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# Designing Joyful Fraction Learning Using PhET Simulation to Support SDG 4 in Primary Schools

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**ABSTRACT**

***Objective:*** *To develop and evaluate the effectiveness of PhET Simulation-based learning media in creating joyful mathematics learning, particularly for teaching fractions to primary school students, while supporting the implementation of SDG 4 (Quality Education).* ***Method:*** *Research and Development (R&D) approach using the Four-D (4D) development model, consisting of the define, design, develop, and disseminate stages. Data were collected through observation, evaluation, and reflection. The participants were 20 fourth-grade students from a public elementary school in Pekanbaru. The effectiveness of the developed learning media was assessed based on students' engagement and learning experiences during the implementation.* ***Results:*** *The findings revealed that the PhET Simulation-based learning media effectively enhanced students' interest and active participation in mathematics learning. Students reported feeling more motivated and challenged during the learning process. Furthermore, the interactive visualization provided by the simulation enabled students to better understand fraction concepts by transforming abstract mathematical ideas into concrete learning experiences.* ***Novelty:*** *Introduces a joyful learning approach by integrating PhET Simulation into fraction instruction for primary school students. The research demonstrates that interactive simulation-based learning media can improve conceptual understanding and student engagement, providing an innovative instructional strategy to support quality mathematics education in primary schools.*

## INTRODUCTION

Nowadays, technical innovations are becoming more complex and advanced (Appio et al., 2019; Baykara et al., 2015; Hossain et al., 2022; Lu et al., 2024). They have addressed every area of human existence, including education. Technology in the sphere of education is regarded as vital since it will improve learning activities (Nepo, 2017). Technology can help students optimize their potential and progress, preventing them from falling behind in learning activities. However, as technology has advanced, it has not been extensively used equitably in Indonesian education and learning, particularly mathematics (Mailizar et al., 2020). Mathematics is a discipline of science that examines abstract things and, as a result, emphasizes how people think (Antonio & Prudente, 2024; Koparan et al., 2023; Thanheiser, 2023). Mathematics education aims to help students improve their skills and use them in real-life situations (More, 2018).

Fractions are one of the contents taught in mathematics classes. Fractions are a difficult subject for elementary school students to grasp because their knowledge of natural numbers cannot be instantly applied to understanding fractions (Oktasari et al., 2022). Students must be able to have conceptual changes or praxeological changes (Afriyani et al., 2018; Prediger, 2011). According to Charalambous and Pitta-Pantazi, the fraction construction consists of five constructions: part-whole, ratio, operator, quotient, and measure. The part-whole concept refers to an object that is continuously divided into

equal portions (Charalambous & Pitta-Pantazi, 2007). The ratio concept is defined as a comparison of two quantities, such as three males and four girls, which can be expressed as 3:4 or 3/4. Meanwhile, the operator concept is defined as the result of multiplying two integers (Ambarita & Zulkardi, 2020; Nusantara et al., 2020; Stacey et al., 2014; Zulkardi et al., 2019). For example, ¾ can be understood as 3 times ¼ of a unit, or ¼ x 3 units. The quotient concept is connected to fractions through division. For example, 1/3 represents one unit divided by three persons. Finally, measure may be described as the outcome of measuring an object's length or a numerical value that can be printed on a number line. Meanwhile, fraction learning in Indonesia focuses on comprehending fractions as part-whole connections (Aththibby et al., 2021; Hasyim et al., 2020; Nurita et al., 2024).

PheT simulation is one of several digital technologies that may be used to teach primary school mathematics. Phet simulation is an internet simulation application created by the University of Colorado (Arifin et al., 2023). It is one of the digital learning media that instructors are supposed to employ in teaching and learning activities, and it may assist students comprehend fraction ideas, particularly in mathematics learning (Arifin et al., 2023). Several research on the usage of PhET simulation have been undertaken earlier. One example is Arifin et al.'s research which used PhET interactive simulation to improve primary school pupils' mathematics knowledge and participation in learning mixed fractions. The study found that students' grasp of mixed fractions improved following two cycles of PhET simulation-assisted mathematics instruction. Furthermore, when students learned mixed fractions via PhET simulation, their interest and passion for learning increased.

Given that fractions are a tough issue for most primary school pupils in Indonesia, particularly in Pekanbaru, this study aims to construct interactive learning activities based on PhET simulation. The design centers on the notion of fractions. Researchers anticipate that students' grasp of fractions will improve as a result of the multiple fraction representations offered through the PhET simulation (Minarni & Napitupulu, 2017; Scheitlin et al., 2023).

## RESEARCH METHOD

The research method used in this study is Research and Development (R&D), and the development model employed is the 4D development model. The 4D model has four stages of development: definition, design, development, and dissemination (Arvianto & St Y, 2023; Hl et al., 2023; Mulyati et al., 2022). The research instrument employs observation, evaluation, and reflection. The participants of this study were 20 fourth grade students from a public elementary school in Pekanbaru, Riau, Indonesia. In the define stage, the researchers define or establishe what is required in advance so that it can subsequently become information and be developed. Several things are observed, including students' learning styles, the learning mediums employed, acceptable learning resources, and so on. The second stage is the design stage, which is beneficial for deciding the design that will be employed by the researchers based on the information gathered at the definition stage, such as the selection of learning materials, methodologies, models, learning media, and others. Then, in the third stage, known as the development stage, it is useful for developing the previously completed design, specifically at the design stage, based on the information collected during the definition stage. The fourth step is the disseminate stage, which involves a testing of the material's development. The researchers test the design of learning fractions using PhET simulation with 20 fourth grade primary school students.

## RESULTS AND DISCUSSION

***Results***

The lesson begins with the teacher conveying the learning objectives and continues by explaining the fraction material to strengthen students' understanding of fractions. The teacher begins by drawing a fraction shape on the whiteboard and asking students to guess the fraction value from the picture presented. This activity is carried out so that we can find out whether students have understood the concept of fractions well in the previous lesson. The following is an excerpt from the implementation of learning in class.

Teacher : Have you studied fractions before?
Students : Yes.
Teacher : Who can answer what a fraction is?
Teacher : What shape is this? (pointing to the fraction shape on the board)
Student 1: Round.
Student 2: Fraction. Other
Students: Circle.
Teacher : Who answered fraction before?
Student : Azka.
Teacher : Why did Azka answer this is a fraction shape?
Azka : Because there are lines.
Teacher : If this is a fraction. What is the name of this fraction? (Pointing to the fraction shape on the board)
Teacher : This is a circle. Divided by 2, shaded. Read what fraction?
Students : One half.
Teacher : This is a circle, divided by 2, divided by 4, shaded 1.
Students : One quarter.

After giving an explanation and students are considered to have understood the material, it is continued by playing games in PhET Simulation (Sugiman et al., 2018; Yusra & Saragih, 2016). In this game, students are divided into four groups with heterogeneous members. Then it is explained and given examples of how the games from PhET Simulation are. However, before the game starts, students will choose the level of games that will be played by each group of students, where the levels consist of level 3, level 4, level 5, and level 6. Then the teacher first give an example of how to play games using PhET Simulation and students start the game guided by the teacher.

In the first game guided by group 2 with level 5 according to the spin activity that has been done before. In this section, the group representative will choose a number/fraction image that will be matched with the form of a fraction model according to the level that has been selected previously. Then other members of the group will provide directions to match the number/image that has been selected and then matched with the fraction model. And so on, and each group will be given 2 chances according to the rules in the PhET Simulation game to match the number/fraction image according to the correct fraction model form.

Indah : Who wants to go first to answer the questions in this game?
Students : Group 2 sis
Teacher : Okay, please for the representative from group 2 to come forward and the other members give directions
Teacher : Please choose which fraction you want to match
Student 1: Fraction 1.
Teacher : Come on, share it with your group members, pleas discuss which pair matches the fraction that has been chosen
(Group) : Fraction 2

Teacher : Okay, are you sure about the answer you chose?
Student 1 & Group : Sure
Teacher : Okay, let's see.
Teacher : The answer is correct, let's continue to the next Fraction. (Fig. 1)

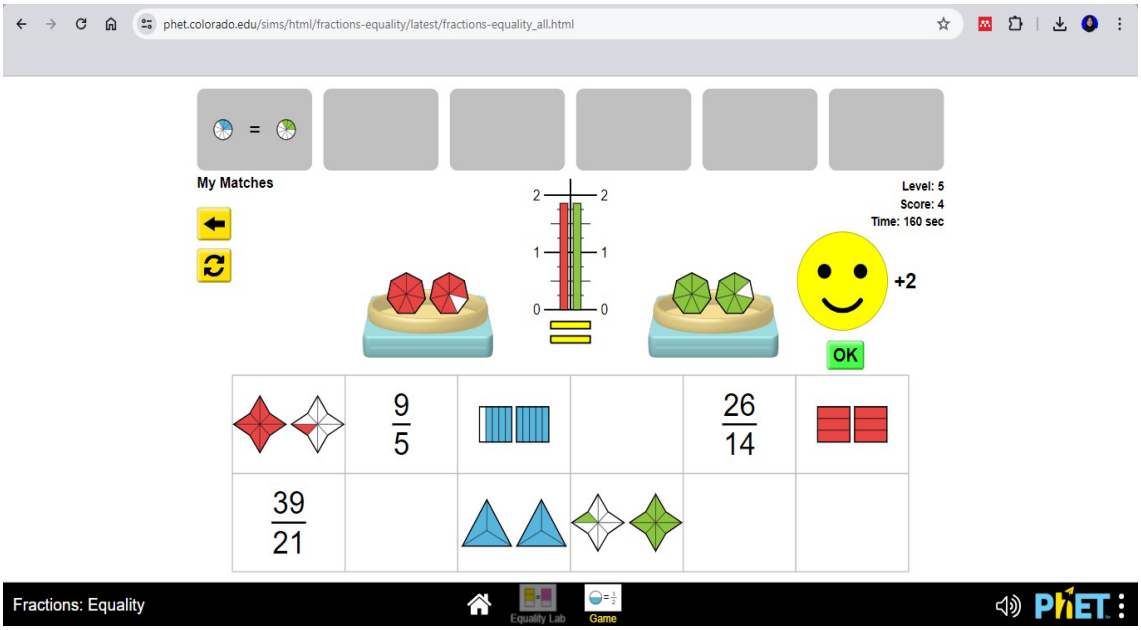


**Figure 1.** Group 2's answer to the given task

After all groups advanced, it was found that group 3 with level 6 worked on the questions in the game in 96 seconds (Fig. 2). This group became the fastest group in working on the questions in the PhET Simulation game.

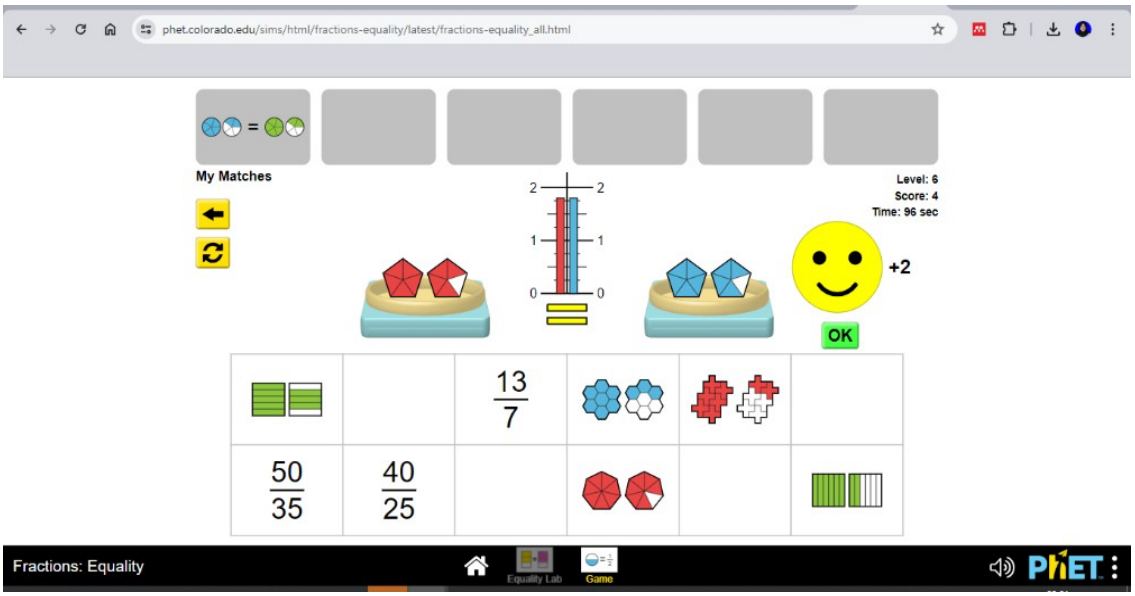


**Figure 2.** Group 3's answer to the given task

Based on the results of fraction games activities using PhET Simulation, it was found that students had difficulty in solving fraction problems with multiples. Because in this game there is also a multiple matching so that students find it difficult to match it with other fractions. Then the students also still have difficulty determining the numeration in the fraction image so that it takes a little longer in the process of matching the fraction image with other fraction options. However, for the entire activity in this game, many

students feel challenged in matching one fraction with another. In addition, they are also very enthusiastic when other groups are trying to match the fractions.

After conducting a series of learning activities on fractions using PhET Simulation, an evaluation activity was carried out to determine the level of students' understanding, and continued with a reflection activity to determine students' interest in the learning carried out. From the evaluation activity, it was found that many students answered question number 3 incorrectly (Yabo, 2020). The question discusses the numerator of a fraction, therefore according to the study, grade 4 students cannot distinguish between the numerator and denominator (Table 1). However, they can mention the value of the fraction when viewed from the picture or vice versa. This can be seen from the evaluation results Table 1.

**Table 1.** Students' successful of solving the tasks

| Task | Percentage |
|---|---|
| Task 1 | 100% |
| Task 2 | 90% |
| Task 3 | 15% |
| Task 4 | 95% |
| Task 5 | 90% |

Teacher : How was the learning process? Fun or just so-so?
Students : Fun.
Teacher : Were you interested during the learning process? Which part interested you?
Students : Interested, in the games section
Teacher : Do you think the next fraction learning activity should be like the one before or use concrete/real media?
Students : Like the one before.
Students : Direct media.
Teacher : What were the challenges in the learning activity earlier?
Students : Matching pictures or fractions in games.

From the results of the reflection, it can be seen that some students enjoy learning fractions using PhET Simulation. With the games provided, it can be a challenge for all students. Where they have to find a suitable partner, calculate the value of the fraction in the picture, then the students also race against the time displayed. It can be concluded that students understand fractions better if the fractions are displayed/illustrated with pictures or vice versa, but students still find it difficult to determine which is the denominator and which is the numerator. So that in the future, students may be expected to be able to practice fraction problems more often, starting from the easiest to the most difficult, of course they can use the PhET Simulation website to practice well.

### *Discussion*

The findings of this study indicate that students have an interest in the learning process and they also feel challenged. The use of PhET Simulation media can be an alternative to eliminate boredom and can increase student activity (Arifin et al., 2023; Hasyim et al., 2020). In addition, the use of PhET Simulation can also provide experience for them, where this media provides concrete visualization so that students can understand well, especially in fractional material in eelementary school (Eveline et al., 2019; Nurita et al., 2024). A recommendation from this study to teachers to be able to implement PhET Simulation media into learning activities, because PhET Simulation itself does not only

present mathematics learning but also other materials. By implementing the use of PhET Simulation media to encourage teaching and learning activities, students will be able to more easily explore learning concepts and can increase students' learning motivation.

## CONCLUSION

**Fundamental Finding:** This study demonstrates that the use of PhET Simulation-based learning media effectively creates a joyful learning environment for teaching fractions in primary schools. The findings indicate that students showed greater interest, active participation, and motivation during the learning process. The interactive and visual features of PhET Simulation enabled students to better understand abstract fraction concepts by providing concrete learning experiences, thereby improving conceptual understanding and engagement in mathematics learning. **Implication:** The findings suggest that PhET Simulation can serve as an effective digital learning medium for supporting innovative mathematics instruction in primary schools. Teachers are encouraged to integrate interactive simulation media into classroom activities to promote student-centered learning, increase learning motivation, and facilitate deeper conceptual understanding. The implementation of technology-enhanced learning also supports the achievement of SDG 4 (Quality Education) by fostering inclusive, engaging, and high-quality educational practices. **Limitation:** This study was conducted with a limited sample of 20 fourth-grade students from a single public elementary school in Pekanbaru. Therefore, the findings may not be generalizable to other educational contexts or grade levels. In addition, the study focused specifically on fraction learning and did not examine the long-term effects of PhET Simulation on students' academic achievement. **Future Research:** Future studies should involve larger and more diverse samples from different schools and educational levels to improve the generalizability of the findings. Further research is also recommended to investigate the effectiveness of PhET Simulation in other mathematics topics and different subject areas, as well as to examine its long-term impact on students' learning outcomes, critical thinking, problem-solving skills, and motivation.

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## AUTHOR CONTRIBUTIONS

**Zetra Hainul Putra** contributed to the conceptualization of the study, research design, methodology development, supervision, formal analysis, manuscript drafting, and project administration. **Jesi Alexander Alim c**ontributed to the development of the research methodology, validation of the learning media, data analysis, and critical review of the manuscript. **Arisya Ruspina Putri** contributed to the development and implementation of the PhET Simulation-based learning media, data collection, and manuscript writing. **Astri Resti Rahmadani** contributed to the investigation, classroom observations, data management, and manuscript editing. **Indah Maslakhatul** contributed to instrument validation, data interpretation, and visualization of the research findings. **Rahmadhani Fitri** contributed to the evaluation of learning outcomes, literature review, and manuscript revision. **Yahya Gunawan** contributed to software implementation, technical validation of the learning media, and quality assurance of the developed product. **Mohd Ridhuan Mohd Jamil** contributed to the conceptual review, interpretation of the findings, international academic perspectives, and critical revision

of the manuscript. All authors have read, reviewed, and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

## CONFLICT OF INTEREST STATEMENT

The authors declare that they have no financial, professional, institutional, or personal conflicts of interest that could have influenced the design, implementation, analysis, interpretation, or reporting of this study. The development and evaluation of the biology practicum guidebook were conducted solely for academic and educational purposes.

## ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

## STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

During the preparation of this manuscript, the authors used a generative artificial intelligence tool solely to assist with English-language refinement, grammar correction, and improvements in academic readability. The tool was not used to generate research data, perform statistical analysis, determine the research findings, or formulate conclusions. All AI-assisted outputs were critically reviewed, revised, and verified by the authors. The authors take full responsibility for the accuracy, originality, interpretation, and integrity of the final manuscript.

## REFERENCES

Afriyani, D., Sa'dijah, C., & Muksar, M. (2018). Characteristics of students' mathematical understanding in solving multiple representation task based on SOLO taxonomy. *International Electronic Journal of Mathematics Education, 13*(3), 281–287. https://doi.org/10.12973/iejme/3920

Ambarita, S. M., & Zulkardi. (2020). Designing mathematical problems task through COVID-19 context. *Journal of Physics: Conference Series, 1657*(1), Article 012048. https://doi.org/10.1088/1742-6596/1657/1/012048

Antonio, R. P., & Prudente, M. S. (2024). Effects of inquiry-based approaches on students' higher-order thinking skills in science: A meta-analysis. *International Journal of Education in Mathematics, Science and Technology, 12*(1), 251–281. https://doi.org/10.46328/ijemst.3216

Appio, F. P., Lima, M., & Paroutis, S. (2019). Understanding smart cities: Innovation ecosystems, technological advancements, and societal challenges. *Technological Forecasting and Social Change, 142*, 1–14. https://doi.org/10.1016/j.techfore.2018.12.018

Arifin, S., Razali, F. B., & Rahayu, W. (2023). Integrating PhET interactive simulation to enhance students' mathematical understanding and engagement in learning mixed fraction. *Al Ibtida: Jurnal Pendidikan Guru MI, 10*(2), 241–252. https://doi.org/10.24235/al.ibtida.snj.v10i2.15056

Arvianto, F., & St Y, S. (2023). Designing an instrument to measure digital literacy competence using the 4D model. *International Journal of Instruction, 16*(4), 845–860. https://doi.org/10.29333/iji.2023.16447a

Aththibby, A. R., Kuswanto, H., Mundilarto, M., & Prihandono, E. (2021). Improving motivation and science process skills through a mobile laboratory-based learning model. *Cypriot Journal of Educational Sciences, 16*(5), 2292–2299. https://doi.org/10.18844/cjes.v16i5.6333

Baykara, T., Özbek, S., & Ceranoğlu, A. N. (2015). A generic transformation of advanced materials technologies: Towards more integrated multi-materials systems via customized R&D and innovation. *The Journal of High Technology Management Research, 26*(1), 77–87. https://doi.org/10.1016/j.hitech.2015.04.008

Charalambous, C. Y., & Pitta-Pantazi, D. (2007). Drawing on a theoretical model to study students' understandings of fractions. *Educational Studies in Mathematics, 64*(3), 293–316. https://doi.org/10.1007/s10649-006-9036-2

Eveline, E., Jumadi, Wilujeng, I., & Kuswanto, H. (2019). The effect of scaffolding approach assisted by PhET simulation on students' conceptual understanding and students' learning independence in physics. *Journal of Physics: Conference Series, 1233*(1), Article 012036. https://doi.org/10.1088/1742-6596/1233/1/012036

Hasyim, F., Prastowo, T., & Jatmiko, B. (2020). The use of android-based PhET simulation as an effort to improve students' critical thinking skills during the COVID-19 pandemic. *International Journal of Interactive Mobile Technologies, 14*(19). https://doi.org/10.3991/ijim.v14i19.15701

Hl, N. I., Nasruddin, N., Sejati, A. E., & Sugiarto, A. (2023). Developing teaching material of research methodology and learning with 4D model in facilitating learning during the COVID-19 pandemic to improve critical thinking skill. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran, dan Pembelajaran, 9*(2), 541–554. https://doi.org/10.33394/jk.v9i2.7110

Hossain, M. S., Kumar, L., Islam, M. M., & Selvaraj, J. (2022). A comprehensive review on the integration of electric vehicles for sustainable development. *Journal of Advanced Transportation, 2022*(1), Article 3868388. https://doi.org/10.1155/2022/3868388

Koparan, T., Dinar, H., Koparan, E. T., & Haldan, Z. S. (2023). Integrating augmented reality into mathematics teaching and learning and examining its effectiveness. *Thinking Skills and Creativity, 47*, Article 101245. https://doi.org/10.1016/j.tsc.2023.101245

Lu, Y., Xu, W., Leng, J., Liu, X., Xu, H., Ding, H., Zhou, J., & Cui, L. (2024). Review and research prospects on additive manufacturing technology for agricultural manufacturing. *Agriculture, 14*(8), Article 1207. https://doi.org/10.3390/agriculture14081207

Mailizar, M., Almanthari, A., Maulina, S., & Bruce, S. (2020). Secondary school mathematics teachers' views on e-learning implementation barriers during the COVID-19 pandemic: The case of Indonesia. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(7), 1–9. https://doi.org/10.29333/ejmste/8240

Minarni, A., & Napitupulu, E. E. (2017). Developing instruction materials based on joyful PBL to improve students mathematical representation ability. *International Education Studies, 10*(9), 23–38. https://doi.org/10.5539/ies.v10n9p23

More, M. (2018). Mathematics and engineering in real life through mathematical competitions. *International Journal of Mathematical Education in Science and Technology, 49*(2), 305–321. https://doi.org/10.1080/0020739X.2017.1387297

Mulyati, I., Astuti, I., & Ernawaty, E. (2022). Development of Canva application-assisted learning media in class XII advanced study materials with 4-D models. *JTP: Jurnal Teknologi Pendidikan, 24*(3), 322–329. https://doi.org/10.21009/jtp.v24i3.30483

Nepo, K. (2017). The use of technology to improve education. *Child & Youth Care Forum, 46*(2), 207–221. https://doi.org/10.1007/s10566-016-9386-6

Nurita, T., Yuliati, L., Mahdiannur, M. A., & Ilhami, F. B. (2024). The effectiveness of case-based STEM integrated with mobile simulation to foster students' creative thinking skills. *International Journal of Interactive Mobile Technologies, 18*(7). https://doi.org/10.3991/ijim.v18i07.48069

Nusantara, D. S., Zulkardi, Z., & Putri, R. I. I. (2020). Designing PISA-like mathematics problem relating change and relationship using physical distancing context. *Journal of Physics: Conference Series, 1663*(1), Article 012004. https://doi.org/10.1088/1742-6596/1663/1/012004

Oktasari, N., Syahrilfuddin, S., & Putra, Z. H. (2022). Fifth grade students' difficulties in solving addition of fractions. *Indonesian Journal of Science, Technology, Engineering, Art, and Mathematics Education, 1*(1), 16–26. https://doi.org/10.31258/ijsteame.1.1.16-26

Prediger, S. (2011). Why Johnny can't apply multiplication? Revisiting the choice of operations with fractions. *International Electronic Journal of Mathematics Education, 6*(2), 65–88. https://doi.org/10.29333/iejme/262

Scheitlin, K., Dietiker, L., & Riling, M. (2023). *Teaching secondary mathematics lessons for joy and wonder*. Association of Mathematics Teaching.

Stacey, K., Almuna, F., Caraballo, R. M., Chesné, J.-F., Garfunkel, S., Gooya, Z., Kaur, B., Lindenskov, L., Lupiáñez, J. L., & Park, K. M. (2014). PISA's influence on thought and action in mathematics education. In K. Stacey & R. Turner (Eds.), *Assessing mathematical literacy: The PISA experience* (pp. 275–306). Springer. https://doi.org/10.1007/978-3-319-10121-7_15

Sugiman, Sugiharti, E., & Kurniawati, N. F. (2018). Growing of the mathematical thinking imaginative to students in designing of the teaching aids for CWD towards joyful learning. *Journal of Physics: Conference Series, 983*(1), Article 012079. https://doi.org/10.1088/1742-6596/983/1/012079

Thanheiser, E. (2023). What is the mathematics in mathematics education? *The Journal of Mathematical Behavior, 70*, Article 101033. https://doi.org/10.1016/j.jmathb.2023.101033

Yabo, R. S. (2020). The joyful experience in learning mathematics. *Southeast Asian Mathematics Education Journal, 10*(1), 55–67. https://doi.org/10.46517/seamej.v10i1.85

Yusra, D. A., & Saragih, S. (2016). The profile of communication mathematics and students' motivation by joyful learning-based learning context Malay culture. *British Journal of Education, Society & Behavioural Science, 15*(4), 1–16. https://doi.org/10.9734/BJESBS/2016/25521

Zulkardi, Z., Putri, R. I. I., & Wijaya, A. (2019). Two decades of realistic mathematics education in Indonesia. In M. van den Heuvel-Panhuizen (Ed.), *International reflections on the Netherlands didactics of mathematics: Visions on and experiences with realistic mathematics education* (pp. 325–340). Springer. https://doi.org/10.1007/978-3-030-20223-1_18

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