KnE Social Sciences
ICLIRBE
International Conference on Learning Innovation and Research in Basic Education
Volume 2022

Research Article

Innovation of Mathematics Learning Models and Media in Elementary Schools in Kurikulum Merdeka Belajar

Uswatun Hasanah

Pendidikan Guru Madrasah Ibtidaiyah, UIN Sayyid Ali Rahmatullah Tulungagung, Indonesia
Pendidikan Dasar, Universitas Negeri Malang, Indonesia

Abstract.
Mathematics learning aims to build students' intellectual, creative, and logical mindsets. This goal can be achieved if learning can be carried out optimally. With technological advances in the independent learning curriculum, there needs to be innovations in the implementation of Mathematics learning in elementary schools. This study aims to examine the innovation of mathematics learning models and media in elementary schools in the independent learning curriculum. The method used in this research is a qualitative method of literature study, by reviewing articles of national and international repute. The results of this study indicate that there are several innovations in the mathematics learning model including the realistic mathematical education (RME) model, open minded problem-based learning, STEAM, blended learning, auditory intellectually repetition (AIR), and computational thinking (CT). While innovations in mathematics learning media include environment-based videos, Tinkercad, *Arduino, and Chibitronics*.

Keywords: Mathematics learning innovation, model, media, elementary school

Corresponding Author: Uswatun Hasanah; email: uswah2601@gmail.com

Published 16 May 2023

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICLIRBE Conference Committee.

1. INTRODUCTION

Learning mathematics in primary schools is to equip students with good mathematical knowledge and apply concepts in contextual situations. Mathematics learning aims to build students' intellectual, creative and logical mindsets. Not only that, mathematics education plays a role in intellectual and emotional development of students, through the development of students' creativity, curiosity about the social environment, culture and students' physical skills [1]. Therefore learning mathematics should be a fun lesson for students. Because in mathematics there are materials that are actually very closely related to student life, such as measurement materials, numbers, opportunities, so this is an interesting thing if the existing concepts are related to contextual life.

Based on several studies in the 21st century, mathematics learning needs to be developed in terms of curriculum material or practical learning so that students' mathematical

creativity can develop [2]. A number of learning models, learning media also color the research in the field of mathematics. The reason is that learning mathematics in the 20th century is different from learning mathematics in the 21st century. The difference lies in the challenges of the times, and the characteristics of students who continue to change.

The 21st century is marked by the Industrial Revolution 4.0. The industrial revolution 4.0 gave rise to technological advances in the form of the internet of things and artificial intelligence that was able to process data on a large scale (big data) [3].The emergence of technology in the form of the internet of things (IoT), opens new opportunities in the world of education in the learning aspect. With regard to learning media, technological advances open up new opportunities for teachers to create interactive and innovative learning media. With the sophistication of existing technology, teachers can also do learning in any conditions. If previous learning relied heavily on face-to-face learning models, now learning can be carried out in various models including online learning models, or learning models that combine the two, called blended learning models.

Especially since the Covid-19 pandemic, learning that was originally carried out face-to-face must switch to distance education, or what is more familiarly called online learning. To support the performance of these teachers, the Minister of Education issued a policy of ”free learning” [4] . The independent learning curriculum wants a more meaningful learning process so that students can become learners who learn. Philosophically, ”free learning” assesses a learning success not from how much knowledge students get but from how much effort students make to gain knowledge [5]and how much this knowledge can be applied in everyday life [6] .

The policy of independent learning provides opportunities for students to study independently according to their talents and interests. Students can learn whatever they want in their own way. Teachers do not have to force students to accept all the material in the textbook, because the most important thing is how students are able to learn independently, freely, happily. No longer studying for fear of being scolded by the teacher or studying for certain tasks. Learning is no longer about transferring knowledge, but learning is a process for constructing knowledge. Students learn about problem solving based on previous understanding and learning experiences [7] .

The independent learning policy gives schools the flexibility to determine the best learning program and in accordance with the situation and conditions of each school [4] . The Independent Learning curriculum has a number of advantages including being simple and deep, relevant and interactive, and making learning more independent. This

advantage will certainly not be seen if mathematics learning is still implemented conventionally. Therefore, there needs to be innovations in digital-based learning models and media so that independent mathematics learning can be realized.

2. METHOD

Research on model innovation and mathematics learning media in the independent learning curriculum uses qualitative research with library research techniques. Literature research is carried out by searching for various relevant sources, such as research journal articles, books and regulations. In this study, the researchers sourced articles of national and international repute, which discussed the latest models and media for learning mathematics.

2.1. Data Distribution

The distribution of data in this study is illustrated in able 1. There have been 30 articles in the last few years, from 2016 to 2022. The number of articles used in each journal is described as follows:

TABLE 1: Data Distribution.

Journal	Reputation	Number of Articles
International Journal on Emerging Mathematics Education (IJEME)	National	1
Journal of Mathematics Teacher Education	International	7
Mathematics Education Research Journal	International	4
Experiences in Mathematics Education	International	1
Digital Experiences in Mathematics Education	International	6
Digit Exp Math Education	International	1
A Journal of Comparative and International Education	International	1
Journal of Mathematics Education	National	5
Total	**National International**	**6 articles 20 articles**

Then the sources collected by the researchers are classified based on two things, namely articles that discuss innovative models of learning mathematics and innovative media for learning mathematics. The next step is the data is interpreted and abstracted. Then the data is quoted, then displayed as findings from previous studies. In the final stage, the researcher draws a conclusion. In more detail can be seen in the following chart:

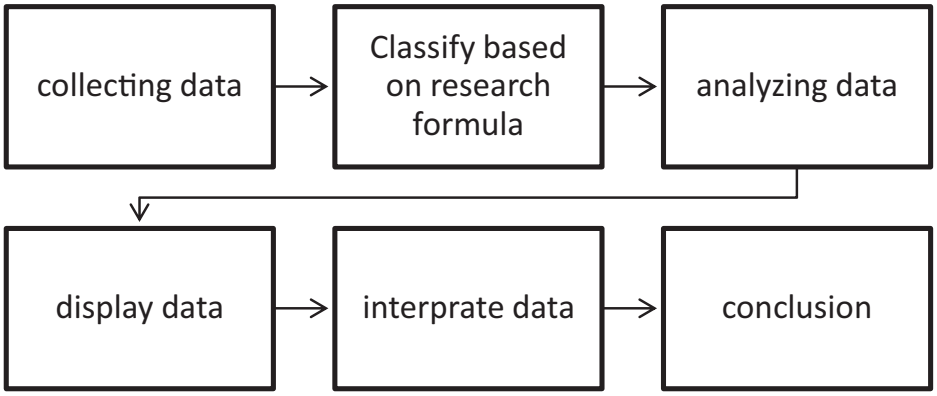

Figure 1: Stages of Research in Literature Studies(Darmalaksana, 2020).

3. RESULTS AND DISCUSSION

3.1. Learning Model Innovation in the Independent Learning Curriculum

Times continue to change, learning also continues to develop. Especially with the sophistication of modern technology, it is necessary to build strong mathematical abilities since children are in early education or basic education. In everyday life, humans cannot be separated from digital technology. However, there are still not many who have created this digital technology to be used in the learning process[8].

This is not an easy thing. Especially if this problem is viewed from the umbrella of the curriculum that overshadows it, so that a new curriculum policy appears which is expected to realize these goals. However, once again changing the standard/curriculum design is also not necessarily effective in improving students' abilities. Especially if the teacher still does not understand properly about the existing curriculum design. Therefore, the main aspect that needs to be considered is the quality of mathematics learning. The quality of mathematics learning is largely determined by the teacher. Teachers who have good knowledge will be able to process information to make appropriate learning design plans[9]. Teachers need to build collaborative learning activities, be it between students, or between teachers and students[10].

There are several innovations that can be done in the learning process so that mathematics learning can run optimally and learning objectives can be achieved. The first is realistic learning or commonly known as realistic mathematics education (RME).[11], [12].RME is an approach in learning mathematics that was adopted from the Netherlands. RME in Indonesia is called the Indonesian Realistic Mathematics Education (PRMI). The implementation of PRMI is manifested in assignments that are 22% oriented to real

world contexts. While in textbooks, PMRI is presented with a model/scheme that meets 35%[1].

Realistic Mathematics Education consists of several characteristics. First, using the daily experiences of students. Second, visualizing reality into a model, and then shifting the models through vertical mathematization before they reach a formal form. Third, involve student activities. Fourth, using the method of discussion and question and answer. Fifth, bring up the interrelationships between concepts, or between topics so that mathematics learning can be more holistic, not separated. Realistic learning is practically able to make it easier for students to understand math material[13]. The implementation of this approach can be adapted to the situation and conditions of each school, because schools have different complexity of problems and different learning opportunities[9], [14].

Second, the use of the Open Minded Problem-Based Learning (PBMO) model. The priority of this PBMO model is that students are given the freedom to express answers, find, recognize, and solve problems using several techniques.[15]. PBMO learning model can build students' mathematical thinking skills logically, analytically, systematically, critically and creatively[11]. This thinking ability is important to develop the ability to collect information, manage and use information appropriately.

The importance of building creative thinking skills has also been revealed by a number of other studies. Bicer et al., explained that mathematics learning today needs to be directed at learning that builds students' creative thinking patterns[2]. Building creative thinking patterns doesn't have to be complicated. For example, students can be asked to show different ways of solving 18×5. It is also not too difficult to apply such a practice. Teachers can use number speaking activities and can see how students can be creative in mathematics[2]. So that creative mathematical thinking can be developed since children are still at an early age. Moreover, psychologically, children at an early or basic age are easier to form than teenagers[16].

Third, the use of the STEAM learning model. In the era of progress in society 5.0, which is accompanied by technological developments in the industrial revolution 4.0, mathematics learning needs to be improved. Improving the quality of mathematics learning can be done through the implementation of learning with the STEM model (Science, Technology, Engineering, and Mathematics)[17]. STEM is a learning model that combines interdisciplinary concepts. STEM aims to build knowledge that is holistic, connected, focused, meaningful and relevant to students. STEM models can be implemented by designing and conducting experiments, analyzing and interpreting data, and communicating and collaborating with multidisciplinary teams[18].

Fourth, the use of blended learning learning models. In the uncertain period of the pandemic (looking at the ups and downs of cases of the spread of Covid-19), policies can change at any time. There are times when learning is carried out online, sometimes learning is carried out face-to-face in class. To anticipate these changes, teachers can use the blended learning model. Blended learning learning model is a learning model that combines face-to-face learning with online learning. The following is the syntax of the blended learning model[19]*:*

1. Searching information online and offline based on relevance, validity, content reliability and academic clarity,
2. Finding, understanding, and confronting ideas or ideas,
3. Interpret information or knowledge from various sources that have been sought from various sources,
4. Communicating ideas or interpretations of the results using online or offline facilities,
5. Constructing knowledge through the process of assimilation and accommodation of the results of analysis, discussion, and drawing conclusions from information obtained using online or offline facilities.

In the Independent Learning curriculum, the implementation of this model can be combined with an independent learning learning platform. With the existence of an independent learning platform, teacher learning is easier if you implement blended learning.

Fifth, the use of the Auditory Intellectually Repetition (AIR) learning model. AIR is a learning model that combines 3 activities. First, auditory is a learning activity that optimizes the sense of hearing, it can take the form of discussion, presentation and argumentation activities. Second, intellectually is an activity that optimizes thinking skills, can be in the form of problem solving, analyzing and creating activities. Third, repetition is an activity of repetition of understanding so that it is broader and deeper. Based on the research results, this model can improve students' mathematical understanding[1].

Sixth, the use of the Computational thinking (CT) learning model. Mathematical activities need to be directed at computing activities that are connected with the concept of scientific disciplines, this activity is called Computational thinking[2]. *Computational thinking*(CT) can be categorized into two categories. First, CT activities are skill-oriented

(such as especially sequencing, looping, conditional, debugging, decomposition, and abstraction). Second, process-oriented CT activities (such as communication, creativity, exploration and use) [20]. The main activity of skill-oriented CT is making instructions for the robot to follow (this activity is called coding). Use of robots in other research[21]able to increase students' interest and attention in learning mathematics. The practice of CT activities can be adapted to the conditions of each school. Where in a simple scope, CT can be applied to making simple games that are suitable to facilitate their friends in understanding mathematical concepts[22].

3.2. Learning Media Innovation in the Independent Learning Curriculum

Teachers as educators as well as facilitators of students in learning need to know how students think. Through these skills, it is possible for teachers to analyze the causes of errors when students work on math problems. Improving skills in paying attention to students' thinking can be done by using environmental-based professional development case videos[23]. The researcher views that the use of environment-based videos also needs to be used in learning mathematics in elementary schools. Where through videos on certain cases based on the environment can lead students' reasoning to investigate and discuss with teachers in analyzing what causes a problem in math practice in real life. So that the involvement of teachers and students in learning mathematics is very important[24]. In a study conducted by Widjayanti et al. also proves that the use of video media or other interactive media can improve student learning mastery(Widjayanti, Masfinatin and Setyansah, 2018)

The use of digital-based learning media is also increasingly being implemented in elementary schools in several countries such as Germany, where one of the developments is using computer aided design (CAD) Tinkercad software. Tinkercad is a free, web-based CAD program that lets people think, create and create[26]. Tinkercad inherits a very intuitive approach to modeling three-dimensional (3D) objects directly, providing easy access to the software for first-time users, such as elementary school students.[27]. This learning media is very helpful for students in geometry material or building spaces that combine one space with another. Like the following picture:

Still related to digital-based learning media, in addition to the use of Tinkercad, there is another digital media calledArduino and Chibitronics. Arduino and Chibitronics are mathematical applications that focus on two things, namely creating digital circuits and controlling them with code[8]. Like the following example:

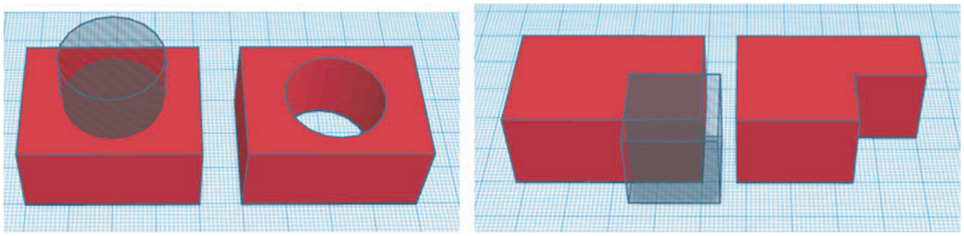

Figure 2: Operations for drilling holes in an object and for subtracting objects with other objects in Tinkercad[27].

Figure 3: Visualization of using Chibitronics and Arduino.

The picture shows an illustration of how a grade 1 student investigates a concrete representation of an odd number using a connecting cube. It turns out that the combination of odd cubes when assembled to form a square. Students made observations about this and they were surprised by the results they got. This is visual proof that the sum of the first N odd numbers is NxN.

These various learning model innovations and learning media can be a reference in implementing mathematics learning in elementary schools. Children in the elementary school range experience very rapid cognitive, affective and psychomotor development, if learning can run optimally. Technological advances must certainly be responded to positively, so that existing innovations are in accordance with the challenges of student life.

4. CONCLUSION

There are several innovations in the mathematics learning model including the Realistic Mathematical Education (RME) model, Open Minded Problem-Based Learning, STEAM, blended learning, Auditory Intellectually Repetition (AIR), and Computational Thinking (CT). While innovations in mathematics learning media include environment-based videos, Tinkercad,*Arduino and Chibitronics.*

References

[1] S. Revina and F. K. S. Leung, "Issues involved in the adoption of Realistic Mathematics Education in Indonesian culture," *Compare*, vol. 51, no. 5, pp. 631–650, 2021, doi: 10.1080/03057925.2019.1650636.

[2] A. Bicer, A. Bicer, C. Perihan, and Y. Lee, "Pre□service teachers' preparations for designing and implementing creativity□directed mathematical tasks and instructional practices," *Mat*, vol. 1, 2022, [Online]. Available: https://doi.org/10.1007/s13394-022-00409-x.

[3] M. P. Rezky, J. Sutarto, T. Prihatin, A. Yulianto, I. Haidar, and A. Surel, "Seminar Nasional Pascasarjana 2019.," *Gener. Milen. yang Siap Menghadapi Era Revolusi Digit. (Society 5.0 dan Revolusi Ind. 4.0) di Bid. Pendidik. Melalui Pengemb. Sumber Daya Mns.*, no. Universitas Negeri Semarang, pp. 1118–1125, 2019.

[4] M. Thohir, "From disruption to mobilization: Ire teachers' perspectives on independent learning policy," *Cakrawala Pendidik.*, vol. 40, no. 2, pp. 359–373, 2021, doi: 10.21831/cp.v40i2.39540.

[5] A. Mudhofi, "No FILSAFAT SEBAGAI WAHANA PENDIDIKAN MENUJU KEMANDIRIAN BANGSATitle," *Cakrawala Pendidik.*, vol. XXXII, 2013.

[6] M. A. Nuryatno, "Critical Remarks on Educational Philosophy of Paulo Freire," *J. Cakrawala Pendidik.*, vol. 1, no. 1, pp. 1–16, 2015, doi: 10.21831/cp.v1i1.1542.

[7] E. Istikhoirini, "Studi Literatur: Edmodo sebagai Media Pembelajaran Matematika Daring dalam Era Merdeka Belajar di Masa Pandemi," *ProSANDIKA UNIKAL (Prosiding Semin. Nas. Pendidik. Mat. Univ. Pekalongan)*, vol. 2, no. 1, pp. 11–18, 2021, [Online]. Available: https://proceeding.unikal.ac.id/index.php/sandika/article/view/500.

[8] J. Hughes, G. Gadanidis, and C. Yiu, "Digital Making in Elementary Mathematics Education," *Digit. Exp. Math. Educ.*, vol. 3, no. 2, pp. 139–153, 2017, doi: 10.1007/s40751-016-0020-x.

[9] S. Llinares, "Instructional quality of mathematics teaching and mathematics teacher education," *J. Math. Teach. Educ.*, vol. 24, no. 1, pp. 1–3, 2021, doi: 10.1007/s10857-021-09488-2.

[10] G. M. Lloyd, C. L. Rice, and A. V. McCloskey, "Opportunities for professional learning about mathematics instruction: the role of joint work in student-teaching triads," *J. Math. Teach. Educ.*, vol. 23, no. 5, pp. 499–525, 2020, doi: 10.1007/s10857-019-09439-y.

[11] S. Revina and F. K. S. Leung, “Educational Borrowing and Mathematics Curriculum: Realistic Mathematics Education in the Dutch and Indonesian Primary Curriculum,” *Int. J. Emerg. Math. Educ.*, vol. 2, no. 1, p. 1, 2018, doi: 10.12928/ijeme.v2i1.8025.

[12] S. Fowler, C. Cutting, S. H.D.Fiedler, and S. N. Leonard, “Design□based research in mathematics education: trends, challenges and potential,” *Math. Educ. Res. J.*, 2021, [Online]. Available: https://doi.org/10.1007/s13394-021-00407-5%0A.

[13] I. L. Purnama and E. Aldila, “Kemampuan Komunikasi Matematis Siswa Ditinjau Melalui Model Pembelajaran Kooperatif Tipe Complete Sentence Dan Team Quiz,” *J. Pendidik. Mat.*, vol. 10, no. 1, pp. 27–43, 2016, doi: 10.22342/jpm.10.1.3267.26-41.

[14] J. Skott, “Understanding mathematics teaching and learning ‘in their full complexity,”’ *J. Math. Teach. Educ.*, vol. 22, no. 5, pp. 427–431, 2019, doi: 10.1007/s10857-019-09446-z.

[15] S. H. Noer, “Mengembangkan Keterampilan Berpikir Kreatif Matematis dan Pembelajaran Matematika Berbasis Masalah Open-Ended,” *J. Pendidik. Mat.*, vol. 5, no. 1, p. 100, 2011.

[16] K. Quane, M. Chinnappan, and S. Trenholm, “Draw yourself doing mathematics: developing an analytical tool to investigate the nature of young children’s attitudes towards mathematics,” *Math. Educ. Res. J.*, no. 0123456789, 2021, doi: 10.1007/s13394-021-00399-2.

[17] V. Caggiano, “Towards identifying the soft skills needed in curricula: Finnish and italian students’ self-evaluations indicate differences between groups,” *Sustain.*, vol. 12, no. 10, 2020, doi: 10.3390/SU12104031.

[18] S. Psycharis, “Steam in Education: a Literature Review on the Role of Computational Thinking, Engineering Epistemology and Computational Science. Computational Steam Pedagogy (Csp),” *S. Psycharis Sci. Cult.*, vol. 4, no. 2, pp. 51–72, 2018, doi: 10.5281/zenodo.1214565.

[19] E. Marlina, “Pengembangan Model Pembelajaran Blended Learning Berbantuan Aplikasi Sevima Edlink,” *J. Padegogik*, vol. 3, no. 2, pp. 104–110, 2020.

[20] S. Krogh, N. Annette, H. Bjerke, and L. Mifsud, “Computational Thinking in the Primary Mathematics Classroom : a Systematic Review,” *Digit. Exp. Math. Educ.*, no. 1, 2022, doi: 10.1007/s40751-022-00102-5.

[21] M. M. Alqahtani, J. A. Hall, M. Leventhal, and A. N. Argila, “Programming in Mathematics Classrooms: Changes in Pre-service Teachers’ Intentions to Integrate Robots in Teaching,” *Digit. Exp. Math. Educ.*, no. 0123456789, 2021, doi: 10.1007/s40751-021-00096-6.

[22] N. Calder, “Using Scratch to Facilitate Mathematical Thinking,” *Waikato J. Educ.*, vol. 2, pp. 43–58, 2019.

[23] D. G. Yildiz, A. Osmanoglu, and F. G. Alayli, “Providing a video‐case‐based professional development environment for prospective mathematics teachers to notice students’ misconceptions in measurement,” *J. Math. Teach. Educ.*, vol. 1, 2021, [Online]. Available: https://doi.org/10.1007/s10857-021-09525-0.

[24] B. D. Kane and E. S. Saclarides, “Doing the math together: coaches’ professional learning through engagement in mathematics,” *J. Math. Teach. Educ.*, no. 0123456789, 2022, doi: 10.1007/s10857-021-09527-y.

[25] W. R. Widjayanti, T. Masfingatin, and R. K. Setyansah, “Media Pembelajaran Interaktif Berbasis Animasi Pada Materi Statistika Untuk Siswa Kelas 7 Smp,” *J. Pendidik. Mat.*, vol. 13, no. 1, pp. 101–112, 2018, doi: 10.22342/jpm.13.1.6294.101-112.

[26] F. DIlling and A. Vogler, “Fostering spatial ability through computer-aided design: A case study,” *Digit. Exp. Math. Educ.*, vol. 2, no. 7, pp. 323–336, 2021.

[27] F. Pielsticker, I. Witzke, and A. Vogler, “Edge Models with the CAD Software: Creating a New Context for Mathematics in Elementary School,” *Digit. Exp. Math. Educ.*, vol. 7, no. 3, pp. 339–360, 2021, doi: 10.1007/s40751-021-00092-w.