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EBS-PBM apps as an innovative digital media for enhancing numeracy skills in learning fractions in elementary school

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Abstract: Numeracy skills, particularly in fractions, are essential foundational competencies for elementary school students, supporting the understanding of more advanced mathematical concepts at subsequent levels. However, various studies have shown that students continue to face difficulties in understanding and performing operations with fractions, due to both cognitive and pedagogical factors. This study aims to describe the design and features of the EBS-PBM Apps as an innovative digital media, as well as to explore students' perceptions, interests, and challenges encountered during its use, and its impact on enhancing numeracy skills. A quasi-experimental approach was employed using a one-group pretest-posttest design, involving 45 elementary school students in Sumedang Regency, West Java, Indonesia. Data were collected using a questionnaire. The results indicate that the EBS-PBM Application was positively received by students and significantly improved their interest and numeracy skills in fractions. The application was considered engaging, user-friendly, and effective in stimulating students' counting abilities in an interactive and contextual manner. This study recommends the integration of digital medium such as the EBS-PBM Apps into mathematics instruction to support early mastery of numeracy skills.

Keywords: *EBS-PBM Apps, Elementary school students, Fractions, Innovative digital media, Numeracy skills.*

1. Introduction

Elementary school students are closely associated with the understanding of symbolic numbers tested at the beginning of first grade through counting activities, number knowledge, and arithmetic operations [1]. From a theoretical and practical point of view, counting is an important skill that is a strong predictor of numeracy fluency and accuracy in later life [2-4]. This presents a significant challenge for teachers, improving students' potential in every aspect of themselves, ranging from character, cognitive abilities, and even practical skills. Teachers' openness to support and help students and cooperation in the school environment are important elements of a successful teaching and guiding process, regardless of the difficulties experienced [5]. In particular, the assessment system in Indonesia is inseparable from the cognitive side of students although the consideration of determining the final grade can be multifaceted, for example from attitude scores, psychomotor, and portfolio. However, much of the literature identifies the family as a key that strongly influences the early development of children's academic skills, including literacy and numeracy [6]. At the same time, a strong push from stakeholders comes, emphasizing literacy and numeracy competencies embedded in the national curriculum.

The numeracy skills of primary school students relate to the skill of solving practical problems that are contextualized in everyday life using various numbers and symbols [7, 8]. The concept of numeracy skills is an urgency that should be acquired by every student without exception. These are a direct outcome of the learning process in schools, reflecting how well students understand the material

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delivered by teachers and how effectively they apply numeracy in practical contexts. Moreover, numeracy skills can stimulate the development of other skills. Studies have shown that numeracy and phonological processing skills influence mathematical growth from kindergarten through third grade [9]. Writing and numeracy abilities are consistently among the strongest predictors of academic achievement in third grade, both in reading and mathematics. This indicates that both skills are important foundations for successful learning in primary school, especially for students from low economic backgrounds and diverse ethnicities [10]. The relationship between children's numeracy skills and later math achievement is well documented.

Research has shown that basic numeracy skills play a crucial role in the development of students' mathematical abilities. Students who have strong numeracy skills early on are generally better prepared for procedural calculations and mathematical story problems at subsequent educational levels [11, 12]. These skills are also closely linked to mathematical problem-solving abilities that typically begin to emerge in the second grade of elementary school [13, 14]. As students progress in age and grade level, their numeracy skills tend to become more complex. Studies have demonstrated that advanced numeracy competence and fluency in solving addition problems are strong predictors of mathematics success by the fifth grade [15, 16]. These findings are supported by recent research emphasizing the importance of mastering basic numeracy skills to support long-term achievement in mathematics [17]. Therefore, it is essential to cultivate students' counting skills from an early age to stimulate their thinking pattern and better prepare them for more advanced mathematical learning [18-20]. Numeracy skills are also known to enhance mental reasoning and problem-solving abilities [21]. In the short term, strong counting skills provide a solid foundation for tackling subsequent learning content, while in the long term, sustained numeracy competence supports academic success and practical functioning in everyday life, where numbers and calculations are consistently involved.

Unfortunately, current findings reveal a mismatch between expected and actual student performance. Research indicates that some students struggle to name numbers from 1 to 10 when presented with numerical symbols, and many express confusion when asked to associate these symbols with their actual meanings [22, 23]. Specifically, in the context of numeracy skills related to fractions in elementary schools, challenges arise from perspective cognitive, affective, pedagogical, and instructional resource-related factors [24]. Put simply, teaching and learning fractions remains a considerable challenge for students [25]. The literature also highlights a concerning lack of deep understanding of fraction content and pedagogical knowledge among both in-service and pre-service teachers [26]. Many studies show that most elementary school teachers lack the content knowledge and pedagogical content knowledge (PCK) to teach fraction concepts effectively [27].

Given these conditions, a multifaceted approach is required. This approach includes context-based learning, the use of interactive tools, and a clear progression of learning. Therefore, addressing this issue involves not only improving classroom teaching but also providing supporting components. In simpler terms, the learning process requires effective instructional media. In line with current conditions, the use of gadgets and access to digital resources has become more accessible and commonplace. This presents a viable alternative that teachers can consider in implementing learning. Researchers have shown that the use of technology can contribute positively to students' cognition [28]. Building on previous research conducted by Kusuma, et al. [29] the development of the Android-based application B'Math was found to enhance elementary students' numeracy skills. The study employed the ADDIE model. B'Math is an educational adventure game designed as Android-based instructional media that features a multi-level arithmetic, including number symbols, comparison, matching, addition, and subtraction—with results limited to values under 20.

However, there are still few digital medium that specifically discuss counting skills on fractions. Therefore, this study can bridge the hope and reality through EBS-PBM Apps as an innovative digital media.

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Based on previous studies, this study generally aims to explore how the results of the application of EBS-PBM Apps from the perspective of elementary school students. From this background, the problem formulation in this study is organized as follows.

(1) How are the design and features developed in the EBS-PBM Apps application as an innovative digital media?
(2) How do elementary school students perceive the implementation of EBS-PBM Apps as an innovative digital media in learning?
(3) To what extent is the level of interest of primary school students in utilizing the EBS- PBM Apps application as an innovative digital media during learning?
(4) What are the obstacles and barriers experienced by elementary school students while using the EBS-PBM Apps application in the learning process?
(5) How does the EBS-PBM Apps application improve students' mathematical understanding skills?
(6) How can the EBS-PBM Apps application as an innovative digital media train and improve numeracy skills on fraction material for elementary school students?

2. Literature Review

2.1. EBS-PBM Apps as Innovative Digital Media

Digital media is a tool to support the learning process and an effective aid to achieve optimal learning objectives. Digital media as learning media can help teachers in transmitting learning materials, transforming abstract concepts into concretes, and simplifying complex topics to be easier to understand [30]. The popular media today is Android-Based Learning, which is learning medium by utilizing the features available in Andorid. The use of Android features can produce interactive learning designs that help maintain students' attention and increase their interest in learning [31-33]. EBS-PBM Apps as an innovative digital media contains various features, namely the Learn, Competition, Quick Test, and Duel [34].

The Learn menu has five main materials taught in this application, namely: conversion of common fractions to integers, common fractions to decimals, common fractions to percentages, mixed fractions to common fractions, and mixed fractions to decimals. Each material is presented systematically and accompanied by practice questions designed to hone students' understanding and skills. The next feature available in this application is the Competition menu, which is designed to increase students' learning motivation through a challenge-based approach. This menu consists of three levels, namely easy, medium, and hard, each of which reflects the level of complexity of the problems that will be faced by the user. This leveling up aims to provide a learning experience that is adaptive and appropriate to students' abilities. The Quick Test feature is an evaluative tool designed to challenge and measure students' speed and accuracy in solving fraction problems. In this feature, students are given an initial 60 seconds to answer the questions provided. Each correct answer will automatically add three seconds to the time, giving students a greater chance of moving on to the next problem. There are a total of 25 questions that must be completed in one speed test session. If students manage to solve all the questions correctly, they will get three stars as a form of appreciation for their completion and perseverance. Through this feature, students are not only trained to understand concepts, but also honed in terms of speed of thinking, decision-making, and effective time management.

The next feature is Duel, an educational game mode that is interactive and involves two students directly. In this feature, each student is given questions about fractions that must be solved quickly and accurately. Each correct answer will give one point to the player. The game is competitive yet educational, where the participant who accumulates ten points first will be declared the winner. Through this feature, students are encouraged to think fast, improve concentration, and develop a spirit of sportsmanship and cooperation in a fun and challenging learning atmosphere.

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2.2. Numeracy Skills

Numeracy is one of the important skills for students in constructing mathematical knowledge [35, 36]. Numeracy skills are essential for students to develop because they can be applied in everyday life [37, 38]. Counting consists of several aspects, namely the use of number words (counting forward and backward, using main numbers and sequential numbers), structured counting (counting while pointing to objects), and resultative counting (understanding and applying the main principles of counting) [39-41]. Learning number sense and numeracy skills in children in their early years of development is an important factor for math achievement in school [42, 43]. Numeracy skills are formed from the interaction of natural potential that provides the basis and learning experiences to strengthen and develop these skills into more complex ones. In other words, it is not entirely determined by genetic or innate factors, but is also strongly influenced by learning experiences and the social environment [16]. Deficiencies in numeracy skills can slow processing speed in solving math problems and hinder the development of automaticity in arithmetic [44]. Processing speed means the ability to solve math problems quickly and accurately within a certain time limit, and automaticity refers to the ability to perform mental calculations in arithmetic operations without using finger counts [45].

2.3. Fraction Materials for Elementary School Students

Research shows that fractions are one of the most challenging math materials to learn and teach in schools [46]. In line with this, to be able to carry out effective learning, requires teachers to be able to realize common student errors and understand how these errors are related to fundamental mathematical concepts [47, 48]. Fractions can be represented in several ways in school mathematics. The use of different verbal, visual and symbolic representations for fractions is common [49]. More details follow.

(a) Verbal representations are expressed in spoken and written language, for example *two- thirds* and *one-half*;
(b) Visual representations in the form of pictures, e.g. diagrams, circles, and number lines; and manipulative aids e.g. *Cuisenaire* rods, pattern blocks, fraction bars, and fraction circles, mltilink cubes, folded paper can be used to illustrate and concretize fractions;
(c) Symbolic representation. Fractions are written as two numbers, but a fraction represents one number from three parts, namely the numerator, denominator, and fraction line [49].

Skills such as simplifying and finding equivalent fractions can be considered prerequisite skills for addition and subtraction of fractions [50, 51]. Fraction arithmetic requires students to make proper fraction connections, determine the size, order, and equivalence of fractions, as well as master fraction simplification, converting fractions to mixed numbers and mixed numbers to fractions [52]. Furthermore, comparing the size of fractions can be done in various ways such as using different sorting strategies, same-sized parts, same number of parts, and benchmark comparisons [53].

3. Methodology

3.1. Research Model

The method used in this study is a one-group pretest-posttest design, which is included in the quasi-experimental category. This design involves one group of students who are given treatment and their abilities are measured using certain instruments [54-56]. The population in this study included all high-grade students in elementary schools located in Sumedang Regency, West Java, Indonesia. Through a random sampling, 45 students from grades 4, 5, and 6 at SDN Gudang Kopi 2 were selected as the research sample. Prior to the implementation, students were first given an explanation on how to use the EBS-PBM Apps. After they understood the instructions given, they were then directed to start using and exploring the application. This study used a one-group pretest-posttest design as illustrated in Table 1.

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Table 1.
Research model.

	Treatment	Questionnaire Measurement
Experiment Class	*X*	*O*

3.2. Participants

This study involved a population of high-grade elementary school students located in Sumedang Regency, West Java, Indonesia. A total of 45 students were randomly selected from one of the elementary schools in Sumedang as the research sample. Prior to the experiment, students were given a detailed explanation of the use of EBS-PBM Apps. After understanding the instructions, they were asked to use the application independently.

3.3. Data Collection Tools

In this study, the instrument used was a questionnaire. The instrument has gone through a validation process by two experts who are lecturers with doctoral degrees from the Universitas Pendidikan Indonesia and have experience in the field of research. The questionnaire serves to collect data regarding students' responses to the EBS-PBM Apps application, as well as to see students' mathematical understanding and numeracy skills on fraction material. The questionnaire was arranged in the form of statements with closed answers, namely: strongly agree (SA), agree (A), disagree (D), and strongly disagree (SD).

3.4. Data Collection Process

The data collection process in this study consisted of four stages, starting from the preliminary stage. At this stage, the researcher submitted a letter of permission to the principal of one of the elementary schools in Sumedang Regency, West Java, to obtain approval for the research. The letter contained a request for permission to conduct data collection involving grade 4, 5, and 6 students. After approval, the research team began the process of data collection. The research team went to the classrooms and carried out the research procedures. The research process included planned activities, such as observations, interviews, and the filling of questionnaires by students. All activities were carried out by observing the principles of research ethics, such as upholding confidentiality, obtaining approval from relevant parties, and creating a safe and comfortable atmosphere for students during the process.

The next stage includes pre-treatment, treatment, and post-treatment. In the pre-treatment stage, students received a detailed explanation of how to use the EBS-PBM Apps application, by referring to the application usage guidebook compiled by Isrokatun, et al. [57]. In this process, researchers were assisted by several university students to provide direct instruction and assistance. After students understood the flow of use, they began to operate the application at the treatment stage. During the activity, the researcher supervised and provided technical assistance if needed, to ensure students' interaction with the application features was optimal. In the final stage, which was post-treatment, students were asked to fill out a questionnaire. This approach aims to obtain comprehensive data.

3.5. Data Analysis

After the data was collected, the next step was to analyze it using a quantitative approach. Quantitative data was obtained through questionnaires that had been filled out by students, then analyzed using a Likert scale to assess their responses. The mean value of each response was calculated to determine the general trend. Furthermore, a one-sample *t*-test was conducted to assess whether there was a significant improvement in the students' overall mathematical ability and numeracy skills on fractions. Data processing was done with the help of software such as Microsoft Excel and IBM SPSS Statistics 24 [58, 59] so that the analysis results obtained can be accounted for accuracy and used as a basis in drawing generalizations for the context of this study.

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4. Result

4.1. Design and Features of EBS-PBM Apps as Innovative Digital Media

4.1.1. User Interface

The User Interface of the EBS-PBM Apps has several features including Splash screen (see Figure 1), Learn, Competition, Quick Test, Duel, and settings (see Figure 2). On this page there is an image of a diamond that indicates how many students have answered the questions, while the star indicates how many stars have been obtained while using this application. On the Learn menu consists of 5 materials (see Figure 3), namely conversion of common fractions to integers (see Figure 4), common fractions to decimals, common fractions to percentages, mixed fractions to common fractions, and mixed fractions to decimals. Each material has practice questions to hone students' ability to understand the material. When students answer there is an indicator that indicates whether the answer is wrong or right, if it is wrong the indicator is red otherwise when answering correctly it will be green (see Figure 5). After the students finish answering all the questions, they will be met with the result screen (see Figure 6). The following is a visualization of the EBS-PBM Apps.

Figure 1.
Splash screen.

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Figure 2.
EBS-PBM Apps homepage.

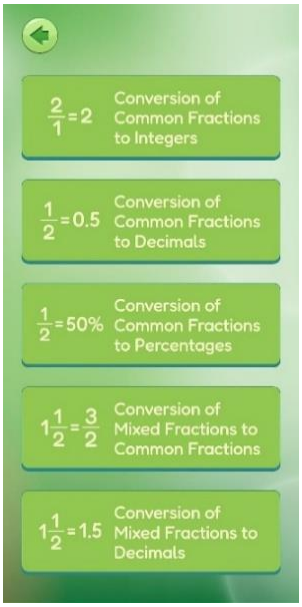

Figure 3.
Learn.

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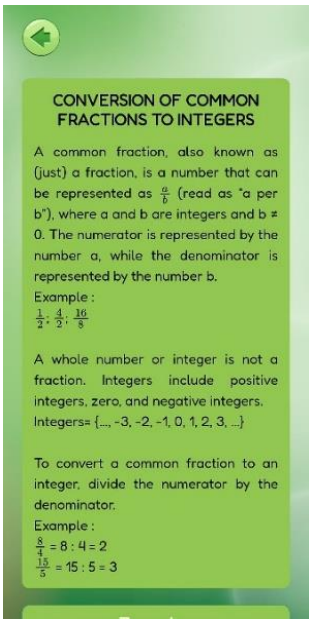

Figure 4.
Learning Materials.

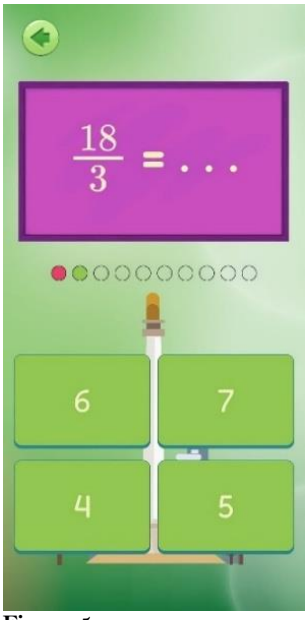

Figure 5.
Practice questions.

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Figure 6.
Practice questions result.

The next feature is the Competition menu, this menu has 3 levels ranging from easy, medium and hard levels (see Figure 7). This level indicates the level of difficulty of the questions that will be given to application users. Each level has 10 questions with randomized material that has been learned on the Learning Materials menu. After answering the question the student will receive a star and the rickshaw will move up (see Figure 8). This is done so that students are able to learn in a structured way from easy questions to difficult questions. If students have worked to a hard level, fireworks will appear to appreciate students who have worked to the end. Visualization of this feature is as follows.

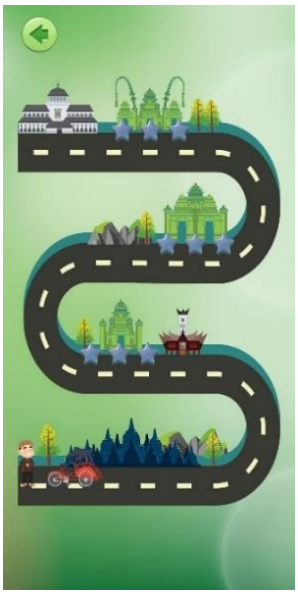

Figure 7.
Competition menu.

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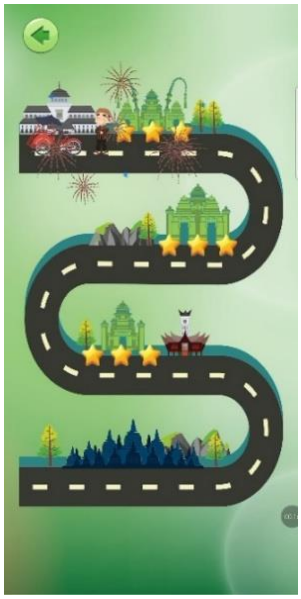

Figure 8.
Competition results.

Quick Test is a feature to test students' ability to work on fraction problems with a 60 second time challenge (see Figure 9). When answering correctly, students will be given an additional three seconds. The questions contained in the Quick Test are 25 questions, if answered all students will get three stars (see Figure 10). This star is added to the home page of the application. The following is an image of the quick test section.

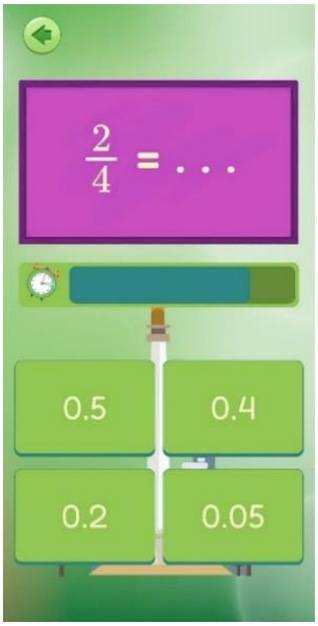

Figure 9.
Quick Test menu.

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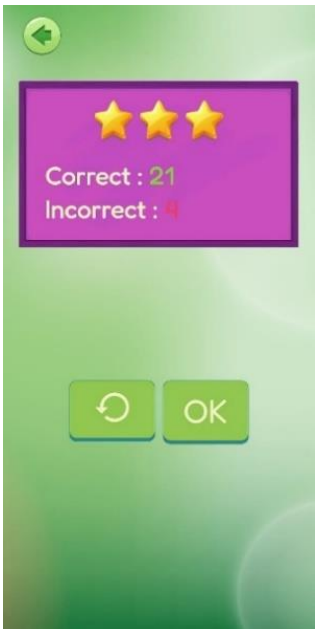

Figure 10.
Quick Test results.

The next feature developed is Duel, which is an interactive game mode involving two people (see Figure 11). In this feature, each student is given questions related to fraction material and asked to solve them quickly and accurately. Each correct answer will earn one point. Players must first collect ten points to be declared the winner (see Figure 12). If one of the students gives a wrong answer, the opponent is given the opportunity to answer the same question with a different alternative answer. This mechanism not only encourages healthy competition, but also trains students' thinking speed and accuracy in understanding the concept of fractions. Here is the visualization of the image.

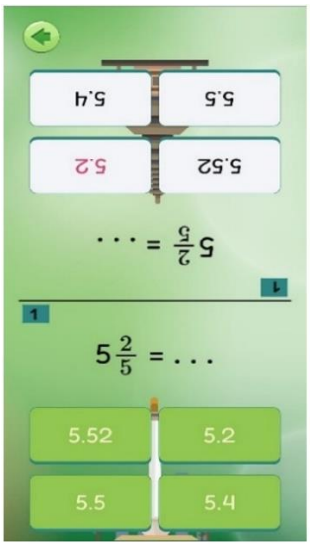

Figure 11.
Duel menu.

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Figure 12.
Duel results.

The next feature provided on the app's home page is the Settings menu, which includes various customization options, including Display settings (light mode and dark mode), Language settings, Background sound settings, Data reset options, Instructions for using the app, and About (see Figure 13). In the Display settings, users can choose between light mode or dark mode according to visual preference and comfort (see Figure 14). EBS-PBM Apps supports the use of two languages, namely Bahasa Indonesia and English, to facilitate users from various backgrounds (see Figure 15). Background sounds in the form of music can be disabled if it is deemed to disturb students' concentration while using the application. In addition, there is a data reset feature that allows users to reset all progress, including the acquisition of stars and diamonds, if they want to start over from the beginning (see Figure 16). The Instructions for use menu contains guidelines on how to operate the application in general (see Figure 17). Meanwhile, the About menu contains information on the developer, contact email address, and the version of the app currently in use. As follows (see Figure 18).

Figure 13.
Setting menu.

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Figure 14.
Dark mode.

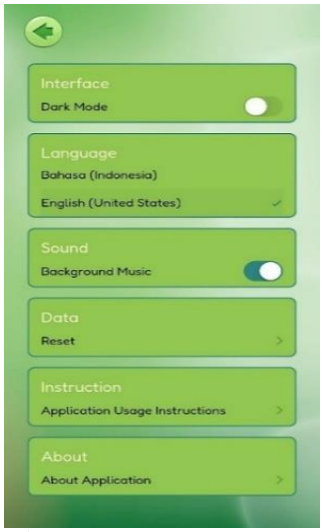

Figure 15.
Language setting.

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Figure 16.
Reset data.

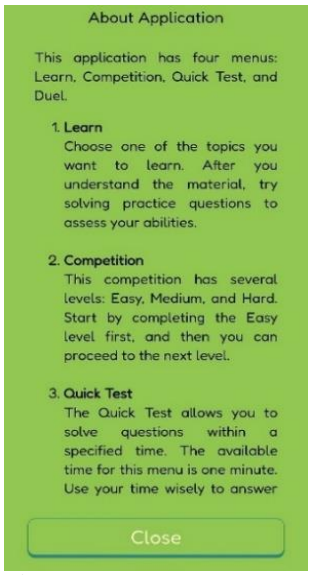

Figure 17.
Instructions for using the app.

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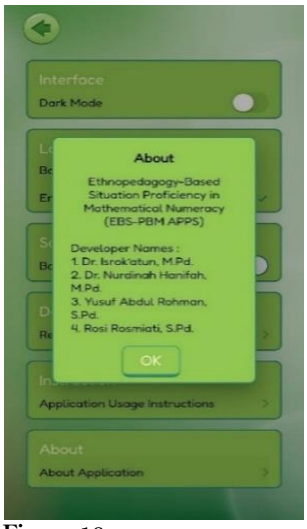

Figure 18.
About the application.

4.1.2. Students Operating EBS-PBM Apps

This research was conducted in the context of face-to-face learning in elementary schools. In accordance with school policy, students are not allowed to bring personal electronic devices (gadgets). Therefore, the implementation of the EBS-PBM Apps application was carried out by utilizing devices provided directly by the researcher. The EBS-PBM Apps application download link is available at the following link: https://play.google.com/store/apps/details?id=com.koderkampung.ebsmobile [34].

All students were given special time to explore the features contained in the EBS-PBM Apps. The researcher ensured that all student activities during the session focused on the utilization of the application. In the Home feature, students are directed to study the material and complete the practice questions available. Next, students proceed to the Competition feature, which is organized in stages from easy, medium, to hard levels. After that, students were given the opportunity to use the Quick Test feature, and at the end of the session they were directed to try the Duel feature with their classmates. After finishing using the application, students were asked to fill out a survey to explore their responses and perceptions of the learning experience using the EBS-PBM Apps. The implementation process is illustrated in Figure 19 and Figure 20, which show students actively using the EBS-PBM Apps during the learning session.

Figure 19.
Students using the EBS-PBM Apps.

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Figure 20.
Students using the EBS-PBM Apps.

4.2. Elementary School Students' Perception of the Implementation of EBS-PBM Apps in Learning

In an effort to evaluate the experience of using EBS-PBM Apps, researchers distributed questionnaires to 45 elementary school students. The data collected from the questionnaire was then processed and visualized to provide a clearer picture of student perceptions of the EBS- PBM Apps application.

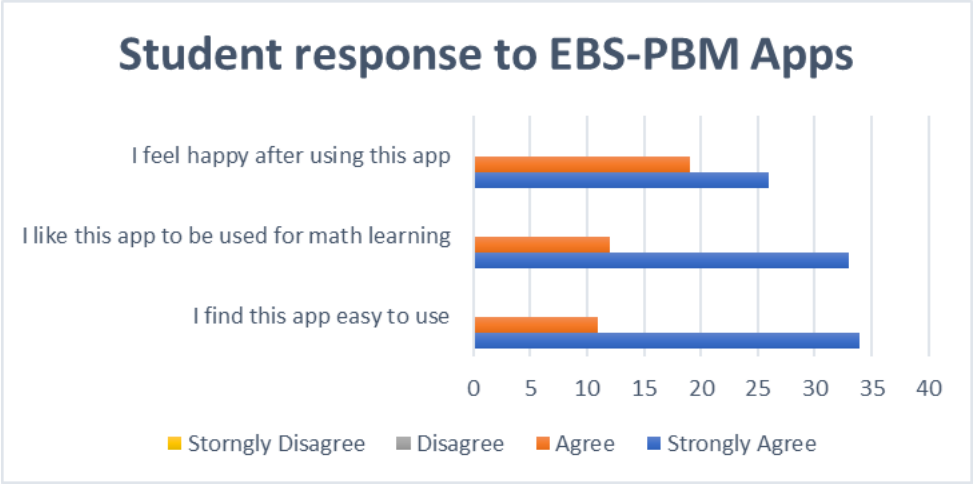

Figure 21.
Results of student responses to the EBS-PBM Apps.

Based on the results of the questionnaire given to 45 elementary school students, a very positive picture of the use of EBS-PBM Apps was obtained. As shown in Figure 21 above, in the first statement, namely "I find this application easy to use", 34 students (76%) strongly agreed, and 11 students (24%) agreed. None of the students who answered disagreed or strongly disagreed. Furthermore, in the second statement, "I like this application to be used in learning mathematics", 33 students (73%) strongly agreed, while 12 students (27%) agreed. There were no students who gave negative responses. In the third statement, "I feel happy after using this app", 26 students (58%) strongly agreed, and 19 students (42%) agreed. All students showed a positive attitude towards their experience after using the app.

Overall, these results show that students have very favorable responses to EBS-PBM Apps in terms of ease of use, suitability in mathematics learning, and enjoyable learning experience. Thus, this application has great potential to continue to be utilized and developed as an innovative and effective digital learning media at the elementary school level. Supporting evidence in drawing research conclusions, data on primary school students' responses to the use of EBS-PBM Apps are not only

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analyzed descriptively, but also statistically tested using one-sample *t*-test. This test aims to determine the extent to which students' positive responses to the EBS-PBM Apps application can be significantly generalized to the study population.

Table 2.
One-sample *t*-test result.

Respondent score				Test value = 3					
N	**Mean**	**Std. Deviation**	**Std. Error Mean**	***t***	***df***	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
45	3.69	0.423	0.063	10.935	44	0.000	0.689	0.56	0.82

The Table 2 shows that the average score of student responses to EBS-PBM Apps is 3.69 with a standard deviation of 0.423. The test was conducted using a one-sample *t*-test with a comparison value (test value) of 3, which represents the minimum limit of the positive response category.

The test results show a *t* value of 10.935 with a significance (Sig. 2-tailed) = 0.000, which means there is a significant difference between the average score of respondents and the test value = 3. Since the significance value is smaller than 0.05, it can be concluded that the average score of 3.69 is statistically different and higher than the value of 3, which is significant. In addition, the mean difference of 0.689 falls within the 95% confidence interval between 0.56 and 0.82, indicating that students consistently gave positive responses to the use of this application.

Thus, it can be concluded that students' responses to the EBS-PBM Apps are positive, significantly at the 95% confidence level, and the app is well accepted in the context of learning in elementary schools.

4.3. Student Interest in EBS-PBM Apps as Innovative Digital Media

The results of the questionnaire data processing show that students have a high interest in the use of EBS-PBM Apps as a digital learning media. This interest is reflected in the positive responses to the various features in the application, namely Competition, Quick Tests, Duel, and Learning materials, as presented in Figure 22.

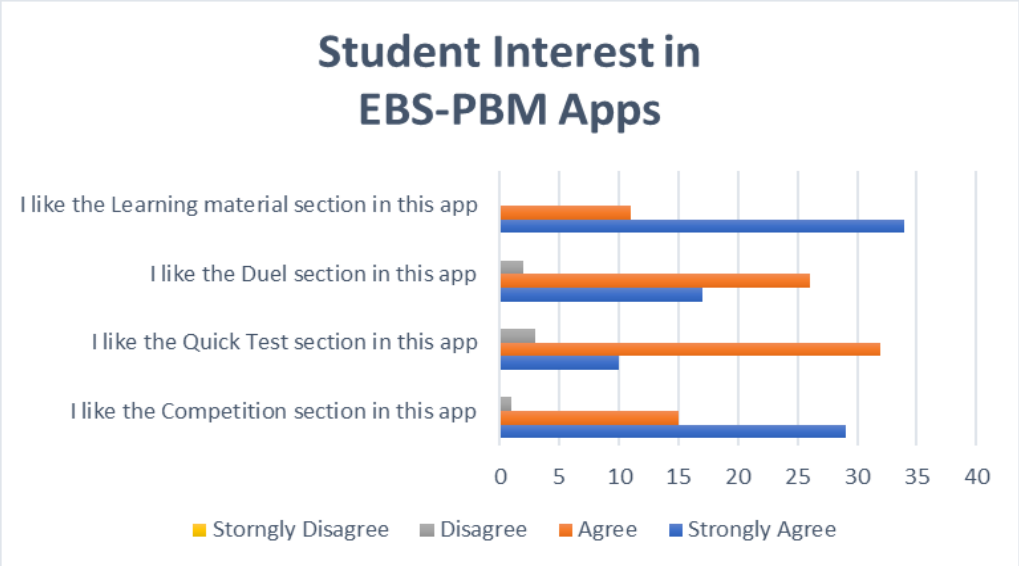

Figure 22.
Survey results of students' interest in EBS-PBM Apps.

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Based on the figure on the statement "I like the Competition section in this app", 29 students (64%) strongly agreed, 15 students (33%) agreed, and only 1 student (2%) disagreed. There were no students who strongly disagreed. The statement regarding the Quick Test feature showed that 10 students (22%) strongly agreed, 32 students (71%) agreed, and 3 students (7%) disagreed. There were no students who chose strongly disagree. Furthermore, in the statement regarding the Duel feature, 17 students (38%) strongly agreed, 26 students (58%) agreed, and 2 students (4%) disagreed. There were no students who strongly disagreed.

Overall, the four features in the EBS-PBM Apps received very high appreciation from the students. The absence of "strongly disagree" responses on all statements indicates that there is no significant resistance to the features offered. This reinforces the conclusion that EBS-PBM Apps has successfully performed its role as an innovative digital media in learning. The app is not only attractive in terms of design and interactivity, but also able to increase students' motivation, engagement, and understanding of the material, especially in learning mathematics on the topic of fractions at the elementary school level.

To complement the qualitative analysis, the survey data was also analyzed quantitatively. The survey involving 45 students was analyzed using one-sample *t*-test. This test was conducted to determine the extent to which students' interest in the EBS-PBM Apps appeared significantly, and whether the findings could be generalized to the study population, or it was not strong enough to be concluded in general. The results of the analysis are presented as follows.

Table 3.
One-sample *t*-test result.

Respondent score				**Test value = 3**					
N	**Mean**	**Std. Deviation**	**Std. Error Mean**	***t***	***df***	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
45	3.47	0.435	0.065	7.197	44	0.000	0.467	0.34	0.60

The Table 3 shows that the average score of students' interest in EBS-PBM Apps as an innovative digital media is 3.47 with a standard deviation of 0.435. The *t* value of 7.197 with a significance (Sig. 2-tailed) = 0.000 indicates a significant difference between the average student interest score and the test value = 3. With a significance below 0.05, it can be concluded that student interest in using this application is statistically higher than the positive threshold. A mean difference of 0.467 with a 95% confidence interval between 0.34 to 0.60 reinforces that students show consistent interest in the EBS-PBM Apps.

This shows that as an innovative digital media, EBS-PBM Apps significantly attracts students' interest in the learning process. This positive reception indicates that the use of app- based technology is able to increase student motivation and engagement, thus supporting the effectiveness of learning in elementary schools.

4.4. Constraints and Barriers Faced by Students During the Use of EBS-PBM Apps

The main problem in the process of adaptation to technology arises from various obstacles and barriers experienced by students, both from technical aspects and from the side of students as users. Therefore, this section will review in more depth the findings related to the use of EBS-PBM Apps. The details are as follows, as shown in Figure 23.

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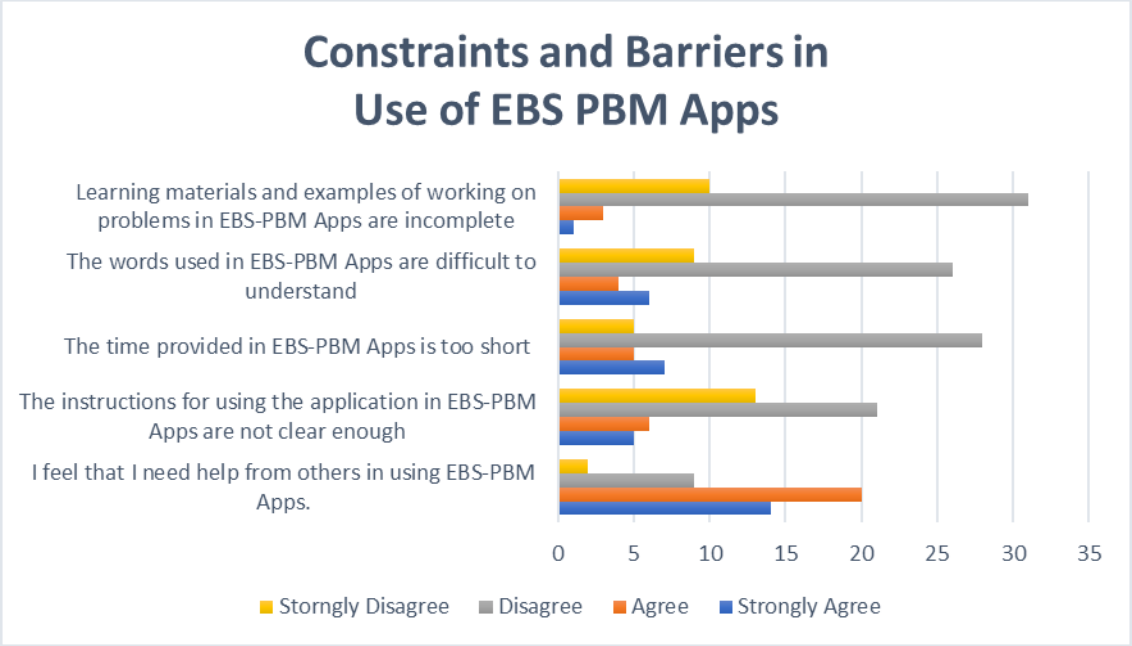

Figure 23.
Survey results of constraints and barriers in the use of EBS-PBM Apps.

Based on the data in the table above, an overview of 45 students' responses to several aspects of obstacles and barriers in using EBS-PBM Apps. The responses provide important information regarding the extent to which this application supports the learning process as well as the obstacles that students feel. On the statement "I feel that I need help from others in using EBS-PBM Apps", 14 students (31%) strongly agreed, 20 students (44%) agreed, 9 students (20%) disagreed, and 2 students (4%) strongly disagreed.

Furthermore, on the statement "The instructions for using the application in EBS-PBM Apps are not clear enough", 5 students (11%) strongly agreed, 6 students (13%) agreed, 21 students (47%) disagreed, and 13 students (29%) strongly disagreed. The statement "The time provided in EBS-PBM Apps is too short" was answered strongly agree by 7 students (16%), agree by 5 students (11%), disagree by 28 students (62%), and strongly disagree by 5 students (11%).

On the statement "The words used in EBS-PBM Apps are difficult to understand", 6 students (13%) strongly agreed, 4 students (9%) agreed, 26 students (58%) disagreed, and 9 students (20%) strongly disagreed. In the last statement "Learning materials and examples of working on problems in EBS-PBM Apps are incomplete", only 1 student (2%) strongly agreed, 3 students (7%) agreed, 31 students (69%) disagreed, and 10 students (22%) strongly disagreed.

In general, responses from 45 students showed that the EBS-PBM Apps had met user expectations in technical aspects, such as clear instructions for use, adequate time allocation, and easy-to-understand and complete language and materials. Although there are some students who still need help when using the application, this is reasonable, given the level of digital literacy of elementary students who are still developing. Therefore, in the future, providing initial assistance can be a solution to increase the effectiveness of using the application more evenly. This finding also strengthens the role of EBS-PBM Apps as an innovative digital-based learning media that is relevant to students' needs.

A quantitative analysis of the survey results was conducted in this study to strengthen the findings from students' responses. The survey involving 45 students was analyzed using one- sample *t*-test. This analysis is to examine the extent to which the obstacles and barriers experienced by students and the need for assistance from other parties in the use of EBS-PBM Apps can be significantly generalized to

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the population, or vice versa, whether the data obtained is not sufficient for general conclusions. The results of the analysis are presented as follows.

Table 4.
One-sample *t*-test result.

Respondent score				Test value = 3					
N	**Mean**	**Std. Deviation**	**Std. Error Mean**	***t***	***df***	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
45	2.69	0.750	0.112	-2.742	44	0.009	-0.307	-0.53	-0.08

The Table 4 shows that the average score of students' perceptions of constraints and barriers in using EBS-PBM Apps is 2.69 with a standard deviation of 0.750. The one-sample *t*-test was conducted with a test value of 3. The analysis results showed a *t* value of -2.742 with a significance (Sig. 2-tailed) of 0.009. Since the significance value is smaller than 0.05, it can be concluded that there is a significant difference between the average score of respondents and the test value = 3. The average difference of -0.307 with a 95% confidence interval ranging from -0.53 to -0.08 indicates that students' perceptions of constraints and barriers in using EBS- PBM Apps are below the threshold.

Thus, it can be statistically concluded that students do not feel significant constraints or barriers in using the EBS-PBM Apps. This finding indicates that the application is relatively easy to use by students and does not require excessive assistance from other parties in its use.

4.5. Effectiveness of EBS-PBM Apps in Improving Students' Mathematical Comprehension Ability

The utilization of digital media such as EBS-PBM Apps is expected to help students in their mathematical comprehension skills in a more interactive and fun way. To assess the effectiveness of this application, the results of a survey measuring students' perceptions in the process of using it were analyzed. The details are as follows, as shown in Figure 24.

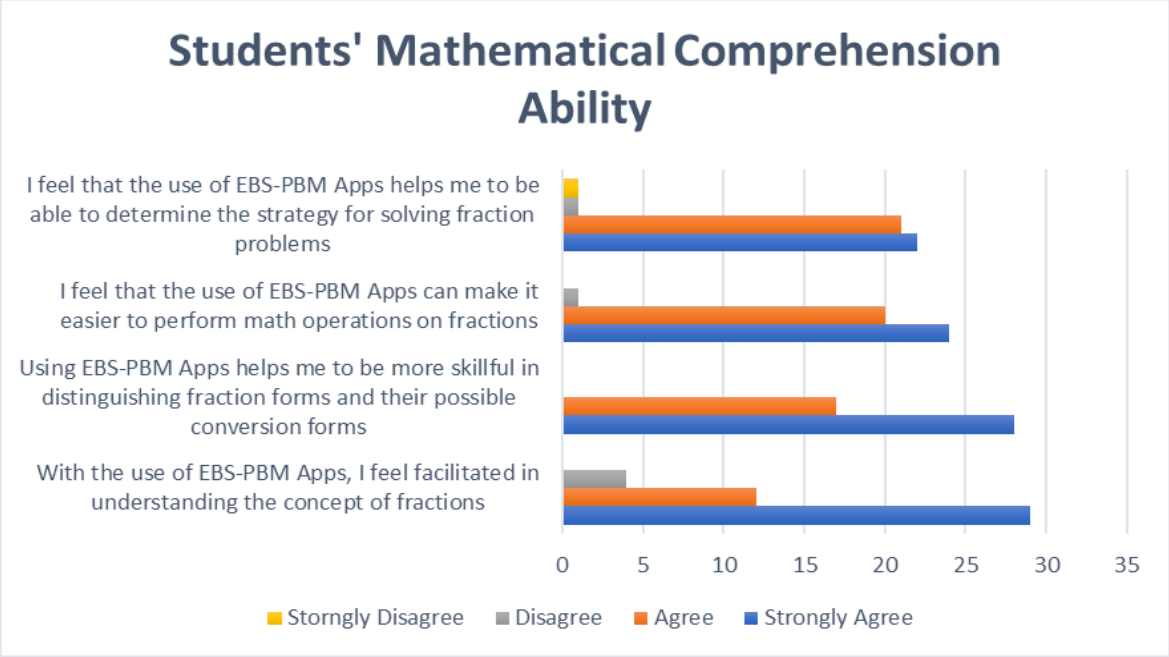

Figure 24.
Students' mathematical ability questionnaire results.

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Based on the data in the table above, an overview of 45 students' responses to the effectiveness of using EBS-PBM Apps in understanding fraction material was obtained. These results provide important insights into the application's contribution to improving students' understanding in mathematics, especially related to the concept of fractions. On the first statement, "With the use of EBS-PBM Apps, I feel facilitated in understanding the concept of fractions", 29 students (64%) strongly agreed, 12 students (27%) agreed, and only 4 students (9%) disagreed. Furthermore, on the statement "Using EBS-PBM Apps helps me to be more skillful in distinguishing fraction forms and their possible conversion forms", 28 students (62%) strongly agreed and 17 students (38%) agreed. There were no students who chose the disagree or strongly disagree options.

The third statement, "I feel that the use of EBS-PBM Apps can make it easier to perform math operations on fractions", was answered strongly agree by 24 students (53%), agree by 20 students (44%), and disagree by 1 student (2%). There were no respondents who strongly disagreed. On the last statement, "I feel that the use of EBS-PBM Apps helps me to be able to determine the strategy for solving fraction problems", 22 students (49%) strongly agreed, 21 students (47%) agreed, 1 student (2%) disagreed, and 1 student (2%) strongly disagreed.

Overall, this result shows that the majority of students gave positive responses to the use of EBS-PBM Apps in learning fractions. The app is considered successful in supporting students' understanding, operational skills, conversion ability of fractions, and problem-solving strategies. Although there were a few negative responses, the proportion was very small and insignificant to the overall student perception. This finding strengthens the position of EBS- PBM Apps as an effective digital learning media, responsive to students' needs, and able to bridge the challenges in learning mathematics that have been considered complex by most elementary school students. In the future, the development of this application can be focused on improving interactive features and adaptive support to reach more students' learning styles.

Quantitative analysis of student response data was conducted to strengthen the descriptive findings and assess the extent to which the effectiveness of EBS-PBM Apps in fraction learning can be generalized statistically. This study involved 45 respondents and was analyzed using one-sample *t*-test on the average score of students' perceptions on each statement.

Table 5.
One-sample *t*-test result.

Respondent score				**Test value = 3**					
N	**Mean**	**Std. Deviation**	**Std. Error Mean**	***t***	***df***	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
45	3.53	0.544	0.081	6.507	44	0.000	0.528	0.36	0.69

The Table 5 shows that the average score of students' perceptions of the effectiveness of using EBS-PBM Apps in improving mathematical understanding ability is 3.53 with a standard deviation of 0.544. The one-sample *t*-test was conducted with a test value of 3. The analysis results showed a *t* value of 6.507 with degrees of freedom (*df*) = 44 and a significance (Sig. 2- tailed) of 0.000. Since the significance value is much smaller than 0.05, it can be concluded that there is a statistically significant difference between the mean score of respondents and the test value = 3. The mean difference of 0.528, with a 95% confidence interval ranging from 0.36 to 0.69, indicates that students' perceptions are clearly above the neutral value.

Thus, it can be statistically concluded that students have a very positive perception of the use of EBS-PBM Apps in improving mathematical comprehension skills. This finding shows that the app is not only easy to use, but also effective in helping to improve students' concept understanding ability and mathematical skills. This strengthens the belief that EBS-PBM Apps has high pedagogical quality and is worthy to be integrated in the learning process at the elementary school level.

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4.6. Effectiveness of EBS-PBM Apps in Improving Numeracy Skills on Fraction Materials

Similar to the previous findings, the following sub-findings were obtained through surveys. The survey distribution to 45 students utilized five triggering statements, more details are as shown in Figure 25.

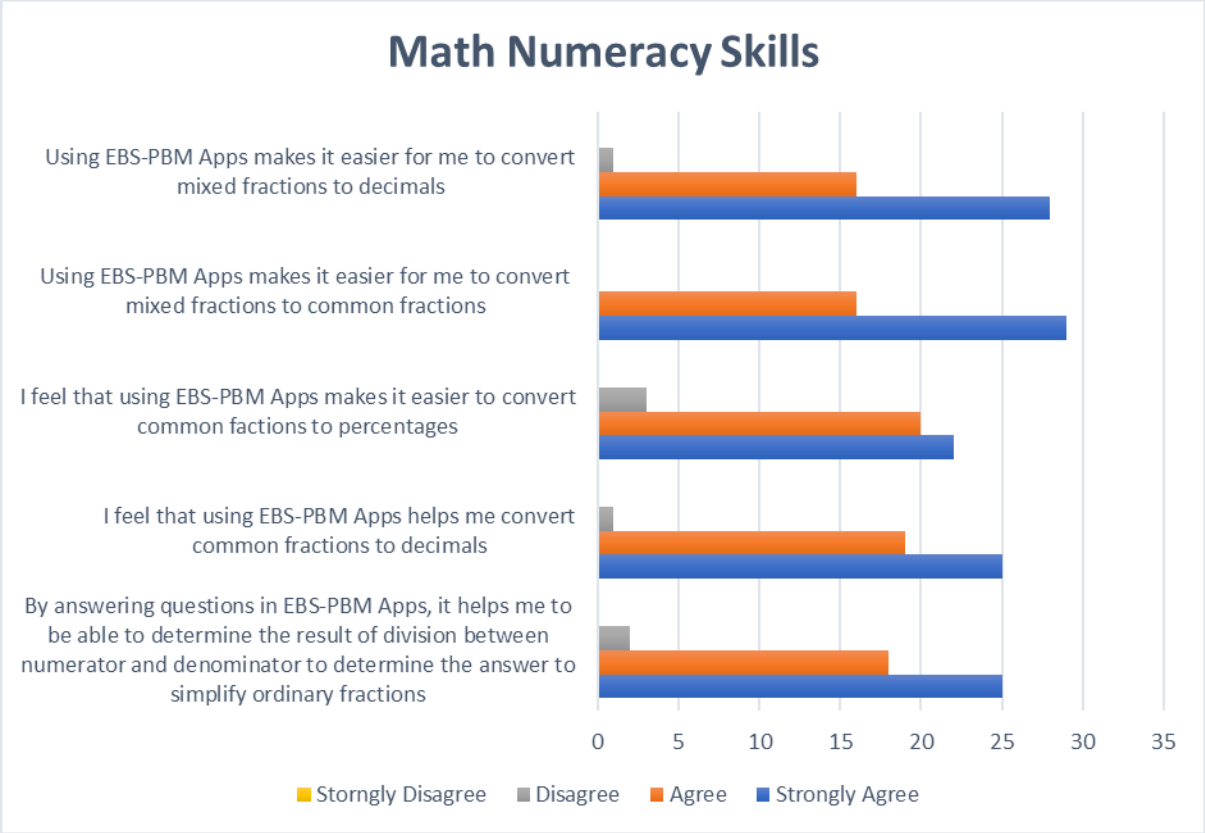

Figure 25.
Survey results of math numeracy skills.

Based on the data in the table above, an overview of 45 students' responses to the effectiveness of using EBS-PBM Apps in improving numeracy skills on fraction material was obtained. This response provides important information regarding the extent to which this application supports students in mastering fractions. On the statement "By answering questions in EBS-PBM Apps, it helps me to be able to determine the result of division between numerator and denominator to determine the answer to simplify ordinary fractions", 25 students (56%) strongly agreed, 18 students (40%) agreed, and only 2 students (4%) disagreed. Furthermore, on the statement "I feel that using EBS-PBM Apps helps me convert common fractions to decimals", 25 students (56%) strongly agreed and 19 students (42%) agreed. Only 1 student (2%) disagreed.

The statement "I feel that using EBS-PBM Apps makes it easier to convert common factions to percentages" also received positive responses, where 22 students (49%) strongly agreed and 20 students (44%) agreed. On the statement "Using EBS-PBM Apps makes it easier for me to convert mixed fractions to common fractions", 29 students (64%) strongly agreed and 16 students (36%) agreed. There were no students who disagreed or strongly disagreed. Similarly, the last statement "Using EBS-PBM Apps makes it easier for me to convert mixed fractions to decimals" also showed similar results: 28 students (62%) strongly agreed, 16 students (36%) agreed, and only 1 student (2%) disagreed. In general, the data shows that most students have a very positive perception of the use of EBS-PBM Apps

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in improving numeracy skills on fraction materials. Especially in the aspects of simplifying fractions, as well as converting common and mixed fractions to decimal and percent forms.

In general, the data shows that most students have a very positive perception of the use of EBS-PBM Apps in improving numeracy skills in fractions. Especially in the aspects of simplifying fractions, as well as converting ordinary and mixed fractions to decimal and percent forms.

Quantitative analysis of student response data was conducted to support the descriptive findings and evaluate the extent to which the effectiveness of the use of EBS-PBM Apps in improving numeracy skills in fractions can be concluded statistically. A total of 45 respondents were involved in this study, and the data were analyzed using a one-sample *t*-test on the average value of student perceptions for each statement given.

Table 6.
One-sample *t*-test result.

Respondent score				Test value = 3					
N	**Mean**	**Std. Deviation**	**Std. Error Mean**	***t***	***df***	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
45	3.54	0.523	0.078	6.951	44	0.000	0.542	0.39	0.70

The Table 6 above shows that the average score of students' perceptions of the effectiveness of using EBS-PBM Apps in improving numeracy skills on fraction material is 3.54 with a standard deviation of 0.523. The one-sample *t*-test was conducted with a test value of 3. The analysis results showed a *t* value of 6.951 with a degree of freedom (*df*) of 44 and a significance value (Sig. 2-tailed) of 0.000. Since the significance value is smaller than 0.05, it can be concluded that there is a significant difference between the average score of respondents with a test value = 3. The average difference of 0.542, with a 95% confidence interval ranging from 0.39 to 0.70, indicates that students' perceptions of the effectiveness of EBS-PBM Apps are above the minimum threshold of effectiveness.

Thus, it can be statistically concluded that the use of EBS-PBM Apps is effective in improving numeracy skills, especially on fractions. This finding indicates that the application has a significant positive impact on students' understanding in calculating and converting fractions, both to decimal and percent form, as well as in simplifying and converting mixed fractions. This reinforces that EBS-PBM Apps has an important contribution in supporting the mathematics learning process in primary schools.

5. Discussion

Learning mathematics at the elementary school level, especially on fraction material, is often a challenge for students and teachers. The results of this study showed that EBS-PBM Apps was able to answer these challenges by presenting an approach that is innovative, adaptive, and in accordance with the characteristics of cognitive development of elementary school students. As stated by well-designed digital medium can be an important tool in simplifying abstract mathematical concepts. This is reflected in the design of the EBS- PBM Apps application which contains Learn, Competition, Quick Test, and Duel menus. These features not only present the material systematically, but also encourage students to practice, try, and learn from mistakes directly through instant educational feedback. More than just a learning tool, EBS-PBM Apps is a learning playground. The questionnaire results show that students feel happy, challenged and motivated when using this application. As stated Eliza, et al. [31] and Lin, et al. [30] fun and challenging learning experiences can build positive emotional engagement, which in turn strengthens the formation of new knowledge.

The app also makes room for the emergence of a healthy spirit of competition. Through the Duel feature, students are trained to think quickly and precisely in a fun atmosphere. This activity is not merely about who wins, but about how they build confidence, work together, and foster a sense of responsibility for their own learning process. In this context, students' passion for learning and social skills develop simultaneously, an important aspect that is often overlooked in conventional learning. In

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terms of cognitive outcomes, the results of statistical analysis show that using this application has a significant impact on improving students' numeracy skills, especially on topics such as conversion of fractions to decimals and percentages. This finding reinforces the Geary [16] and Birgin, et al. [21] ideas that numeracy skills require not only mastery of concepts, but also intensive practice in various meaningful contexts. EBS-PBM Apps provide that space explicitly, with a gradual learning flow and visualizations that help the process of internalizing mathematical concepts. However, not all students are immediately able to operate the app independently. Some of them need initial assistance, especially in understanding the initial navigation and technical instructions. This is reasonable given that the digital literacy of elementary school students is still in a developing stage. As reminded by Kaufmann, et al. [45] digital-based learning still requires adequate learning environment support so that all students can access the benefits equally.

In general, this research confirms that educational technology such as EBS-PBM Apps is not only a medium for learning but also able to bridge the gap in learning experiences between students. EBS-PBM Apps allows every child to experience meaningful, active and happy learning. Thus, as expressed by Clements and Sarama [18] the task of education today is not only to convey knowledge, but also to create learning experiences that inspire and imprint in students' memories. Thus, the integration of digital medium designed with the rightpedagogical approach can be a new hope in improving students' basic skills, especially numeracy skills which are an important foundation in daily life and future academic success.

6. Conslusion

This study shows that EBS-PBM Apps is an innovative digital media that is effective in improving the numeracy skills of elementary school students, especially on fractions. The app combines visual, interactive, and challenges that can increase students' interest, participation, and understanding. Features such as Competition, Quick Test, and Duel not only make learning more fun, but also encourage students to think quickly and accurately. The results of data analysis showed a significant improvement in numeracy skills after using the app. Although some students still need initial assistance, in general the EBS-PBM Apps are well received and able to answer the challenges of learning fractions that have been difficult to teach conventionally. This finding confirms the importance of integrating pedagogically designed technology to create meaningful, equitable and enjoyable learning experiences for all students.

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Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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