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Development of Constructivist-based PowToon Animation Multimedia on Simple Fractions

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Abstrak

Kesulitan siswa sekolah dasar dalam menyelesaikan simple fraction disebabkan karena siswa mengalami kegagalan pemahaman tentang konsepsi pecahan sederhana. Sementara itu, hasil-hasil studi terdahulu memungkinkan adanya integrasi multimedia animasi PowToon terhadap pendekatan konstruktivis untuk memfasilitasi konsepsi pecahan sederhana. Tujuan penelitian ini untuk mengembangkan constructivist-based PowToon animation multimedia (CoPAM) sebagai media belajar materi pecahan sederhana yang valid, praktis, dan efektif. PowToon dikembangkan dengan metode research and development (R&D) dengan model define, design, dan development (3-D) yang melibatkan sebanyak 12 siswa kelas empat sekolah dasar. Analisis data yang digunakan berupa analisis deskriptif dengan metode pengumpulan data menggunakan observasi, tes (pre-test dan post-test), angket validasi (validasi ahli media dan materi, respon guru, dan respon siswa), dan dokumentasi. Hasil penelitian menunjukkan CoPAM memiliki kriteria produk yang sangat layak dari segi kevalidan, kepraktisan, dan keefektifan untuk memfasilitasi siswa sekolah dasar dalam memahami pecahan sederhana. Rekomendasi studi berikutnya diperlukan untuk melakukan pengembangan dan pengujian produk CoPAM atau sejenisnya secara lebih lanjut (bisa melalui tahapan desiminasi) dengan melibatkan jumlah partisipan yang lebih besar dan luas dengan pengujian statistic inferensial.

Kata kunci: *Multimedia*, PowToon, *Konstruktivis, Pecahan*

Abstract

The difficulty of primary students in solving simple fractions is because students fail to understand the concept of simple fractions. Meanwhile, the results of previous studies allow the integration of PowToon animation multimedia into a constructivist approach to facilitate the conception of the simple fraction. This research aims to develop constructivist-based PowToon animation multimedia (CoPAM) as a valid, practical, and effective learning media for simple fraction material. PowToon was developed using a research and development (R&D) method with a define, design, and development (3-D) model that involved 12 fourth-grade primary students. The data analysis used was descriptive analysis with data collection methods using observation, tests (pre-test and post-test), validation questionnaires (validation of media and material experts, teacher responses, and student responses), and documentation. The results showed that CoPAM has very feasible product criteria for validity, practicality, and effectiveness to facilitate primary students in understanding simple fractions. The recommendations for the next study are needed to further develop and test CoPAM products or the like (which could go through the dissemination stage) by involving a larger and wider number of participants by testing inferential statistics.

Keywords: Multimedia, Powtoon, Constructivist, Fraction

1. INTRODUCTION

Fraction is a complex material, but it is very much needed to solve problems in the life of primary students (Copur-Gencturk & Doleck, 2021; Wulandari & Amir, 2022). In addition, the fraction is needed by primary students in academic achievement and later career development (Empson et al., 2021; Tian et al., 2021). At the primary school level, the fraction is not only about shading a part of the whole and procedural knowledge but also about

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solving problems involving conceptual knowledge (Andriah & Amir, 2021; Copur-Gencturk & Doleck, 2021). Meanwhile, the sub-material of fraction oriented to conceptual knowledge by visual representation of images representing the numerator and denominator is called the simple fraction (Simon et al., 2018; Simon, 2019).

Solving problems at the primary school level related to a fraction is basically due to the difficulty of using simple fractions (Lee & Lee, 2022; Wulandari & Amir, 2022). In the fractional algorithm, the simple fraction is used when students change one form of the fraction to another as an equality fraction (Karamarkovich & Rutherford, 2019; Simon et al., 2018). In this case, primary students usually have difficulty understanding and using reasoning involving simple fractions, including because students fail to understand the sequence of numbers, namely whole and integer (Sidney & Alibali, 2017; Simon et al., 2018). In addition, students also have difficulty representing verbal information on story questions into simple fractions (Aliustaoğlu et al., 2018; Baek et al., 2017).

The facts obtained from the preliminary study of the fourth-grade students of SDN Salen and conducting interviews with the class teacher showed that students had difficulty in understanding the simple fraction, which was still low. It is shown when students are given a question in the picture form of food that must be divided into several parts. The students were still confused in answering, even though the question was still relatively easy. The students are faced with a question in the form of a box divided into several small squares that are shaded and unshaded. The students also still have difficulty determining which box shows the numerator and denominator. In this case, the difficulties experienced by students are because students have an inadequate understanding of representing simple fraction questions, as well as a lack of student motivation in class (Sidney & Alibali, 2017; Zhang & Rivera, 2021).

The constructivist-oriented learning environment supports students in the general range of primary schools to understand simple fractions conceptually. In this case, student activity during the learning process increases, resulting in student behavior and attitudes towards fractions changing positively (Ibanez & Pentang, 2021; Zhang & Rivera, 2021). Students' instructional activities constructed and intervened based on constructivist theory can prevent students from fractional difficulties (Hwang et al., 2019; Simon, 2019). Although constructivist teaching methods can guide students towards understanding, the teachers' knowledge of mathematical content is also a factor so that students can reason logically against calculations involving fractions (Klemer et al., 2018; Loibl & Leuders, 2018). The learning construction of fraction units (as one of the prerequisite materials for simple fractions) by teachers who emphasize the visual representation of fractions will present students' conceptual knowledge (Hunt et al., 2019; van Garderen et al., 2021). In this case, students are facilitated to have experience in constructing knowledge and concepts (Supardi et al., 2019; Yunita et al., 2020). Some experts mention that although constructivist-oriented learning interactions facilitate students' understanding of fractions. However, for students who have a disability in mathematics, it can potentially 'paralyze' students (Hunt et al., 2019; Hunt & Tzur, 2017). In this case, other experts provide alternative solutions for using PowToon by integrating a constructivist approach to improving student learning performance (Alias et al., 2020; Chaijaroen et al., 2019; Wu et al., 2018; Zambrano & Campuzano, 2020). Meanwhile, PowToon is a multimedia animation in the form of a web application. PowToon has an advantage over other types of multimedia, namely that users can add sound, music, images, text, and recordings (Donna et al., 2021; Zambrano & Campuzano, 2020). Previous studies have not comprehensively focused on using constructivist-oriented PowToon on simple fraction material for primary students. The results of studies regarding the use of PowToon multimedia make simple fractions easier for students to understand so that it impacts primary students' learning outcomes and motivation for simple fractions (Seftiana & Delia, 2021; Setiyani et al., 2020). PowToon in the fraction material has been confirmed to be integrated with religious values. The implementation of PowToon also made primary students' creative thinking skills towards fractions (Rachmiati & Mansur, 2021; Sari & Manurung, 2021). Regarding the implementation of PowToon in primary school mathematics learning practices, PowToon has also been confirmed to provide an understanding of basic mathematics material (Awalia et al., 2019; Sanjaya et al., 2021). Using animated multimedia (a kind of PowToon) in learning can help teachers increase students' motivation (Abdulrahaman et al., 2020; Park et al., 2019).

It was considering the gap between the empirical facts of previous research and the field toward the ideal expectations of students' understanding of simple fractions. Considering the need for a constructivist approach that is integrated with the advantages of PowToon animation multimedia. This study tries to develop PowToon-oriented multimedia animation with a constructivist approach to build primary students' understanding of simple fractions. The PowToon animation multimedia with a constructivist approach is called constructivist-based PowToon animation multimedia (CoPAM). The CoPAM development is urgent to avoid simple fraction problems, which can impact the overall misconception problem in fractional material (Baek et al., 2017; Nasution et al., 2018; Ratnasari, 2018). In addition, although primary students can represent a fraction by shading the fraction part, it does not guarantee that students understand the concept of a simple fraction as a whole (Khairunnisak et al., 2012; Marmur et al., 2020). In this case, constructivist-based PowToon integration of simple fractions will facilitate students in visually representing simple fractions that represent conceptual knowledge (intuitively) to symbolic representations (fractional form a/b) or vice versa. The primary students avoid failure to understand simple fractions (Morano & Riccomini, 2020; Roesslein & Codding, 2019). So, this research aims to produce a valid, practical, and effective CoPAM used to improve learning outcomes that are oriented towards understanding primary students' simple fractions.

2. METHOD

This study uses research and development methods with a 3D model consisting of define, design, and development. The 3D model is modified from Thiagarajan's 4D model (Rochmad, 2012), i.e., without dissemination. Related to this dissemination stage, researchers will follow up on other research in the future. The use the 3D model that the researchers used to produce CoPAM was carried out by involving 12 fourth-grade primary school students at SDN Salen, Mojokerto, East Java, with the stages according to Figure 1.

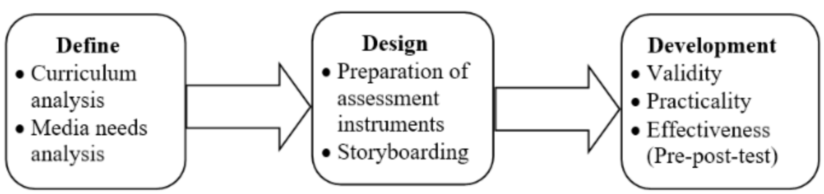

Figure 1. CoPAM Development Stages Using A 3D Model

In Figure 1, the first stage (define stage) has three data analysis stages: curriculum analysis and needs analysis. Through curricula analysis, an initial description of the basic competencies and appropriate indicators for the development of CoPAM is obtained. The availability analysis includes the types of multimedia that are possible to use in primary schools and observations through interviews to explore teacher expectations for the CoPAM that will be developed. The second stage, namely the design, aims to produce a CoPAM design. This stage begins with the preparation of assessment instruments and making evaluation questions. Next, determine the ratio of the video and the background used. Determine the use of background colors and types of writing per the material needs and student needs. Followed by selecting appropriate characters and images, assisted by the Canva application. The final process at this stage is inserting a dubbing or dubbing sound on each video slide. Next is the development stage; at this stage, the validity test is carried out based on expert input on CoPAM, practicality test through teacher and student responses, and tests the effectiveness of student learning outcomes against simple fractions.

Data collection techniques used interview instruments, validation sheets, questionnaires, tests, and documentation. All of these instruments have been validated by one lecturer in mathematics education and one lecturer in primary school teacher education. Interviews were conducted with fourth-grade primary school teachers by asking the teachers' problems when teaching students and documenting the tools and conditions of learning mathematics in class. The validation sheet is intended for assessment by materials and media experts of CoPAM. The grid on material expert validation covers content and presentation, while the media expert assessment grid covers display, presentation, and effects (see Table 1). The questionnaire is the response of teachers and students to CoPAM. The grid of this questionnaire has technical aspects, presentation, and media quality (see Table 2). The assessment aspects on the validation sheet and questionnaire were adapted from Andriah and Amir (2021) and Wulandari and Amir (2021). Meanwhile, the test instrument includes questions about six simple fraction essays given before and after the implementation of CoPAM (see Table 3).

Table 1. Validation Grid of Material Experts and Media Experts

Aspects	Material expert		Media expert
	Topic suitability		Cover design
	Core Competencies		Image suitability
Contents	Basic competencies	View	Interesting pictures
	Material clarity		Font type
	Student interest		Font size
	Language convenience		Image layout
	Color composition		Image size
Presentation	Selection of illustrations	Effect	Color
	CoPAM duration		Illustration
	Image quality		Transition effect

(Andriah & Amir, 2021; Wulandari & Amir, 2021)

Table 2. Grid of Teacher Response Questionnaires and Student Responses

Aspects	Teacher responses	Student responses
	Suitability of student	Student fun with CoPAM
Technical	CoPAM operations	Interest in studying the material
	Interest in learning	Desire and curiosity
	Student center advantages	Interest in using CoPAM
Presentation	Language use	Retention of material
	Sentence effectiveness	Explanation of the examples
	Combination of elements	Material clarity
Media Quality	Font type and size	Animation quality
	Pictures and animations	Text quality
	Useful for teachers	

(Andriah & Amir, 2021; Wulandari & Amir, 2021)

Table 3. Pre-Test and Post-Test Grids

Basic competencies → Indicators	**Items**
3.1 Describing equivalent fractions with concrete drawings and models	
Pre-test (Total)	**6 items**
3.1.1 Determining the fraction worth by using concrete objects or pictures	1, 2, 3, 4
3.1.2 Writing fractions according to concrete objects or pictures	5
3.1.3 Determining the result of the largest fraction among other fractions through concrete objects or pictures	6
Post-test (Total)	**6 items**
3.1.4 Indicating the equivalent fraction of the colored part	1, 2
3.1.5 Drawing a shape that represents a fraction	3
3.1.6 Determining the part of the fraction (the numerator and denominator) through different images of the same type	4a, 4b
3.1.7 Calculating a fraction that is equal to another fraction number	5

Table 4. Product Development Assessment Criteria

Value range	**Validity levels**	**Practicality levels**	**Effectiveness levels**
81-100	Very valid	Very practical	Very effective
61-80	Valid	Practical	Effective
41-60	Quite valid	Quite practical	Quite effective
21-40	Less valid	Less practical	Less effective
<20	Very invalid	Very impractical	Very less effective

(Perdana et al., 2021; Saputra & Mampouw, 2022)

This study uses data analysis techniques in the form of descriptive statistics that perform calculations and conclusions according to the data obtained. The analysis carried out includes quantitative and qualitative descriptive analysis. In this study, an analysis was carried out to measure the validity, practicality, and effectiveness of the developed CoPAM. Qualitative descriptive analysis was conducted to determine the validity of CoPAM from material expert validators and experts, including analyzing expert input and criticism of CoPAM. Meanwhile, quantitative descriptive to analyze the practicality of CoPAM in the form of numbers obtained from questionnaire responses and student test results. The results of the CoPAM feasibility analysis are based on the conversion of the total value based on the level of validity, practicality, and effectiveness adapted from Perdana et al. (2021) and Saputra and Mampouw (2022), see Table 4. Specifically, regarding the effectiveness, the range values obtained were converted into percentages.

3. RESULT AND DISCUSSION

Result

At the define stage, interviews were conducted to identify the needs of teachers and students in schools. The results of interviews with teachers showed that the teacher had never taught material using multimedia in the form of video animation. Teachers only teach through books and explain using the lecture method to students, sometimes also using simple media made from printed images. In addition to teachers, researchers also conducted interviews related to needs analysis of students who asked about what kind of media students liked to support their learning. Students convey their preferred media in the form of multimedia that has characteristics such as PowToon.

At the design stage, the CoPAM design is made. At this stage, the first thing to do is open the PowToon website (web www. PowToon.com) and create an account using e-mail. After that, start designing the video frame that will be used, determining the color on the background, the characters used, the supporting images for the story, and entering the dubbing or voice acting of the video. Meanwhile, at the development stage, one media expert validator carried out the CoPAM design validation and one material expert validator. The CoPAM assessment result focused on aspects of content, presentations, view, and effect in Table 5.

Table 5. Expert Validation Results

	Material Expert	**Score (%)**	**Total (%) → Category**
Assessment Aspects	Contents	18 (90)	38 (90) → Very valid
	Presentation	20 (100)	
	Media Expert	**Score (%)**	**Total (%) → Category**
	View	16 (80)	34 (85) → Very Valid
	Effect	18 (90)	

The CoPAM validation in Table 5 shows that the CoPAM design is very valid. However, there are some suggestions for improvement by experts, namely the provision of a list of materials at the beginning of the CoPAM display, the selection of font sizes in CoPAM is enlarged, and the degradation of color selection in CoPAM should be softer or use pastel colors. Researchers followed up on the revision results by experts on the CoPAM design to get the final CoPAM design applied to research participants (see Figure 2).

Figure 2. Constructivist-based PowToon Animation Multimedia (CoPAM)

The results of applying the final design of CoPAM in learning to facilitate primary students in understanding simple fractions visually and symbolically produce data on the practicality of CoPAM by teachers and students (see Table 6). In addition, data on the effectiveness of simple fraction learning outcomes were obtained (see Table 7). The practicality of CoPAM by the teacher describes the teachers' response while learning simple fractions. Meanwhile, the practicality of CoPAM by students shows student responses after using CoPAM so that students can understand simple fractions in a more conceptual and fun.

Table 6. Practical Results of Copam

Aspects	Technical	Presentation	Quality	Total (Category)
Teacher Response (%)	100	100	93.75	97.5 (Very practical)
Student Response (%)	90	92	94	91 (Very practical)

Table 7. Effectiveness Results of Students' Simple Fraction Towards Copam

Evaluation	Student total	Lowest score	Highest score	Average
Pre-Test	12	56.5	70.5	62.3
Post-Test	12	70.0	93.5	85.5

The results of the practicality of CoPAM by teachers and students in Table 6 show that in technical assessment, presentation, and quality CoPAM has a value above 80. This means that CoPAM is seen as very practical to be used by teachers and students. In this case, it can be interpreted that CoPAM makes it easier for teachers to teach and students to construct an understanding of simple fractions.

The implementation of CoPAM in Table 7 resulted in an average post-test of 85.5 (very effective), while the average pre-test was 62.3. In this case, there is also a difference in the average higher scores on the post-test. Similar differences can be seen in the highest and lowest scores between the pre-test and post-test. Although student learning outcomes obtained after the application of CoPAM were obtained from the descriptive statistical analysis results. However, this is sufficient to reflect the very effective application of CoPAM to facilitate students' understanding (as study participants) of the simple fraction. So that statistical analysis that allows for a wider generalization and the next research stage is recommended to be carried out further.

Discussion

The results of the study development resulted in a valid CoPAM to facilitate primary students at the fourth-grade level in understanding simple fractions. In this case, CoPAM developed based on the integration of PowToon animation multimedia towards the constructivist approach showed its success so that students could construct a more meaningful understanding of simple fractions. The results of studies related to developing and implementing constructivist PowToon learning in building knowledge also show similar results (Alias et al., 2020; Chaijaroen et al., 2019; Wu et al., 2018; Zambrano & Campuzano, 2020). In this case, the constructivist element in CoPAM makes it easier for students to understand simple fractions from visual to symbolic representations or vice versa (Hunt et al., 2019; van Garderen et al., 2021). The visual representation of the simple fraction represents conceptual knowledge, while the symbolic representation in calculating the fraction represents procedural knowledge (Andriah & Amir, 2021; Morano & Riccomini, 2020; Roesslein & Codding, 2019; Wulandari & Amir, 2022).

CoPAM has also been declared practical by teachers to be used in teaching simple fractions. This practicality can be seen when the teacher finds it helpful in motivating primary students to study (Andini et al., 2018; Park et al., 2019). In this case, CoPAM helps teachers know fraction content so that students can still reason logically about fractions (Klemer et al., 2018; Loibl & Leuders, 2018). Students have also stated the practicality of CoPAM. In this case, students feel that CoPAM, which facilitates constructivist learning, can reduce students' difficulties in learning fractions (Hwang et al., 2019; Simon, 2019). The results of another study on animated multimedia show that it makes it easier for students to understand the material better (Lindner et al., 2021; Park et al., 2019).

The effectiveness of CoPAM, which is classified as animated multimedia, can be seen in the increase in simple fraction learning outcomes for primary students. The results of related studies on applying PowToon can help teachers improve student learning outcomes against simple fractions (Seftiana & Delia, 2021; Setiyani et al., 2020). Similar to the study results, the use of PowToon in the practice of learning mathematics also provides understanding for primary students (Awalia et al., 2019; Sanjaya et al., 2021).

The findings in this study indicate that CoPAM has advantages in constructing procedural and conceptual fraction knowledge (Andriah & Amir, 2021; Copur-Gencturk & Doleck, 2021). The selection of CoPAM as animated multimedia is proven to support the continuity of learning compared to media that only use images (Kühl, 2021; Stebner et al., 2017). In addition, the effectiveness of CoPAM is expected to prevent students from difficulties and even misconceptions about fractions (Baek et al., 2017; Nasution et al., 2018; Ratnasari, 2018). Similar studies related to the constructivist element of CoPAM have confirmed that constructivism-oriented learning can prevent students from misconceptions (Ibanez & Pentang, 2021; Tamur & Juandi, 2020). Thus, CoPAM has implications as an alternative (as well as initial findings) for other researchers and educators to develop and use animation multimedia integration (one of which is PowToon) to the constructivist approach so that primary students' understanding of simple fractions is more meaningful.

Although the results of the development of CoPAM in this study had implications declared valid, practical, and effective to stimulate the understanding of the primary student in simple fractions. However, CoPAM has limitations in the limited scope of development and evaluation. Thus, the researchers recommend that further studies on the development of CoPAM involve a larger and wider range of participants using inferential statistics (not only descriptive statistics). Similar to the recommendations in this study, other studies that use a limited number of samples and research sites are advised to use more general statistical tests (Amir et al., 2020; Chiesi & Bruno, 2021; Kopparla et al., 2019). This is also related to the limitations of this study's CoPAM development stages, which only reached the development stage (3D). In contrast, the full Plomp development stage included the final stage, namely dissemination (4D). So it is also recommended to carry out further development of CoPAM up to the dissemination stage. Other studies related to product development using 3D involving primary students also suggest similar recommendations (Amir & Wardana, 2017, 2018). The recommendations are needed to ensure generalization and confidence in CoPAM products to facilitate primary students' learning, especially fourth graders, to understand simple fractions.

4. CONCLUSION

The development of PowToon animation products integrated with the constructivist approach (CoPAM) is declared feasible with valid, practical, and effective criteria. The validity of CoPAM shows that CoPAM can help students learn to understand simple fractions. This is also confirmed by the CoPAM validity, which makes the difference in learning outcomes of simple fractions in a better direction. The practicality of CoPAM also shows a positive response by teachers and students during and after the simple fraction learning process towards CoPAM. Further studies are needed to develop and test CoPAM by involving a larger number of students and a more comprehensive range of research sites through the dissemination stage.

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