effectively improve students' scientific literacy skills. This was also proven by Yaumi et al. (2017), who obtained the results of the N-Gain analysis that the average achievement of students' scientific literacy increased by 0.4 and 0.3 with moderate categories after applying the discovery learning model. As for the learning process, you can use learning media. One of the media that can be used is Android. Ramdani et al. (2020) said that Android-based media products on science materials can be implemented in learning, especially during the COVID-19 pandemic. Hatimah and Khery (2023) also show the influence of Android-based chemistry learning media on students' understanding of concepts and scientific literacy on redox and electrochemical reaction materials.

Based on the description, the effectiveness of the discovery learning model with the help of Android media to improve students' scientific literacy can be known. This research has a novelty to develop and implement discovery learning models with the help of learning media in the form of Android applications in learning, proven to improve students' scientific literacy. The relationship between discovery learning models, Android, and scientific literacy can be further studied using the literature review method from several previous research articles. This study aims to describe and conduct a study of implementing a discovery learning model assisted by Android applications through literature studies.

RESEARCH METHOD

This study used the qualitative literature review method. Literature review research is the result of analysis of various conceptual information and qualitative and quantitative data from various previously published scientific articles.

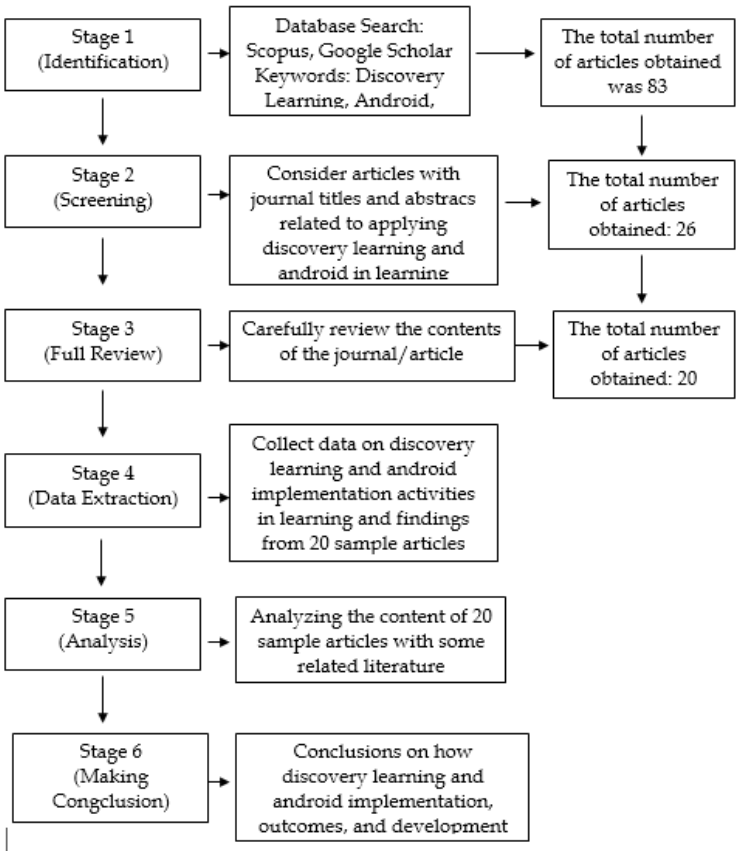

Figure 1. Research flowcharts to discover learning with Android to increase students' scientific literacy (Petyko et al., 2021).

Based on this, to support the proof of learning effectiveness using the discovery learning model, it can be integrated with the use of Android in learning (Ariana et al., 2020; Hajrah et al., 2021; Mahdi et al., 2019; Niswatuzzahro et al., 2018; Utami et al., 2019). The relationship between discovery learning models, android use, and scientific literacy can be further studied using literature review methods from several previous research articles. The method used in this study is a literature study that serves as a guideline in studying a research problem (research review). The type of data used is secondary data. Secondary data is obtained by reading, learning, and understanding through other media sources from literature, books, and documents (Creswell, 2012). This literature review uses international and national journals for the 2018-2023 publication range. The framework of the literature study includes identification, screening of titles and abstracts, complete literature review, data extraction, analysis, and conclusion-making adopted from Petyko et al. (2021), according to Figure 1.

RESULTS AND DISCUSSION

Results

A search of 20 international and national articles resulted in an analysis of two related discussions. The discussion will be delivered on the influence of discovery learning models on scientific literacy and the influence of androids.

The Effect of Discovery Learning on Students' Scientific Literacy

The results of research articles that have been found about the effect of the discovery learning model on students' scientific literacy are presented in **Table 1**.

Table 1. The result of an article study on the effect of discovery learning on students' scientific literacy.

Author(s)	Results
Winarni et al. (2020)	The discovery learning learning model applied to grade IV elementary school significantly influences language and scientific literacy. The discovery of learning using ICT can improve students' scientific literacy skills when compared to conventional learning.
Bahtiar et al. (2022)	Based on the results of the analysis of scientific literacy skills, it was found that female and male students have different literacy abilities; namely, female students have a higher level of scientific literacy ability than male students. The selection of discovery learning models with the help of PhET can improve the scientific literacy skills of both female and male students.
Maghfiroh et al. (2023)	The e-discovery learning-based physics module developed was declared feasible based on expert assessment, 94% with an outstanding category. Based on students' responses to the physics e-module, they obtained a score of 90%, which was categorized as very good. The physics e module can improve students' scientific literacy skills by obtaining an N-Gain score of 0.4 in the medium category. Developing physics e-modules based on discovery learning is efficacious in improving students' scientific literacy skills.
Warlinda et al. (2022)	Applying the guided discovery learning model with the SETS approach supported by the chemistry e-module significantly influences the scientific literacy of SHS 1 Padang grade XI students.
Budiarti et al. (2021)	The science module of Newton's Law material based on discovery learning models can improve students' scientific literacy.

Author(s)	Results
Widiyana et al. (2021)	Discovery learning-based animation media is suitable for learning, especially in the material of the human circulatory system in the eleventh grade of high school science. The animated media-based Discovery learning model effectively increases the dimension of students' scientific literacy content. Discovery learning model-based animation media can increase the dimensions of student scientific literacy content by 52% with sufficient categories. Discovery learning-based animation media is suitable for learning, especially in the material of the human circulatory system in the eleventh grade of high school science. Applying the guided discovery model is efficacious in improving students' scientific literacy competence. This is evidenced by a significant increase in the average score of scientific literacy after applying the model in distance learning in three elementary schools in remote, suburban, and urban areas.
Rahmawati et al. (2023)	Discovery learning model learning through blended learning with practicum methods using a simple volumetric gasometer can support scientific literacy. This can be seen from the difference in the average results of the post-test, which is higher than the pre-test, and the difference in the average results of the experimental class post-test, which is higher than the control class.
Berliana et al. (2023)	The application of the reading to learn and discovery learning models on excretory system material has a positive influence on students' scientific literacy abilities, as shown by an increase in pre-test and post-test scores at n gain values of 0.59 with the upper medium category with a magnitude of d-effect of 2.12 (significant effect). The application of the reading-to-learn model and the discovery learning model has a positive effect on learning outcomes, as shown by an increase in pre-test and post-test scores at n gain values high category. Applying the reading-to-learn and discovery learning models, both influence scientific literacy skills and student learning outcomes.
Putri & Marianti (2021)	Discovery learning-based student worksheets on excretory system material are valid and practical to use in learning, according to material experts, media experts, teachers, and students. Student worksheet-based discovery learning on excretory system material effectively improves the scientific literacy of high school students.
Priadi et al., (2022)	There is a significant influence on the application of the google classroom-assisted discovery learning model on the scientific literacy skills of grade X students in ecosystem subject matter at SHS 16 Bandar Lampung. This can be seen from the average N-gain score data obtained between the experimental class and the control class on each indicator of scientific literacy competence.
Purnamawati & Basuki (2021)	Applying the muja discovery learning model can improve knowledge and competence in scientific literacy. In cycle 1, the percentage of scientific literacy is 43%, and in cycle 2, 53% of students have achieved good and excellent categories. This result has exceeded the established success indicator of 50%.
Yolida et al. (2022)	The discovery learning model assisted by Edmodo has a natural effect on the scientific literacy ability of grade X students of SHS 1 Baradatu in the new average era. The discovery learning model can help students improve their scientific literacy skills, as seen from the increase in the average score of pre-test, post-test, and N-Gain. Students' scientific literacy skills are improved using the Edmodo-assisted discovery learning model.

The Effect of Using Android on Students' Scientific Literacy

The results of research articles that have been found about the effect of using Android on students' scientific literacy are presented in **Table 2**.

Table 2. The result of an article study on the effect of Android on students' scientific literacy.

Author	Result
Permana et al. (2021)	The resulting product is an android-based e-module that reflects the concept of literacy, namely aspects of content, context, scientific process, and scientific attitude. The validation result is valid. The feasibility test results of Android-based e-modules are suitable for use as teaching materials.
Qamariah et al. (2021)	Science learning based on the Experiential Learning Model (ELM) with the support of Android significantly influences scientific literacy, covering knowledge, competence, and student attitudes.
Winarni & Purwandari (2019)	Turtle mobile learning is a scientific literacy resource developed for Android smartphones. Based on the test results, the app can improve scientific literacy about turtle conservation and has been implemented in many countries through its availability through the Google Play Store.
Jalil et al. (2019)	A-SSI media to improve the scientific literacy of grade I junior high school students on earth material is very good, with an average percentage of general, material, and technical aspects of 88.9%. (2) The feasibility of A-SSI media to improve students' scientific literacy on earth material earth layer material based on practical aspects is declared practical with a percentage of learning implementation of 89.8% with very good criteria supported by activities shown by students in the learning process. There is a response given by students in the learning process with A-SSI media, 88.9% of students gave a positive response to the use of A SSI media, (3) The feasibility of A-SSI media to improve scientific literacy skills of earth layer materials based on aspects of effectiveness was declared effective by increasing scores from pre-test to post-test. The average post-test score was 70.5 in the n-gain category. N- Gain nine students in the "medium" category and one in the "high" category.
Farida et al. (2018)	Android-based science learning media has the following characteristics: attractive visualization, easy to use, flexible, and practical. They developed android-based science learning media worthy of teaching in terms of material evaluation, media evaluation aspects, and based on student trial results and product effectiveness to improve scientific literacy. The results showed that Android-based science learning media is used appropriately and effectively for teaching.
Farida et al. (2019)	The implementation of the Susan Loucks-Horsley model on Android media for scientific literacy in various school categories showed that the experimental class's N-gain was higher than that of the control class in all school categories, meaning that the scientific literacy of the entire experimental class was better than that of the control class. There was no statistically significant difference in average scientific literacy scores in experimental classes among the three study sample groups from high, medium, and low-category schools. The school category suitable for implementing Susan Loucks-Horsley-based science learning models on Android is the all-school category.
Listianingsih et al. (2021)	Android-based comics can improve students' scientific literacy. Based on the validation results, the comic can be said to be valid, and student responses are positive. The selection of digital comics can increase students' interest and learning outcomes because the side of comic images can visualize the situation between these numbers, so it is expected to help students understand and provide reasons for learning material.
Elhak et al. (2023)	The feasibility test of an android-based mobile physics pocketbook is very feasible to answer scientific literacy on energy sources. The results of the student's responses were so positive that Phy-pokemon was declared very feasible to be used as a learning medium to address scientific literacy about energy sources.

Discussion

The analysis conducted was the effectiveness of the android-assisted discovery learning model to improve students' scientific literacy. Based on the results of a review of the articles in Table 1, it was found that the discovery learning model can improve students' scientific literacy skills (Bahtiar et al., 2022; Berliana et al., 2023; Budiarti et al., 2021; Maghfiroh et al., 2023; Priadi et al., 2022; Purnamawati &; Basuki, 2021; Rahmawati et al., 2023; Warlinda et al., 2022; Widiyana et al., 2021; Winarni et al., 2020; Yolida et al., 2022). The discovery learning model is a model that requires students to find their concepts through a series of activities they do. The discovery learning model has a syntax suitable for the classroom to improve scientific literacy and student learning outcomes, such as identifying problems, searching for data, processing data, and drawing conclusions from problems in the field. Through self-discovery, students also feel more about the meaning of the process they do during learning, so they remember the concepts they have obtained. Discovery learning models have a better effect on scientific literacy than direct learning models. In addition to scientific literacy skills, the discovery learning model can train students' cognitive knowledge to improve learning outcomes. Based on facts and observations, the application of discovery learning has several advantages of helping learners improve cognitive skills and processes. A discovery learning model that emphasizes active learner learning in finding concepts (Kulsum et al., 2020; Rosdiana et al., 2017).

Indicators of scientific literacy skills trained through the discovery learning model include remembering and applying appropriate scientific knowledge, making correct predictions, identifying questions investigated in scientific studies, analyzing and interpreting data, and drawing appropriate conclusions. The ability to analyze is contained in the sub-indicators of scientific literacy and the ability to measure student learning outcomes Berliana et al. (2023). Scientific literacy assessments can be conducted through students' science contexts, concepts, and processes. The context of science refers to situations in everyday life that become grounds for applying processes and understanding science concepts. Laila's research (2020) shows that after the discovery learning model is carried out, the results in the context of science, science concepts, and science processes of students are included in the intermediate category. There is a significant ability influence after being given the discovery learning model. Apply scientific literacy in learning activities; there needs to be a learning model that supports aspects of scientific literacy, namely, to achieve aspects of results (able to make the right decisions using scientific literacy). Based on the three dimensions of scientific literacy established by PISA, there is a process dimension. The scientific approach or scientific process-based approach emphasizes the process dimension. The scientific approach has several experiential learning strategies: observing, questioning, trying, associating, and communicating. Therefore, students must find out, not be told, so that they can lead to the guided discovery process. The discovery learning model provides opportunities for students to know, do, and be actively involved in finding and understanding the concepts of examples of phenomena that exist in life. Ahfiani & Arif (2023) suggest that the discovery learning model and scientific literacy method are applied in learning to improve students' scientific thinking skills. Thinking scientifically is a way to hone students' minds in practical learning, which aims to think broadly, aesthetically, and thoroughly. The scientific literacy approach can be developed by inviting students to be actively involved in the learning process and continue to create exciting and fun learning so that students can learn according to the experience they have gained during daily activities but still integrate with scientific literacy. This shows that the discovery

learning model is suitable for improving students' scientific literacy (Amazida et al., 2021; Mustikawati, 2021; Nurhayati, 2018; Rahman et al., 2022; Widiastuti et al., 2022).

Based on the analysis of the article in Table 2, it was found that the use of Android can increase students' scientific literacy (Elhak et al., 2023; Farida et al., 2018; Farida et al., 2019; Jalil et al, 2019; Listianingsih et al., 2021; Permana et al., 2021; Qamariah et al., 2021; Winarni & Purwandari, 2019). Electronic learning or learning with the help of electronic media can improve learning outcomes. Technology prepared in the learning process includes the internet and the Android operating system. Android can be used as a learning medium. Media in education is a learning resource that contains instructional material to attract students to learn. The media provides learning experiences to students, clarifies material from teachers, learns things that are difficult to observe directly, observes events that occurred in the past, and looks at parts that are difficult to observe or hidden from a tool so that it makes it easier for teachers during the learning process in class. Good media creation must include several aspects and indicators such as user ease perception, attitude, intention, perceived usefulness, and the actual system used. Using Android as a learning medium can be an alternative solution to make students more active in the learning process.

The more active students will affect learning outcomes. Learning outcomes are also closely related to students' scientific literacy (Hadisaputra et al., 2019; Shofiyah et al., 2020). Ramdani et al. (2020) stated that learning using learning media allows students to focus on content. Android-based media has the advantage that it can be used independently both at school and outside school because this media is easy to get and download via Google Drive; it can be used practically and can be downloaded via a gadget or through a computer. Istighfarini et al. (2022) showed that the use of Android-based application media is made by paying attention to the domain of scientific literacy, which consists of three aspects, namely knowledge, application, and reasoning. Android application media is considered new, so it is more exciting and exciting, mainly since videos can also be accessed according to learning needs. Latip and Faisal (2021) stated that, generally, the characteristics of media developed to improve scientific literacy have an interactive nature that is accommodated by animation. This interactive nature is expected to facilitate scientific knowledge, especially procedural knowledge, and facilitate scientific competence in explaining scientific phenomena and interpreting data (Jin et al., 2019; Palupi et al., 2020; Stieff, 2020; Teig, 2020). In addition, common characteristics found in each media that have been developed include the phenomenon or contextuality of the material presented in the design of the media display (Anggraeni & Sole, 2018).

The design display is part of a stimulus so that students are interested in learning the material contained in the media. In addition, phenomena are also used to develop context domains in scientific literacy, which become frames for other literacy domains. Haidah et al. (2022) explained that android learning media affects students' scientific literacy skills. Learning media can help us understand learning. Smartphones are a necessity that makes it easier for students to read or learn subject matter. Using android-based learning media can foster students' scientific literacy to support student learning activities. Students can develop thinking skills, be scientific, and form a relationship between their knowledge and their application in everyday life. This shows that Android can be used as a learning medium so that it can improve students' scientific literacy (Hidayati et al., 2023; Kusumawardhani et al., 2017; Lestari et al., 2021; Raharjo et al., 2017). Using media, the learning atmosphere will be exciting and more

varied so that learning results will be better (Sukma & Handayani, 2022; Wijayanto & Istianah, 2017). Engaging in learning media can also improve student motivation (Putri et al., 2021). The Android media can be in the form of digital educational games, videos, YouTube, PowerPoint, multimedia, Macromedia/Adobe Flash, digital comics, e-books, e-modules, flipbooks, augmented reality, virtual reality, educational websites, educational television, and educational applications, such as teacher rooms, quipper schools, and smart classrooms (Asani, 2023; Atdhini et al., 2023; Kartika & Lutfi, 2023; Mustofa et al., 2023; Najib et al., 2023; Yulianti et al., 2023). Based on 20 articles that have been analyzed, the application of discovery learning models and the use of Android media from year to year fluctuates. The most deployments were in 2021, and the fewest were in 2018 and 2020. In 2022 and 2023 have the same number. A graph of the number of research trends can be seen in Figure 2.

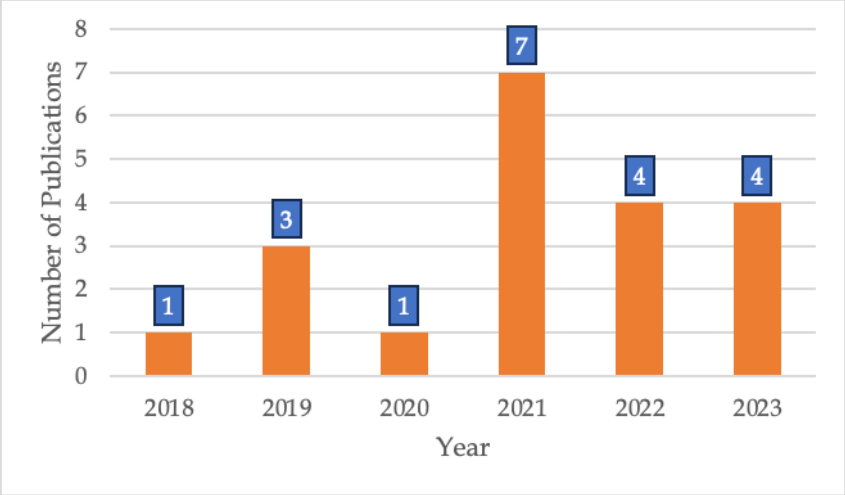

Figure 2. Number of studies 2018-2023.

Then, the application of the discovery learning model or the use of Android to improve scientific literacy at each school level has differences. Very few are still at the elementary school level, only 10%. High school has the same percentage, 45%, at the junior and senior levels. This shows that the application of learning is more widely used in secondary schools. The graph of the application of discovery learning and the use of Android applications at various levels can be seen in Figure 3.

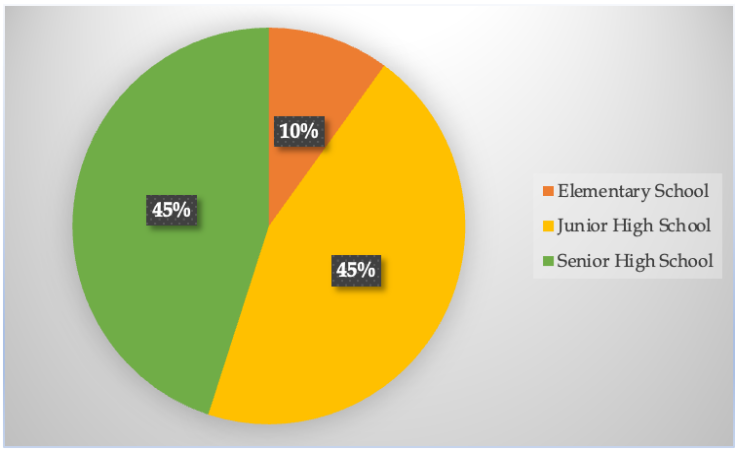

Figure 3. Application of discovery learning and use of Android apps in learning.

Based on the results of an analysis of 20 articles conducted, it was found that the discovery learning model using Android applications effectively increases students' scientific literacy at various levels of education. This study shows that it is necessary to develop practical learning tools to improve scientific literacy. Researchers and practitioners are expected to develop learning tools and teach content to students actively. If learning can facilitate scientific literacy through discovery learning models with the help of Android applications, students' scientific literacy skills will increase.

CONCLUSION

Fundamental Finding: Based on the results of the article analysis, the application of discovery learning models integrated with Android is feasible and can be used to improve students' scientific literacy. Discovery learning is the model chosen during the learning process, and Android is a learning medium. Scientific literacy is the ability of a person to understand and make decisions in a problem related to natural conditions and changes that occur in nature by human activities. **Implication:** This research is expected to make the basis of learning devices by the characteristics of the discovery learning model that uses Android as a learning medium so that learning becomes quality. **Limitation:** This research is limited to more than an android-integrated discovery learning model for improving scientific literacy. Research also has limited article sources, namely Google Scholar and Scopus. **Future Research:** It is hoped that there will be further research that discusses innovation, design, models, and other learning media that can improve scientific literacy skills so that more literature sources will be available.

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