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Development of Blended Learning Model in Mathematics for Elementary School

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Abstract

This research aims to develop a Blended Learning Model Namely Type Station Rotation for math learning in Elementary Schools. The research and development method refers to the Dick, Carey, & Carey development model. The testing was carried out in 3 stages: a trial with 1 class, a trial with 3 classes, and an expanded trial to 9 classes. The test results state that the developed learning model is effective based on the validation of learning model components, including the social system, reaction principles, support system, instructional impact, and accompanying impact. The average learning achievement is 94%, and the learning motivation level reaches 76% with a high category. Therefore, this learning model is deemed suitable for field testing.

Keywords: Blended Learning, Math Learning, Elementary School.

1 INTRODUCTION

Learning in the 21st century is the result of societal evolution over time. As society progressed from primitive to agrarian, then industrial, and now towards an informative society, the impact of rapid digitalization is evident. Since 1960, the use of computers, internet, and smartphones has significantly advanced. Society has shifted from being primarily offline to being more connected online. For instance, the number of internet users in Indonesia was 88.1 million in 2015 and has now increased to 196.7 million, constituting 73.7 percent of the population. Due to the swift pace of digitalization, schools in Indonesia cannot escape the need to keep up with these developments.

21st-century learning emphasizes student-centered education. According to Shahril et.al (2023), it is believed to be a learning process that focuses on students, providing them with opportunities to be active and think critically. In the context of 21st-century or digital learning, technology plays a crucial role. Teachers must prepare their students to navigate life in the digital era, utilizing their knowledge of subject matter, teaching methods, and technology to facilitate advanced students through creative and innovative learning experiences, both in face-to-face and virtual situations. One innovation that teachers can apply to enhance learning services in both face-to-face and virtual (online) situations is through the Blended Learning Model. Some research results supporting this perspective include studies by Kholifah et al. (2020), Attard and Holmes (2020), Charlier and Platteaux (2005), Larsen (2013), and (Kuo et al., 2014). Thus, through the implementation of the Blended Learning Model, students can be trained to be skilled and proficient in using technology

Blended learning is a combination of online-based and face-to-face learning in the classroom (conventional way). A number of technologies, applications, tools, software, and

devices can be applied into the numbers of learning problems. It offers flexibility of uses various technologies for problem solving in education (Patrick & Sturgis, 2015). Blended learning model can be implemented independently through different media such as audio, video, online discussions, quizzes, assignments, emails, and direct conversations, providing flexibility that adapts to real-world conditions (Elyakim, 2019). Another view was expressed by Prescott et al. (2018) where the implementation of blended learning also needs to be supported by the teachers' ability to develop digital technology. It is indicating that the implementation of blended learning requires support from educators. Blended learning simplifies the learning process and ensures broader accessibility.

Blended Learning is a necessity in the learning process. The implementation of blended learning makes it easier for teachers to apply learning. This is meant that using an online server such as a website can be accessed on all unlimited electronic devices. Blended learning provides support in optimally integrated communication and an easy-to-access learning experience. Blended learning is more effective in improving learning outcomes with the help of technology than online and face-to-face learning which are carried out separately (Leidl et al., 2020). Learning through blended learning provides new experiences during the learning process so that it can develop students' cognitive level (Kacetl & Semradova, 2020). The development of blended learning is able to improve the online or offline learning process, increase student independence through new model learning experiences and thereby help to achieve learning outcomes (Bock et al., 2018). According to Kadirbayeva (2022: 1118) through the implementation of blended learning, mathematics becomes easier to understand. Therefore, implementing the blended learning model in elementary schools is still relevant, especially in mathematics subjects.

Blended learning following technology era in the context of mathematics education not only provides ease of access but also enhances the attractiveness of learning. Students can interact both in-person and online, making it easier for them to understand difficult mathematical concepts (Yildirim & Vural, 2016). By learning mathematics with blended learning, students are able to interact both directly and online.This condition makes it easier for students to solve mathematical problems given by the teacher. The use of computer-based multimedia by teachers can trigger and maintain students' interest in learning mathematics (Wang et al., 2021). Overall, mathematics education through blended learning is not only a necessity but also an effective alternative to improve learning outcomes, overcome comprehension difficulties, and enhance students' interest in learning. By integrating technology, blended learning positively contributes to the learning experience and creates a more dynamic learning environment.

Blended learning in education consists of various models, with four commonly implemented models identified by Horn & Staker (2011: 4-15), there are Station Rotation, Flex, Self-Blend, and Enriched Virtual. The Station Rotation model involves students learning in different activities or learning centers, including whole-group instruction, small-group instruction, peer-to-peer activities, tasks, and individual computer or tablet work. According to Brooke (2015), the rotation model can be classified into four instructional models: station rotation, lab rotation, flipped classroom, and individual rotation.

When choosing the Station Rotation model or other blended learning methods, it is crucial to maintain open communication and continuously evaluate the effectiveness of the chosen approach. Setting clear learning goals and missions early on and informing students about these objectives are essential for the success of this new model. Without clear goals, it becomes challenging to determine the effectiveness of the learning model. In the absence of clear goals, selecting effective learning software that engages students in critical thinking and develops conceptual understanding is nearly impossible. The pedagogy and design of online learning software are equally important as the pedagogy and design of in-class learning. This rotation activity can be in the form of a class with a class, a class and computer lab, or a class outside the school, adjusted to individual and learning needs (Gusmawan, Priatna, 2020). This is also similar to research by Dakhi, et al 2020 stating that "The Rotation Model includes four sub-models, namely: Station-Rotation Model, Lab-Rotation Model, Flipped-Rotation Model, and Individual-Rotation Model".

According to Sarria and Molina from Broward College in their paper "An Innovation Sensation: Shifting Charter Schools from traditional to Blended Learning Models", the characteristics of the Rotation Model include: (1) a rotation-model implementation within a given course or subject, (2) students rotating on a fixed schedule, (3) at least one learning lab for predominantly online learning, while additional classrooms house other learning modalities, and (4) learning in the lab supervised by a paraprofessional supervisor. Thus, utilizing to these characteristics of Station Rotation model in research provides a solution for addressing differences in students' learning abilities. Students can be divided into several small groups, with each group learning under the guidance of a teacher, while other groups work on tasks individually or collaboratively, and the next group studies using internet/computer media. These learning activities occur in rotational basis in one classroom, scheduled according to an optional timetable.

2 RESEARCH METHODS

The research conducted utilizes of the Research and Development method, which is a method used to create a specific product and test its effectiveness (Sugiyono, 2015:297). The product generated in this development research is the Station Rotation Type of Blended Learning model for Elementary Schools. The development in this study adapts the development model from Dick, Carey, & Carey (cited in Gall, Gall, & Borg: 2007). The procedures in this development model include identifying learning objectives, formulating, developing designs, testing, and revising. The trial subjects for this research are fourth-grade students at Panglima Besar Jenderal Soedirman Islamic Elementary School in East Jakarta, consisting of 9 classes with a total of 215 students. The analysis of learning model's components includes syntax, social system, reaction principles, as well as instructional and accompanying impacts.

3 RESULT AND DISCUSSION

3.1 Development of the Station Rotation Blended Learning Model

The developed learning model in this research is Blended Rotation model with a specific type called Station Rotation for fifth-grade math learning in elementary school. The development procedure includes preliminary study and needs analysis, learning objectives analysis, indicator analysis, development, and assessment.

3.1.1 Preliminary Study & Needs Analysis

This activity begins with a search for references/literature regarding research results on the implementation of Blended Learning in elementary schools. Based on the search results, only found studies on Blended Learning implementation in elementary schools abroad, with no findings in Indonesia. Subsequently, interviews were conducted with one of the Teachers Council Head (*Ketua Dewan Guru*). The interview results concluded that the implementation of Blended Learning in elementary schools is limited as not much implementation, at least for private elementary schools which have complete facilities, there were already those who implemented it, but for State Elementary Schools it seemed there was none at all. This statement is strengthened by the results of a survey from 12 teachers (from different schools) who have state employee status and teach in state elementary schools which also show that none of them have implemented Blended Learning in their respective schools. Some teachers were even unfamiliar with the term. From this data, the analysis revealed that the implementation of Blended Learning in Indonesian elementary schools is still very minimal.

The lack of insight into this matter could impact on educational progress. Basically, there are already activities to integrate information and communication technology (ICT)

for learning in elementary schools, but the majority of students only use ICT as a learning resource. Based on this analysis, the researcher concluded to implement and develop Blended Learning in elementary schools and choose one model from various types determined through literature review. Staker & Horn (2012) mentioned that the popular Blended Learning model applied abroad is the Rotation Model with the Station Rotation type. After further exploring into the theory, its implementation, advantages, and disadvantages, researcher decided to choose this type as the starting point for Blended Learning research in elementary schools. One prominent advantage of this type is its use of only one classroom and making it less complicated to implement.

3.1.2 Material Analysis

Material analysis was conducted by examining the curriculum in elementary schools, adjusted to the trial period. The national curriculum of 2013 was implemented at the trial location. The researcher, together with teachers, reviewed, determined, and developed the material based on the syllabus and theme books (teacher's and student's books) provided by the government. The analysis resulted in the decision to focus on the Fraction topic.

3.1.3 Learning Indicator Analysis

After examining and determining the material, the researcher and teachers formulated the learning objectives, which also served as the basis for designing the Learning Implementation Plan to be tested on fifth-grade students.

3.1.4 Product Development

At this stage, the researcher designed and developed the product, including: (1) the Blended Learning Station Rotation model for math learning; (2) teaching tools such as Learning Implementation Plans, student worksheets, quizzes, learning activity instructions at each station, and (3) assessment instruments. The draft of the designed learning model was reviewed by an expert, a lecturer specializing in instructional design, for validity. The validation results confirmed that the learning model and its tools were valid and met the criteria, making them suitable for testing

3.2 Results of Product Testing and Revision

The product testing consists of 3 stages: stage 1 (testing in 1 class), stage 2 (testing in 3 classes), and stage 3 (expanded/field testing in a total of 9 classes). Stages 1 and 2 are conducted to evaluate the implementation of the learning model through observation and interviews with the class teachers who applied it. Stage 3 is for measuring the feasibility of the learning model and its tools.

3.2.1 Testing in 1 Class and Revision

This testing is carried out to see if the learning model and its tools align with expectations. The results of the first trial identified data from observations and interviews with class teachers that needed attention and revision, including: (1) The allocation of time in the lesson plan needs to be reviewed to avoid discrepancies in learning activities among each station; (2) Technical instructions for learning activities need to be more prominent and engaging for students, and the sequence of learning activities needs to be clearer.

3.2.2 Testing in 3 Classes and Revision

From the trial of the learning model and its tools in 3 classes, observations and interviews with teachers yielded the following conclusions: (1) The timing implementation is now appropriate based on feedback from the first trial; (2) The types of learning activities at each station are more engaging for student participation; (3) One teacher suggested that implementing this model in class may require at least 2 teachers.

3.2.3 Expanded Testing and Improvement

Stage 3 or field testing was conducted to collect the following data: (1) validation results of the Learning Model components; (2) validation results of the Lesson Implementation Plan (RPP); (3) validation results of Student Worksheets/Activities; (4) practicality results of the Learning Model by teachers. The Validation Results of Blended Learning Model Components, Station Rotation Type from the field trial results, validation results of the Blended Learning Model components were obtained as presented in the following table:

Table 1. Validation Results of Learning Model Components

Component	Average Score by Validator	Criteria
Syntax	13	Very Valid
Social System	13,8	Very Valid
Reaction Principles	10	Very Valid
Accompanying and Instructional - Impact	12	Very Valid

The average score from the validator indicates a very valid criterion; therefore, it can be concluded that the developed model meets all the established criteria.

3.2.4 Validation of Lesson Plan Implementation

The assessment of the lesson plan instrument used an evaluation sheet that was deemed suitable for use. The validation results of the lesson plan are presented below.

Table 2. Lesson Plan Validation Results Top of Form

Validator	Score	Criteria
1	4,58	Very Valid
2	4,42	Very Valid
3	4,83	Very Valid
4	4,33	Very Valid
5	4,67	Very Valid
6	4,08	Valid
7	4,08	Valid
8	4,25	Very Valid
9	4,00	Valid
Average Score	4,36	Very Valid

From the above table, it can be analyzed that the average score from the 9 validators is 4.36, falling into the score interval "X > 4.2', which means it meets the criteria and is considered "very valid". Based on the table, it can be concluded that the ease/practicality of the developed learning model, after being tested, was deemed very practical by teachers and met the minimum practicality requirements. The level of ease/practicality of the learning model according to 215 students is as follows:

Table 3. Practicality of the Learning Model by Students

Aspect	Practicality Level
Ease in understanding instructions	90,81%
Ease in carrying out learning activities	89,80%
Timeliness in completing tasks	73,20%
Ease in rotating between stations	95,7%

3.3 The Effectiveness Station Rotation Type of Blended Learning Model in Mathematics Learning for Elementary School

In order to assess the effectiveness of the developed learning model, the survey results of students' learning motivation involved in the implementation of the Blended Learning Station Rotation type model are examined in relation to the learning outcomes at the end of the program. A survey involving 215 students was conducted to determine their learning motivation in Blended Learning Station Rotation. Data processing revealed that the overall average motivation level of students participating in Blended Learning was 76%, categorized as "high". This is consistent with the findings of Pimpiban (2021), where questionnaire results indicated positive student attitudes toward the station rotation model, finding the learning to be fun and enjoyable, fostering motivation for learning beyond the classroom.

Additionally, a survey was conducted to understand students' feelings about the implementation of the Blended Learning Station Rotation model. Out of the 215 surveyed students, 200 expressed satisfaction with the learning approach, 8 did not respond, and 1 did not like it.

Regarding the Posttest, conducted at the end of the Blended Learning Station Rotation implementation to assess students' understanding/cognition, the Minimum Completion Criteria set by the mathematics teacher is 75. The research results align with previous studies (Banyen et al., 2016; Obiedat et al., 2014; Bi & Shi, 2019) indicating that blended learning has proven to influence student learning outcomes positively, facilitating classroom learning due to its ease of access, flexibility, and independence (Divayana, 2019; Rasmitadila et al., 2020).

Based on the correlation analysis between students' learning motivation in Blended Learning Station Rotation and their post test results, a correlation coefficient of 0.734 was obtained with a 5% significance level. Therefore, it can be concluded that there is a strong correlation between students' learning motivation during Blended Learning and their learning outcomes. Consequently, the Blended Learning Station Rotation model can be considered effective. This finding aligns with Govindaraj & Silverajah (2017), emphasizing that the station rotation type of blended learning can enhance learning outcomes, improve student performance (Ayob et al., 2020), and boost students' intrapersonal intelligence (Ambarli et al., 2020). Additionally, Christina et al. (2019) found that blended learning through the station rotation type enhances students' higher-order thinking skills.

Development of Blended Learning Station Rotation Model Products The development of the learning model in this study refers to the Dick, Carey & Carey development model for learning model development procedures and adapts the Blended Learning Station Rotation model from Stake & Horn. The focus of the learning model development in this study is specifically on developing the syntax of mathematics learning with the Blended Learning Station Rotation model.

3.3.1 Steps of the Blended Learning Station Rotation Model

Step 1: Classroom Setup and Preparation of Learning Tools The process begins before the learning activities start, where the teacher arranges the classroom into several stations, or learning areas, based on the needs of the lesson. For example, a class can be divided into four stations. The teacher must consider the placement of the stations, especially for online learning, to avoid issues with internet connectivity. During the first trial, the online learning station faced internet disruptions due to being close to the wall. The solution was to have students move their seats slightly away from the wall to improve the connection. Additional tasks during this step include preparing materials such as station names, activity instructions, learning media, resources, and worksheets. The teacher places or attaches the names and instructions at each station so students can read them easily. While the teacher will verbally explain the activities at the start, having the instructions visible at each station helps students understand their tasks more clearly. If online media is used, the teacher may bring portable devices like tablets and distribute

them to students when they are ready. Worksheets are prepared for stations that require them.

Step 2: Organizing Students, the teacher forms groups according to the number of stations, taking into account students' varying backgrounds. The teacher should be aware of which students may struggle with technology, their cognitive abilities, and their personalities. A well-balanced group includes students with diverse skills and experiences, helping to foster emotional intelligence and self-confidence. Time management is also essential for the smooth running of the model. Ideally, each station should have a learning activity lasting between 45 minutes and 1 hour. Students should already be seated at their assigned stations before the lesson begins.

Step 3: Introducing the Topic, before starting the activities at each station, the teacher introduces the topics to be studied, ensuring they align with the 2013 national curriculum for elementary schools. The material covered at each station is based on what the teacher has introduced, with only the type of activity differing. At the end of the introduction, the teacher explains the specific activities at each station and reminds students to read the instructions at each station before moving to the next after completing their rotation.

Step 4: Learning at Stations, Once the introductory material is provided, students begin learning at each station according to the instructions. During the first trial, the teacher and researchers designed various activities, such as discussions, reading, drawing, coloring, observing, role-playing, online learning, solving math problems, and writing math explanations. The combination of activities ensures students remain engaged. While students work, the teacher may stay at one station to offer extra help or move between stations to monitor and support students. The teacher also observes students' behavior during this time.

Step 5: Presentation, after finishing their activities, students are asked to present their work to the class. The teacher then gives feedback and rewards for their efforts.

Step 6: Reflection and Evaluation, the teacher leads a reflection session, asking students to recall the material learned at each station and discuss how the learning impacted them. The teacher also encourages students to reflect on their group work and identify any challenges they faced.

3.3.2 Social System of Blended Learning Station Rotation

In this learning model, the social system developed involves both teacher-student and student-student interactions. During the group formation process, the teacher manages the social system to maintain order **in** the students' activities. The teacher's role changes throughout the learning process. At the start, the teacher acts as a source of learning by providing introductory material. As the lesson progresses, the teacher shifts to the role of facilitator, guide, and evaluator. During the middle phase of learning, the teacher evaluates students by observing their work. Throughout the station-based learning and presentation activities, students play a crucial role in managing the social system. They engage with each other to complete group learning tasks at each station, whether the activities are done in groups or individually.

3.3.3 Reaction Principles of Blended Learning Station Rotation

At the start of the activity, the teacher serves as a learning source by delivering the material, similar to traditional teaching, to introduce the subject matter. In the next phase, the teacher provides direct guidance at one of the stations if students need extra help, ensuring they stay on track when working with more complex material. Throughout the implementation of this learning model, the teacher’s role in offering guidance remains essential. The teacher also observes and evaluates students' attitudes during group discussions and assesses each student’s contribution to their groups. If students encounter issues during online learning, such as slow internet connections or problems with their tablets, the teacher addresses these challenges immediately. Special attention is also needed at the online learning station, where some students were found using the online media for purposes other than intended.

3.3.4 Supporting System of Blended Learning Station Rotation

This learning model requires a more extensive support system compared to other models, especially for implementation in elementary schools. A key requirement is online learning media, including internet access and devices. In this study, tablets were used as devices due to their practicality and portability. Blended learning is an evolution that stems from careful planning and effective internet use (Banggur et al., 2018). The study also confirms that technology such as computers, the internet, and mobile devices are effective tools that help both teachers and students, providing alternative methods for teaching and learning (Guzer & Caner, 2014). From a pedagogical perspective, the blended learning model fosters active, student-centered learning environments and promotes positive interactions during the learning process (Blankson et al., 2014). This approach also amplifies the advantages of technology in education. Additional support materials include student worksheets, which help enhance students' skills. These worksheets consist of drawing/coloring sheets, observation activity question lists, and group discussion result sheets. Student books are also necessary as reference sources to help students explore information more deeply.

3.3.5 Instructional and Supporting Impact of Blended Learning Station Rotation

The learning objectives set for students are successfully met according to the established basic competencies. Additional effects observed include students becoming more comfortable with participating in discussions after receiving guidance at the discussion station, even though some initially struggled with understanding their roles within the group. Students also build self-confidence by presenting in front of the class and learning to stay focused on their tasks at each station to complete them on time. The variety of activities at each station greatly enhances cooperation and communication among students, creating an active and supportive learning environment. Student feedback on this learning model is highly positive, with 94% expressing that the rotation and online learning activities are both exciting and enjoyable.

3 CONCLUSION

This model is an adaptation of the Blended Learning approach, specifically developed into the Station Rotation type for elementary school mathematics. The validation results show that the model is appropriate for field testing, based on the evaluation of several components of the learning model, such as its structure, social system, reaction principles, support systems, instructional impact, and additional effects. The motivation of students using this model is considered "high," as indicated by the motivation data collected. Furthermore, the learning outcomes demonstrate a strong completion rate for fraction lessons. The correlation between learning motivation and student performance suggests a significant relationship between the students' motivation and their academic results during the implementation of the Blended Learning Station Rotation model in mathematics. However, some challenges were observed in the field. First, teachers need time to adjust to this model, especially since the rotation system and online media have not been previously implemented in these classes. While one class did use the rotation system, it was not integrated with online learning. Second, determining the appropriate time allocation for the rotation system requires further study, particularly in relation to the types of activities at each station. Third, teachers are not fully familiar with the various learning applications used in online education. Overall, while this model shows potential as an effective learning strategy, it requires careful attention to teachers' adaptation to the system and the use of online learning technologies. With additional research and proper support, it has the potential to enhance the quality of mathematics education in elementary schools.

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