Development of Interactive Learning Media for Congruence Material as a Preparation Means for Mathematics Olympiads

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Abstract

The National Science Olympiad (OSN) is a prestigious Olympic competition in Indonesia. However, in preparation, there are many obstacles experienced by certain educational institutions. These obstacles include the lack of teachers who focus on teaching mathematics Olympiad material. This condition requires teachers to be extra in preparing material and practice questions. Based on these problems, the interactive learning media "MathSyik" was developed which makes it easier to prepare for mathematics olympiads, especially on congruence material. The "MathSyik" application is equipped with material in the form of videos, practice questions, and quizzes with points and time features. This research was prepared using the 4D model R&D method. Based on the validation results of two material experts and two media experts, a score of 95.5% was obtained by the media expert and a score of 80.63% by the material expert, both of which were declared very valid and valid. Thus, the learning media "MathSyik" can be used as preparation material for mathematics olympiads on congruence material.

Keywords: *Mathematics Olympiad; Learning Media; Congruence.*

Abstrak

Olimpiade Sains Nasional (OSN) merupakan kompetisi olimpiade yang bergengsi di Indonesia. Namun, dalam persiapannya terdapat banyak kendala yang dialami oleh lembaga pendidikan tertentu. Beberapa kendala tersebut diantaranya adalah belum adanya guru yang fokus mengajar materi olimpiade matematika. Kondisi tersebut menuntut guru untuk lebih ekstra dalam menyiapkan materi serta soal latihan. Berdasarkan permasalahan tersebut, dikembangkan media pembelajaran interaktif “MathSyik” yang memudahkan persiapan olimpiade matematika, utamanya pada materi kongruensi. Aplikasi “MathSyik” dilengkapi dengan materi dalam bentuk video, latihan soal, serta kuis dengan fitur poin dan waktu. Penelitian ini disusun menggunakan metode R&D model 4D. Berdasarkan hasil validasi dua ahli materi dan dua ahli media didapatkan skor 95,5% oleh ahli media dan skor 80,63% oleh ahli materi, keduanya dinyatakan sangat valid dan valid. Dengan demikian, maka media pembelajaran “MathSyik” dapat dijadikan sebagai bahan persiapan olimpiade matematika pada materi kongruensi.

Kata Kunci: Olimpiade Matematika; Media Pembelajaran; Kongruensi.

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INTRODUCTION

The National Science Olympiad (OSN) is one of the prestigious events for students in Indonesia. In this competition, the best students who are interested in science from the district and provincial levels are selected (Wahyu Iskandar et al., 2023). Wahyu Iskandar et al. (2023) also emphasized that one of the objectives of holding OSN is as an effort so that students can master science and technology well. In addition, Arifin (2020) also explained in his article about other objectives of holding OSN. Arifin explained that OSN is one of the government's efforts, especially the Directorate General of Primary and Secondary Education of the Ministry of Education and Culture, to develop several skills and knowledge possessed by students. Furthermore, Arifin explained that the development of these skills and knowledge includes aspects of knowledge or cognition, the development of honest character, orderly according to applicable regulations, competitiveness, not giving up easily, creativity, and an attitude of love for the country. In addition, OSN is also a government effort to equalize achievements and develop the potential of the nation's children into a talented and characterful generation (*National Science Olympiad (OSN) SMA / MA / Equivalent*, nd). It is hoped that with the various goals achieved, students can represent Indonesia in international-level olympiad events.

OSN has the goal of supporting the development of students' potential in various aspects of life. Therefore, it is important to make thorough preparations to achieve the goals of implementing OSN optimally. Far from the goals of OSN above, it turns out that there are several difficulties experienced by students and educational units in implementing OSN preparations. Based on an article written by Ikashaum et al. (2021) explains that there are educational units in Lampung that have not provided special teachers to provide OSN coaching. Furthermore, Ikashaum et al. (2021) also explain that teachers who provide OSN training are class teachers or subject teachers who still have to divide their time to teach in class. This condition is also the same as the article written by Wahyu Iskandar et al. (2023). Based on these conditions, teachers find it difficult to divide their time between teaching in class or providing OSN guidance to students.

Another difficulty is also explained by Wahyu Iskandar et al. (2023) in his article. Wahyu Iskandar et al. (2023) explained that in implementing OSN guidance, teachers also have to work extra hard to create or find complete OSN-type materials or questions. The existence of OSN-type materials and questions can add to students' experience in solving mathematics olympiad questions. By deepening the OSN-type materials and questions, students will become accustomed to solving mathematics olympiad-type questions. Zalukhu et al. (2023) Emphasized that experience in solving olympiad-type questions will affect the performance of olympiad participants. In this case, the difficulty of teachers in preparing materials and mathematics olympiad-type questions will affect students' performance in mathematics olympiads. Coupled with the burden of teachers who also have to prepare learning materials in class, the OSN guidance process will not run optimally if this condition continues. If the guidance process does not run optimally, then the purpose of OSN cannot be felt optimally by students. Therefore, to overcome the above problems, it is necessary to add appropriate teaching materials to support the achievement of OSN goals optimally.

One of the teaching materials that can be added to the learning process is learning media. In this study, the development of learning media in the form of the "MathSyik" application was carried out which facilitates students to get OSN guidance easily, especially on congruence material. Congruence material is one of the materials tested in the mathematics olympiad at the high school/equivalent level. Several previous studies have also developed learning media as a means of preparing for the mathematics olympiad. Some of these studies include research conducted by Krisetiawan et al. (2023). Krisetiawan et al. (2023) have developed *digital book media* as a means of preparing for the mathematics olympiad at the elementary school level. Unlike the research conducted by Krisetiawan et al. (2023), this study will develop an interactive application that is specifically for the high school/equivalent level. In addition, other similar research was also conducted by Wijayanti (2020). Wijayanti (2020) has developed a mathematics module equipped with questions and solutions of the olympiad type. In contrast to the research conducted by Wijayanti (2020), this study did not develop a

mathematics module, but an interactive application that contains several menus and features in it. In addition, in the search for researchers, no one has developed interactive learning media as a means of preparing for mathematics olympiads at the high school/equivalent level.

There are several menus in the "MathSyik" application, including the material menu, practice questions, and quizzes. With this menu, teachers do not need to look for material or questions of the mathematics olympiad type that will be used in the OSN guidance process. One of the advantages of the "MathSyik" application is the choice of learning videos in the material menu section. The videos presented are about the concept of understanding, congruence properties, Fermat's theorem, Wilson's theorem, and the derivation of the formula. It is hoped that this feature will make it easier for students to learn congruence material. In addition, the "MathSyik" application also has a quiz menu equipped with a time limit feature. This feature is based on conditions in the olympiad competition which also pays attention to time in awarding points. This is supported by an article written by Wahyu Iskandar et al. (2023) explaining that if there are conditions where two students have the same points, then the next consideration is based on the time used to work. Various menus and features in the "MathSyik" application can answer some of the difficulties that have been described above. Therefore, it is hoped that with several menus and features in the "MathSyik" application, students' OSN preparation can be maximized, so that OSN goals can also be achieved optimally.

Based on the description above, the purpose of this study is to develop an interactive learning media called "MathSyik" which is used in the preparation of the mathematics olympiad, especially in the congruence material. There are several innovations and menus in the "MathSyik" learning media that are adjusted to the needs of students and teachers in the preparation of the mathematics olympiad. It is hoped that with various innovations and menus, it can optimize the preparation of students' mathematics olympiad. Through the "MathSyik" learning media, it is also hoped that teachers can provide maximum preparation to students. With these hopes, the objectives of OSN can be achieved well.

RESEARCH METHODS

The research method used is Research & Development (R&D). Sugiyono (2018) explains that the R&D method is a research method that aims to develop or create a particular product, as well as to test the effectiveness of the product being developed. Meanwhile, Okpatrioka (2023) also explains that the R&D method is a series of processes or steps that aim to develop a new product or improve a product that has been previously developed. In addition, Fayrus & Slamet (2022) also explain a more specific definition of R&D in the educational aspect. Fayrus & Slamet (2022) explain that R&D research in education focuses more on developing a product in education and validating the product. In line with several definitions of R&D, this study will develop the "MathSyik" learning application which is used as a means of preparing for the congruence material mathematics olympiad. However, in this study only development and expert validity testing were carried out, no product effectiveness testing was carried out. The model used in this study is the 4D model which consists of the define, design, develop, and disseminate stages.

At the definition stage, the researcher identified problems in the preparation of the mathematics olympiad at the high school level. The problem identification process was carried out by searching for previous sources through previous studies. At this stage, the researcher also formulated solutions based on the problems found.

At the design stage, researchers design the learning application design. The design process is carried out starting with the menu and features to be developed, determining the application theme, and determining the supporting media to be used to develop the learning application.

In the development stage, researchers develop applications based on the design or plan that has been made in the previous stage. The development process is carried out using Adobe Animate software. After the development process, the learning application that has been developed is then tested for validity by material experts and media experts. In total, four experts carry out validation, two of whom are material experts and two others are media experts. After testing the level of

product validity, calculations are then carried out based on the following guidelines (Sugiyono, 2018) :

Table 1. Validity Measures of Material & Media

Interval	Criteria
0% - 20%	Invalid
21% - 40%	Invalid
41% - 60%	Quite Valid
61% - 80%	Valid
81% - 100%	Very Valid

After being declared valid by material experts and media experts, the learning application that has been developed is then disseminated. The dissemination process is carried out through the MGMP mathematics forum of the MA Kudus Regency. The dissemination process is also equipped with a brief explanation of the purpose, uses, advantages, and disadvantages of the application from the researcher.

RESULTS AND DISCUSSION

To maximize the preparation for the National Science Olympiad (OSN) in mathematics, researchers developed learning media in the form of an application called "MathSyik". Learning media functions as a channel for messages that can stimulate attention, interest, thoughts, and feelings in a learning activity to achieve the desired learning goals (Kristanto, 2016). The material or message to be conveyed through the "MathSyik" media or application is related to congruence material which is packaged with several interesting and useful features in preparing for the mathematics olympiad. This application was developed through 4 stages, namely definition, design, development, and distribution. In general, the definition stage is related to the collection of all information that is useful in developing a product (Irnando et al., 2020). At this stage, researchers analyze the needs of students, educational institutions, and educators in preparing for the National Science Olympiad (OSN) in mathematics. This process is carried out through previous research literature related to the

preparation of the National Science Olympiad (OSN) in mathematics. Through this process, data was obtained that several schools had not prepared teachers specifically to provide OSN guidance to students (Ikashaum et al., 2021) & (Wahyu Iskandar et al., 2023). Teachers who provide OSN guidance are required to divide their time between teaching subjects in class and guiding students who want to take part in OSN (Ikashaum et al., 2021) & (Wahyu Iskandar et al., 2023). In addition, researchers also found conditions where teachers had to work extra hard to prepare materials and questions before carrying out OSN guidance to students (Wahyu Iskandar et al., 2023). The process of finding these materials and questions will take a long time and is at risk of being less relevant to the material tested in the OSN process. So based on this description, it is important to involve teaching materials that can facilitate OSN preparation.

After the definition stage, the next stage is designing. In general, this design stage is related to determining the design of the product to be made (Irnando et al., 2020). In overcoming the various difficulties that have been described above, a learning application will be developed that facilitates the preparation of the OSN mathematics, especially on the congruence material. The application is named "MathSyik". The "MathSyik" application was developed based on several needs analyses above. There are several points of need used in the design process, including developing teaching materials that can facilitate students to prepare for OSN in terms of material and example questions, quizzes to hone students' abilities in solving Olympiad-type questions and providing time for the teaching materials developed. At this design stage, the researcher designed the application display in the form of background design, selection of writing fonts, selection of image elements, and selection of colors. In the first stage, this was done using the Canva application.

After the design stage was successfully carried out, the researcher then continued to the development stage. The development stage was carried out by activating several features in the learning application. The activation process uses various coding carried out through the Adobe Animate application. Some of

the elements that are activated include the next-previous button, scoring, time features, and learning video buttons.

There are several menus and features in the "MathSyik" application to support students' preparation for the mathematics olympiad on congruence material. The menus provided include the material menu, practice questions, and quizzes. The following is a description of some of these menus:

Figure 1. MathSyik Application Material Menu

In the material menu, complete congruence material will be provided, starting from the definition, properties, and theorems. The existence of this material feature provides students with a deep understanding as well as provisions for solving mathematics olympiad questions. In an article written by Ansari et al. (2023), it is explained that one of the challenges faced by students in preparing for the mathematics olympiad is the lack of deep understanding of a material. With this material feature, it can provide students with a deep understanding of congruence materials which are one of the materials in the mathematics olympiad. This menu also provides a video button that will direct students to the YouTube application to listen to the material in audio-visual form. The videos presented are related to the origins of concepts, properties, and theorems in the congruence material. In addition, this application also provides video tutorials on solving Olympiad-type questions combined with an explanation of the concept of congruence. It is hoped that with several videos presented, can encourage students' enthusiasm for learning. This hope is also supported by research by

Isnaini et al. (2023) who explained based on the results of their study that the use of videos in mathematics learning helps students to be more independent and enthusiastic, so that it can support the effectiveness of learning. In addition, Hadi et al. (2021) also concluded that the presence of video tutorials in mathematics learning can make it easier for students to understand the material presented. The purpose of this material menu is to make it easier for students to learn congruence material without using other sources.

Figure 2. "MathSyik" Application Practice Questions Menu

In the practice questions menu, several questions and solutions for the congruence material of the mathematics olympiad are presented. The goal is for students to be familiar with the congruence material of the mathematics olympiad type and how to solve them. The existence of this feature is based on the conditions found by Suastika & Suwanti (2019). Suastika & Suwanti (2019) explained that there are still many students who do not know the procedure for solving mathematics olympiad questions. It is hoped that the practice questions and solutions provided can be understood in depth by students, making it easier to solve similar olympiad questions with similar procedures. The solution to the questions in this practice questions menu is equipped with a ScrollPane feature that can make it easier for students to listen gradually.

Figure 3. "MathSyik" Application Quiz Menu

In the quiz section, several mathematical olympiad-type questions are presented on the congruence material which can be used as material to test students' abilities. In addition, with this quiz feature, students can get used to solving olympiad-type questions. Latifah (2018) explained that students' habituation in solving olympiad-type questions can make it easier and provide an overview of working on questions during the math olympiad competition. This section is also equipped with a time feature that can provide a time limit for students when working. If students cannot complete each question within five minutes, the question will automatically move to the next section. This feature will make it easier for students to manage their time in the work process. Effective time management will also have a good impact on points in the math olympiad competition (Wahyu Iskandar et al., 2023). In addition, the time limit imposed on completing practice questions can also help improve student learning outcomes (Puryati, 2017). It is expected that some of these advantages can support the OSN training process optimally for students. In addition, this menu is also equipped with a point feature that will increase if students answer each question correctly. The point feature will help the student evaluation process.

At this stage, the researcher also published the application that has been created. After the application is published, the researcher then conducts a product validity test for material experts and media experts. In total, there are two material experts and two media experts who will provide an assessment. The assessment is

carried out using a validity questionnaire. From the testing process, the results of the media expert validity test are as follows:

Table 2. Expert Validity Test of "MathSyik" Application Media

Rated aspect	Validator 1	Validator 2
Learning Media Display	14	15
Text Format Letters	10	8
Color Selection	17	20
Buttons/Navigation	9	10
Functional Buttons	10	10
Application Identity	8	10
ScrollPane Usage	15	15
Ease of Use	10	10
Total	**93**	**98**
Score	$\frac{93}{100} \times 100\% = 93\%$	$\frac{98}{100} \times 100\% = 98\%$
Average	**95.5%**	

From Table 2, it is known that based on the media expert validation test, a score of 93% was obtained by validator 1 and 98% by validator 2. If the average calculation is carried out, a score of 95.5% is obtained. This score is categorized as very valid based on the measurements in Table 1.

In addition to conducting validity tests on media experts, researchers also conducted validity tests on material experts. The following are the results of the material expert validation test:

Table 3. Validity Test of Material Experts for the "MathSyik" Application

Rated aspect	Validator 1	Validator 2
Legibility	10	7
Suitability for Mathematical Olympiad Preparation	13	12
Clarity	9	6
Material Format	10	6
Relevance of Practice Questions	10	6
Quiz Quality	10	6
Benefit	15	9
Total	**77**	**52**
Score	$\frac{77}{80} \times 100\% = 96.25\%$	$\frac{52}{80} \times 100\% = 65\%$
Average	**80.63%**	

From Table 3, it is known that the results of the validation test by validator 1 obtained a score of 96.25% and validator 2 65%. From this score, the average calculation was then carried out and a score of 80.63% was obtained. Based on Table 1, the average score is categorized as very valid. Thus, the "MathSyik" application has been categorized as valid by material experts as a means of preparing for the congruence material of the mathematics olympiad.

After the “MathSyik” learning application was declared valid by material experts and media experts, the next step was dissemination or distribution. At this stage, the researcher disseminated the “MathSyik” application to MA mathematics teachers in Kudus Regency. The dissemination process was conveyed through the MGMP mathematics forum of MA Kudus Regency.

Based on the results of the validity level calculation, the "MathSyik" learning media was declared very valid by material experts with a score of 95.5% and was declared valid by media experts with a score of 80.63%. Thus, the "MathSyik" learning media can be used in mentoring high school/equivalent mathematics olympiad training on congruence material. The "MathSyik" learning media is a digital learning media that involves the use of technology in the learning process. The use of digital media in the learning process has a positive impact on the learning process. This statement is also supported by Nurcahyani et al. (2021). Nurcahyani et al. (2021) explain that the use of technology or digital media in the learning process can produce a more interesting and innovative learning atmosphere. With this uniqueness, it will have a positive impact on the attitudes of students in the learning process (Nurcahyani et al., 2021). Wibowo & Pratiwi (2018) also supports the research results Nurcahyani et al. (2021) which explains that the use of digital teaching materials creates an interesting response for students and is preferred compared to learning using conventional teaching materials. In addition, the positive impact of using digital teaching materials is also explained by (Smaragdina et al., 2020). Smaragdina et al. (2020) explained that the use of digital teaching materials in the learning process is in accordance with the characteristics and learning styles of the current generation of students. The suitability of student characteristics with the teaching materials used will

increase student interest in learning and not cause boredom in learning. It is hoped that with several positive impacts of using digital teaching materials on the "MathSyik" learning media, it can support the preparation process for students in the congruence material mathematics olympiad.

In addition to having a positive impact on students' attitudes in preparing for the congruence material of the Mathematics Olympiad, the existence of teaching materials can also support students' understanding of the congruence material. Aisyah et al. (2020) explained that teaching materials are used as one of the requirements to achieve an effective and efficient learning process. Aisyah et al. (2020) also explained that without teaching materials, teachers will have difficulty in achieving the effectiveness and efficiency of the learning process, as well as difficulty in achieving learning objectives. The importance of teaching materials in supporting the learning process is also emphasized by Belawati (2003) who explains that teaching materials have several functions in helping students and educators in the learning process. Some of the roles of teaching materials for students include helping students to learn independently, helping students in determining the speed of learning, and helping students in determining the sequence of learning systematically (Belawati, 2003). Some of the roles of teaching materials for teachers include making teachers facilitators in learning, saving time, and making learning more effective and interactive (Belawati, 2003).

Of the several roles of teaching materials and teaching materials in the learning process, the "MathSyik" learning media is one of the solutions to solving the problems that have been described. Wahyu Iskandar et al. (2023) explained that teachers still have difficulty in preparing teaching materials as preparation for the mathematics olympiad. Belawati (2003) explained that one of the roles of teaching materials is to help teachers provide effective and efficient learning. In this case, teachers will find it easier to prepare students to take part in the mathematics olympiad through the "MathSyik" learning media, especially on congruence material. In addition, Belawati (2003) also explained that one of the roles of teaching materials in the learning process is to help students learn more independently. In preparation for the mathematics olympiad, students'

perseverance in learning is one of the keys to success. Students cannot spend their full time with the teacher. Students' efforts to learn independently can help them prepare for the mathematics olympiad better. Through the “MathSyik” learning media, students can prepare for the mathematics olympiad more independently, especially on congruence material.

In the previous section, it has also been explained that the “MathSyik” learning media has several menus and advantages. Some of the menus available on the “MathSyik” learning media include the material menu, practice questions, and quizzes. The advantages of the “MathSyik” learning media include the scrolling display in the practice questions section, the timer in working on the quiz, and the score when the quiz is finished. However, from these advantages, there are several other disadvantages to the “MathSyik” learning media. Some of these disadvantages include the limited quantity of practice questions and quizzes. In fact, in preparation for the mathematics olympiad, not only do you need practice questions that have high difficulty, but you also need relatively large amounts of practice questions. From these disadvantages, the researcher suggests that further researchers can add a relatively large number of practice questions and quizzes so that they can be used as more intensive practice materials for students.

CONCLUSION

The National Science Olympiad (OSN) is one of the prestigious events that is useful in developing students' abilities in various aspects of life, especially in mathematics. However, there are several problems in preparing for the mathematics olympiad. In the process of preparing for the mathematics olympiad in several schools, teachers have difficulty finding materials and practicing olympiad-type questions. In addition, several schools have not prepared teachers who specifically handle the preparation of the mathematics olympiad. Teachers assigned to guide students who will take part in the mathematics olympiad must be able to divide their time with teaching activities in the classroom. With these various problems, it will disrupt the process of preparing for the mathematics olympiad. To overcome these problems, researchers took the initiative to develop

the "MathSyik" learning application. The "MathSyik" application provides a summary of congruence material, practice questions, and quizzes that can be used in preparing for the mathematics olympiad. The "MathSyik" learning application has been tested on material experts and media experts.

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