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Analysis of Android-Based Science Learning Media to Improve Motivation and Learning Outcomes of Elementary School Students: A Systematic Literature Review

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Abstract: According to some elementary school students, science subject matter is included in the category of difficult and less interesting material to learn. Because most of the materials in Science Lessons are abstract. This causes a lack of student motivation and suboptimal learning outcomes. Responding to these challenges, many learning media have been developed, one of which is android-based learning media which is desired to be one of the innovative solutions to overcome challenges in science learning. This study aims to analyze the validity and effectiveness of android-based learning media, especially in science learning in elementary schools in an effort to increase student motivation and learning outcomes. The methodology in this study is by means of a Systematic Literature Review (SLR) which involves 21 relevant articles that are searched using Harzing's Publish or Perish machine with scopus and crossref reference categories, then processed using the PRISMA flow. The results of this study show that all learning media written in the article show a valid and effective category for increasing student motivation and learning.

Keywords: Android-based science learning media; Learning outcomes; Primary school; SLR; Student motivation

Introduction

Natural Science (IPA) learning in elementary school has a meaningful role in building students' initial understanding of the world around them. Through science learning, students are trained to observe, ask questions, and find answers about natural phenomena they encounter in the surrounding environment. It has the goal of developing students' sense of desire and critical thinking. A strong understanding of science concepts will be very beneficial for students in daily life, such as understanding the importance of keeping the environment clean, using natural resources wisely, and understanding the ever-evolving technology. In addition, science also plays a role in shaping students' scientific attitudes, such as objectivity, openness to other people's opinions, and the habit of seeking truth based on facts, as conveyed by Khamrani (2002) that the scientific attitude that will be developed through science learning is an attitude that will always prioritize evidence, be flexible and flexible, and be critical or sensitive to the environment (Maulani et al., 2022). To be able to have a scientific attitude, students' critical thinking skills must continue to be trained, because currently we are in the era of the rise of artificial intelligence. So his presence must be able to strengthen critical thinking skills, not the other way around (Darwin et al., 2024).

However, in reality, science teaching is faced with a number of challenges, such as lack of student motivation

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and suboptimal learning outcomes, which often hinder the learning process. Many students think that science material is too difficult and abstract, so it is not interesting to learn. Traditional learning methods, such as lectures and memorization, often leave students feeling bored and inactive in the learning process. In addition, the limitations of attractive learning facilities and media are also an obstacle in increasing student motivation and learning achievement, in this case the Science subject. This is very much in accordance with research that states that there are four things that are challenges in science learning, namely: limited learning media, low student motivation to learn, limited facilities and infrastructure, and less varied learning methods (Ratno1 et al., 2024). And there are many more challenges that arise in science learning in elementary schools. In this study, the challenge of concern is related to low motivation and learning outcomes of students and the use of learning media.

In the digital era like now, technological developments present new opportunities to improve the quality of education. Teachers can use pre-existing or available digital technology-based learning resources or develop their own (Rachmadtullah et al., 2023). One of them is through the use of Android-based learning media. Android-based learning media offers a variety of interactive features, such as animated videos, simulations, and quizzes, which can make the learning process more interesting and enjoyable. The use of familiar Android devices for students provides easy access to learning materials anytime and anywhere. This learning media can also be adjusted to the individual learning style of each student, so that the effectiveness of learning can increase significantly. Digital learning media not only excels in terms of accessibility and interactivity, but can also serve as an effective tool to improve student motivation and learning outcomes. Even research Lin et al. (2025) states that the study found that compared to traditional tools, augmented reality (which is one of the media developed based on android) in an interactive learning environment significantly improved overall learning effectiveness (g= 0.717, 95% confidence interval [CI] = 0.606–0.827) at the level of 0.05. This statement certainly strengthens that with digital learning media, students will be more actively involved in various learning activities, such as conducting virtual experiments, discussing with friends, and completing assignments independently. Digital learning media are also able to provide faster and more specific feedback, which helps students understand their mistakes and improve their understanding. Various previous studies have shown that digital learning media is able to increase student motivation, interest, and achievement in studying science.

Learning motivation is a key factor in achieving optimal learning outcomes, especially in science subjects. This motivation is in a person who is not visible, because he is a one's mental process of producing and sustaining goal-oriented actions (Kim & Castelli, 2021). Research has proven that the higher the motivation of students, the better the learning outcomes they achieve. Students' interest in science, the relevance of the material to daily life, and interesting learning methods are important factors in increasing learning motivation. One of the things that we can learn to find out the level of student motivation in science learning is with pedagogical experiments, which are experiments consisting of stages of identification, training, and control, in each group (experimental and control) student motivation analysis is carried out in science learning (Nikitin et al., 2020).

Android-based learning media is expected to be an alternative innovative solution to overcome challenges in science learning. Because improving learning must always be sought. In the context of this research, one of the efforts that can be made is to utilize innovative, interactive media, combined with various relevant learning models (Masyitha et al., 2023). By utilizing Android technology, science learning can be presented in a more interesting, interactive, and relevant way to students' lives. Interesting visualizations, interactive simulations, and multimedia features contained in android-based learning media can be tools for students to more easily understand complex science concepts and materials. Student involvement in the learning process will increase significantly with the existence of android-based learning media. In addition, the advantage of android-based learning media can be accessed from anywhere, both at school and at home, plus another value of using android-based media is that it can bridge materials that require abstract thinking (Ramdaniet al., 2020; Siswosuharjo et al., 2021; Asani et al., 2023).

Students' motivation to learn will be encouraged because they feel more challenged and enjoy the learning process. Students who have high motivation in participating in learning will usually show an enthusiastic attitude in learning. Among the indicators of enthusiasm in learning can be said to be active and enthusiastic about following and paying attention to learning, actively asking questions in activities to explore the material (Caella & Yulianto, 2024). With high motivation in involvement in the learning process, the knowledge obtained by students will be more profound and meaningful so that they can improve their academic achievement. Therefore, the use of android-based learning media is highly recommended to maximize the quality of science learning so that educational goals are achieved in a better direction.

Through a systematic literature review, this study aims to identify factors that affect the effectiveness of android-based learning media in order to increase the interest and motivation and learning outcomes of elementary school students in science subjects. If previous studies focused on the effectiveness of learning media in general, this study will specifically examine the factors that affect the successful use of android-based learning media in the context of science learning. The final result of this study is expected to contribute and provide useful value for educators and developers of learning media, as well as policymakers in designing and implementing more effective learning strategies based on android technology, especially in the context of science learning at the elementary school level.

Method

The methodology used in writing this study is to use the Systematic Literature Review approach by following the flow of PRISMA (*Prefered Reporting Items for Systematic Literature Reviews and Meta Analyse*). SLR is a literature analysis carried out with a structured and clear and comprehensive series through the stages of the process of identification, assessment, and collection of data from research that has been carried out by other researchers (Rohmaya, 2022). The stages in this study are by reviewing and identifying journal articles in a structured manner following predetermined steps. The stages in this study are to carry out 4 main stages, namely identification strategy, selection criteria (screening), quality assessment (eligibility), and data extraction (included) (Alannawa & Hidayati, 2021).

Figure 1. Stages of systematic literature review

As an initial stage, it is to choose a theme that will be the focus of the research, then formulate a problem in the form of a research question. The third stage determines the inclusion and exclusion criteria, and continues with the stage of determining the database and keywords.

The main theme in this study is about the effectiveness of android-based learning media, especially in science learning, with the research question (RQ) in this research is:

RQ1: What android-based learning media have been successfully developed to improve the motivation and learning outcomes of elementary school students in science subjects?

RQ2**:** What is the level of validity and effectiveness of Android-based learning media in order to increase the motivation and learning outcomes of elementary school students in science subjects and what factors make the media effective?

After determining the RQ, the next stage is to create inclusion and exclusion criteria. The inclusion criteria are very necessary to obtain articles that are in accordance with the research objectives (Fauza et al., 2023). The purpose of inclusion and exclusion criteria is used to minimize ambiguity and reduce the possibility of bias in the literature study (Putra et al., 2023). The following are the inclusion and exclusion criteria in order to get articles that are in accordance with what is set out in the systematic review study to select articles:

a) Journal articles published in the 2022-2024 range and have open access.
b) Journal articles that are relevant to the theme of the effectiveness of android-based learning media in improving the motivation and learning outcomes of elementary school students in science subjects, with the specification of discussing Android-based science learning media and the intended outcome is about motivation and improvement of learning outcomes, as well as using research with qualitative, quantitative, RnD methods.
c) The research population in the analyzed journal articles is elementary school (SD) students, and students of Special Needs Elementary School are not included in this category.
d) Journal articles that are indexed by scopus, google, sinta, scholar, or repository.

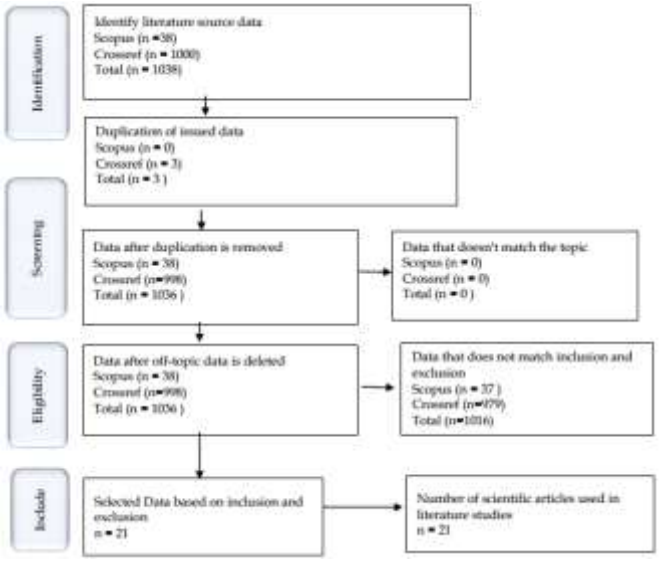

Figure 2. Article selection flow diagram

The next stage is to determine the database and keywords. The database used in the process of searching for journal articles is reference articles in Scopus and

Crossref with the help of Harzing's Publish or Perish (PoP). Publish or Perish itself is an application or software that is used to take and analyze an academic or academic citation in the form of a raw data source, which will then be analyzed so that it can be used as various forms of citation matrix, including the number of pages and total citations, as well as the h-index (Khoirunnisa & Fikri, 2023).

The keywords used in the PoP are "android-based science learning media", "student motivation", "science learning outcomes", "elementary school". After completing these stages, the results of the data search will be visualized in PRISMA diagrams. PRISMA creates a uniform peer review technique that uses a list of best practices to help ensure the quality and reproducibility of the revision process (Pahmi et al., 2023). After entering the PRISMA stage, data analysis will be carried out by linking the data that fall into the inclusion criteria with a descriptive assessment of research quality to show illustrations that are in accordance with the problems contained in the research question (Research Question). Figure 2 is intended to provide an illustration of the flow at the stages described above.

Results and Discussion

Based on the method used in the research, namely by using PRISMA, as many as 38 articles from *Scopus* and as many as 1000 articles from *Crossref* were obtained which were included in the keywords as well as carrying out article selection, so that 21 articles were obtained that would be *reviewed*, the 21 journal articles will be mentioned as the identity of the article by including the article number as a marker for the order of the article, title, author, journal, and the name of the learning media developed in these articles, which can be seen in the table 1.

Table 1. Journal Article Analysis

Article number	Article title	Writer	Journal	The name of the developed media
Article 1	Anima-lie: android-based learning media on animal life cycles materials for elementary school	Sri Lestari Handayani, Island Dahlia (2022)	Elementary school scientific journals	A mobile learning application called anima-lie on animal life cycle materials for grade iv elementary school (Handayani & Dahlia, 2022)
Article 2	Digital comics learning media based on problem based learning in science subjects for fourth grade elementary school	Kadek Nita Puriasih, I Gede Astawan, Gusti Ayu Putu Sukma Trisna (2022)	Undiksha pgsd pulpit	PBL-based digital comics for science subjects for class IV animal life cycle materials (Puriasih & Trisna, 2022)
Article 3	Development of science learning media klanimal android based for elementary school students	Fadhilah Nur Lailatus Sa'adah, Fitria Nur Hasanah (2023)	Edunesia : a scientific journal of education	Media Android-based klanimal learning for materials Classification of animals by type of food (Saadah & Hasanah, 2023)
Article 4	Development of android-based "megowan" learning media (knowing animals) for class v elementary school students	Risa Hayati, Fitria Nur Hasanah (2023)	Umsida preprints server	Media Android-based named "Megowan" recognizes animal classes based on their food type Class V Elementary School(Hayati & Hasanah, 2023)
Article 5	Utilizing ispring suite to develop medifora android-based application as a science learning media for fourth grade elementary school students	Rohmani, Purie Nawa Utami (2024)	Ijmars: international journal of multidisciplinary approach research and science	An android-based application called medifora with the help of i spring suite 10 for science learning in elementary school life cycle material (Rohmani & Utami, 2024)
Article 6	The effectiveness of android-based science learning model to increase student learning outcomes	Deka AyuKhotima, Su'ad, Santoso, Hendri Pratama(2022)	Asian Education	Design of an android-based experimental learning model for learning science of human respiratory materials in grade v elementary school in the form of a guidebook (Khotima et al., 2022)

Article number	Article title	Writer	Journal	The name of the developed media
Article 7	Improving science learning outcomes for elementary school students through the development of flipbook media	Alicia Salzabila's daughter, Moh. Fathurrahman (2024)	Science education research journal	Digital teaching materials Based on Flipbook of Style Materials for Grade IV Elementary 2 Students(Salzabila & Fathurrahman, 2024)
Article 8	Development of android-based sikair interactive learning media to improve learning outcomes of class v elementary school students on the material of the water cycle	Widya Septiani, Budi Hendrawan, Rahmat Permana (2023)	Jetish: an educational, technological, informational, social sciences, and health journal	Development of android-based interactive learning media for water cycle materials in elementary school grade V (Septiani et al., 2023)
Article 9	Development of android-based augmented reality learning media on the human respiratory system to improve student learning outcomes	Yusuf Rashid Ridho, Novi Setyast (2024)	Science education research journal	Media Android-based augmented reality learning about the human respiratory system Grade V Elementary School (Rosyid & Setyasto, 2024)
Article 10	Development media of explore the digestive system (jesip) android based on science learning at 5th grade elementary school	Tendi Darisman, Dede Iskandar, Karlimah, Erwin Rahayu Saputra, Syarip Hidayat (2023)	Dwija Scholars: Journal of Pedagogic Research	Exploring the digestive system in humans (jesip) (Darisman et al., 2023)
Article 11	Development of digital learning media based on augmented reality to improve student learning outcomes of elementary school	Nanda Lailatul Nafis, Moh. Fathurrahman (2024)	Research and development in education (raden)	Learning media based on augmented reality technology on maple science and natural resources material class v elementary school (Nafis & Fathurrahman, 2024)
Article 12	Development of hydrological cycle learning media based on android application for fifth grade elementary school students	Dhea Rahma Safitri, Fajar Cahyadi, Asep Ardiyanto (2024)	Journal of basic education	Hydrological cycle software application for grade 5 sd. files with .apk extension. (Safitri et al., 2024)
Article 13	Development of android-based digital teaching materials using articulate storyline 3 to increase student motivation and learning outcomes in natural and social science subjects	Aprilia Rizqi Sri Sofiantari , Tri Astuti (2024)	Science education research journal	Learning media: "oh my environment is damaged" (apoljar) articulate storyline 3 science subjects class v elementary school(Sofiantari & Astuti, 2024)
Article 14	Assemblr edu learning media based on augmented reality to improve learning outcomes of grade v elementary school students	Zumrotun Nafi'ah , Sri Sami Asih (2024)	Science education research journal	Augmented reality-based assemblr edu learning media on maple science and earth layer structure material media in class v sdn kadiren blora district (Nafi'ah & Asih, 2024)
Article 15	Android-based educational game learning media containing gending rare local wisdom on science subjects for grade 5 elementary schools	Ni Made Milayani Suarningsih, I Gede Margunayasa, I Wayan Lasmawan (2024)	Scientific journal of education and learning (Ganesha University of Education)	Android-based educational game with local wisdom gending rare science subject 5th grade (Suarningsih et al., 2024)
Article 16	The development of 2d android learning application on the topic of light properties for elementary school science subject	Norhasyimah Hamzah, Syahirah Nadiah Hamedon,	Innovative teaching and learning journal (itlj)	Application Android 2D learning on Light Properties Topics for Elementary School Science Subjects (Hamzah et al., 2024)

Article number	Article title	Writer	Journal	The name of the developed media
		Arihasnida Ariffin, Siti Nur Kamariah Rubani, Normah Zakaria (2024)		
Article 17	Development of puzzle-assisted mobile learning media to improve student science learning outcomes	Zulfa Nur'aini, Ali Sunarso (2024)	Pendipa journal of science education	Mobile learning assisted by puzzles in science subjects of animal life cycle material class v sd negeri 2 redin purworejo (Nur'aini & Sunarso, 2024)
Article 18	The effectiveness of android-based e-modul discon (e-modul disroid) on sound material on student learning outcomes	Nurul Alifha Azizah, Zulnuraini, Sinta Satria Dewi (2023)	Tadulako social science and humanora journal	Android-based discon e-module (disroid e-module) on sound material Grade V in Elementary Presidential Instruction 6 lolu (Azizah et al., 2023)
Article 19	Development of android-based dilan e-module (didroid) on hot materials for elementary school students	Mutia Febriyana, Azizah, Abdul Rahman, Aprilina Rizqi Auliya, Melyani Sari Sitepu (2022)	Munaddhomah: journal of Islamic education management	Android-based dilan e-module (didroid) on hot material for students of Khalifah Islamic Elementary School Palu(Febriyana et al., 2022)
Article 20	Developing android based my science app learning media with a sets approach on the topic of the solar system in elementary schools	Fita Permata Sari, Arief Budhiman, Herry Prasetyo (2023)	JPPPF (journal of research and development of physics education)	My science app is android-based with a sets approach on solar system science material for grade vi students of SD Negeri Salebu 03 Majenang (Sari et al., 2023)
Article 21	Development of Augmented Reality Book (AR-Book) Based Science Learning Media on Human Digestive System Material to Improve Student Learning Outcomes	Dina Abdilah, Desi Wulandari (2024)	Science education research journal	development of Augmented Reality Book (AR-Book) media, material for the human digestive system class V SDN Kalibanteng Kidul 01 (Abdilah & Wulandari, 2024)

Discussion

RQ1: What android-based learning media have been successfully developed to improve the motivation and learning outcomes of elementary school students in science subjects?

Of the 1035 articles obtained from the PRISMA process, 21 articles were obtained that had met the inclusion criteria set previously. The analysis shows that in order to be able to provide learning that answers the learning needs of students, so that motivation can be formed in students to participate in learning, especially science learning and at the same time as an effort to improve student learning outcomes, teachers try to overcome it by presenting learning media that are innovative, creative, and adapted to the development of the times and technological advances that are currently developing. Because it is undeniable that currently by utilizing learning media, it will be one of the factors that has an important influence on the learning process (Sukir, 2019). The learning materials presented using androids that can be easily accessed by students can be a support to facilitate the teaching and learning process because it can include a variety of visual elements, ranging from video, audio, animation, images, sounds, and even text (Farida et al., 2020).

RQ2: What is the level of validity and effectiveness of Android-based learning media in order to increase the motivation and learning outcomes of elementary school students in science subjects and what factors make the media effective?

To determine the level of validity and effectiveness of the android-based learning media, it is carried out by validity test. Validity test as according to Rohmah et al. (2023), it is a stage that must be passed to make the measuring instrument acceptable or standardized. This validation is very important to find out the level of validity of a learning media developed, in this case, of course, related to android-based learning media. This validation is carried out by material experts and also media experts. In Alsyabri (2021) the validity test is usually carried out after the Andorid-based learning media has been developed, and subsequently validated

by experts or experts. The validation process includes discussion activities and direct interviews with experts about the product or media developed as well as about the improvements that must be made. Then the design of the media will be assessed by competent people (validators) who have understood and mastered the principles of developing a learning media based on validity instruments. The validation tool or instrument is a tool that is commonly used to collect data, and it can be in the form of a questionnaire for validation from each expert (Dewimarni et al., 2022).

The level of validity and effectiveness of android-based learning media developed in the 21 articles is shown in the following table 2.

Table 2. The Level of Validity and Effectiveness of the Media Developed

Article No.	Material expert	Media members	Effectiveness
Article 1	85.5%	89.93%	83.64%
Article 2	4.83	4.83	Effective
Article 3	85%	89%	0.70
Article 4	80%	85.71%	0.90
Article 5	76.32%	78.42%	80%
Article 6	94%	98%	88.49
Article 7	88.75%	91.25%	96%
Article 8	100%	90%	0.80
Article 9	85%	86%	0.73
Article 10	89.58%	86.60%	87.50%
Article 11	87%	88%	0.66
Article 12	95%	75%	Effective
Article 13	95%	75%	87.13
Article 14	70.80%	87.50%	73.38
Article 15	94.16%	91.00%	81.60
Article 16	70.80%	87.50%	82.47
Article 17	90.27%	88.88%	0.75
Article 18	79%	74.48%	Effective
Article 19	90%	100%	90%
Article 20	96.25%	95%	Effective
Article 21	92%	90%	0.71

The validity level of each journal article sourced from material experts and media experts, all stated to be valid with different scores, most of which are displayed on a percentage scale and some on a scale of five and in a direct descriptive form, as shown in table 2 above. All articles that are declared valid at the same time are also declared effective with varying scores. The validity grouping criteria of the 21 articles follow the criteria contained in the (Sunaryo et al., 2022), as follows:

Table 3. Validity Criteria

Validity value (%)	Category
0-20	Invalid
21-40	not valid
41-60	Valid enough
61-80	Valid
81-100	very valid

And there is one article whose validity follows a scale of five (Mukholifah et al., 2020) with the following criteria:

Table 4. Criteria for a Five-Scale Score

Score interval	Criterion
4.22 - 5	Highly valid
3.41 – 4.21	Valid
2.61 – 3.40	Quite valid
1.80 – 2.60	Less valid
1 – 1.79	Very invalid

The statement about validity related to effectiveness is not only about the development of android-based media in science learning, but also proven in other research in other fields such as in the field of mathematics conducted by Marthani et al. (2022), who explained that the digital learning media "BABADA" in the continuation of flat building obtained an average of 89.17% validity from all aspects with the category of very good, and the effectiveness test using the Wilcoxon test was declared effective in use, in the field of English carried out by Arsyad et al. agreed, that educational games can be categorized into media that can maximize English learning outcomes with reliable validation 0.7 and an N-Gain effectiveness score of 0.49 which means that learning media in the form of educational games can be used as learning media with an effective category (Arsyad et al., 2023), as well as in the field of social studies as done by Fatmawati and others, who stated that android application-based learning media which has a media validity level of 4.00, and material validity of 3.23, as well as an N-Gain effectiveness level of 0.74 is included in the category of android application-based learning media that is declared effective and feasible to improve student learning outcomes in social studies subjects (Fatmawati et al., 2021).

From all the articles researched in this writing, it can be concluded that the factors that affect the validity and effectiveness of android-based science learning media include; The media developed has gone through the analysis of experts, namely material experts and media experts, as well as has obtained input or revisions related to matters that are considered inappropriate, and obtained validity test scores with valid categories, then the next stage is tested in small and large groups with pretest and posttest techniques to determine the level of effectiveness.

From the process of analysis and synthesis in 21 selected journal articles, it can be concluded that android-based science learning media with various forms developed has an important contribution to efforts to improve student learning outcomes, one of which is because student learning motivation has increased with the presence of these learning media.

This is very much in line with what was conveyed by Sri et al. (2018), that the use of android applications on students can change learning to be more effective and can improve student learning outcomes (Izhar et al., 2022). Some other positive aspects of the use of digital media in addition to improving motivation and learning outcomes are that it can also be used as a moral agent media in cyberspace, namely by utilizing VR in ethical education programs can be an effective media as a moral agent in cyberspace (Shim, 2023), can even be used to overcome students' phobia of mathematics with the help of two-dimensional animated videos (Novianti et al., 2023).

Conclusion

Learning media, in this case android-based science learning media is said to be able to increase student motivation and learning outcomes are learning media that have valid category validity test results and have effectiveness test results with effective categories.

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Author's Contribution
The contribution of each author to this research is as follows: M.H.; contributed to the conceptualization, methodology, preparation of the original draft, as well as results and discussions, A.F.N.; responsible for validation, methodology, and review writing, B.H.C.K.; supervise and consult mothers in the Conclusion, A.A.L.; assisting with the conclusion and review of the manuscript, B.H.C.; support the conclusion and review the manuscript.

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