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Development of STEM-Based Distance and Time Speed Tool to Improve Critical Thinking Ability of Elementary School Students

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Abstract

This research develops teaching aids for mathematics learning materials of distance, speed, and time. The making of this teaching aid is based on the needs of innovative learning, the needs of students, the results of previous research on the problem of learning difficulties in terms of speed, distance, and time. The results of the initial observation of the need for teaching aids stated that mathematics learning materials about distance, speed and time needed the right teaching aids. The teaching aids developed are designed as attractive as possible to improve independent learning at school and home. This learning aid is made interesting with the Tamiya 4D game method that is suitable for elementary school students. The research and development method used is the ADDIE Model (Analysis, Design, Development, Implementation, Evaluation) which is a learning device development model. This model was developed by the ADDIE development model which consists of 5 main stages, namely: (1) analyzing (2) design (3) developing (4) implementing, and (5) evaluating. This method and model was chosen because it aims to produce a product in the form of Tamiya props material speed, distance, and time. The product that was developed was then tested for feasibility with validity and product trials to determine the extent to which students' critical thinking was developed after learning using Tamiya props on STEM-based speed, distance, and time-based materials. The results of the validation of material experts, linguists, and media experts show that the evaluation results show the quality of teaching aids by material experts is classified as a very good category with a score of 82, 44%. The quality of teaching aids by linguists is classified as very good with a category score of 87.75%. The quality of teaching aids by media experts is classified as very good with a category score of 85%. The results of the teacher's response test are included in the very good category with a score of 86.93%. Based on the percentage of score acquisition, it can be concluded that the teaching aids for solving problems on questions about distance, speed, and time materials are appropriate for use in learning activities.

Keywords: *STEM-Based Mathematics Teaching Aids; Tamiya; Critical Thinking; Elementary School*

Introduction

Learning mathematics in elementary schools is one of the studies that is always interesting to put forward because of the different characteristics, especially between the nature of children and the nature of mathematics. For this reason, it is necessary to have a bridge that can neutralize these differences or

contradictions. Graphs et al, (2020) Mathematics subject is learning that involves constructing thinking processes and applying abstractions, and connecting ideas logically. Then these ideas often appear in solving problems of speed, distance, technology, space, and time in everyday life (Asrifah et al., 2020). Material speed, distance, and time according to the basic mathematical definition, distance is a concrete quantity, simplifying distance to cm is an abstraction quantity. In teaching this material, students can use an abstraction scale to a concrete magnitude through problem-solving in everyday life (Sudrajat et al., 2021). In line with the research by Hott et al, it was found that many students with math difficulties and disabilities needed evidence-based learning strategies and interventions to improve students' thinking skills (Setiawan et al., 2021).

Research with a STEM approach with finding similar problems, including Researches related to the mathematics curriculum framework and STEM-based activities (Bakırcı & Karışan, 2017), rectangular modules with a STEM approach to improve critical thinking skills (Dkk, 2020). Initial observations were carried out at SD Negeri Pondokcina 1, the elementary school is one of the schools in the city of Depok that uses the 2013 curriculum. Learning in mathematics material about measuring speed, distance, and time is carried out through observation, interviews, and questionnaires, through zoom classes, and Google application as an additional tool (Irawan & Iasha, 2021; Sari et al., 2020). The concept of STEM-based teaching aids can of course be measured by the thinking ability of students so that it will feel complete when teachers can develop innovative learning concepts and have an impact on thinking skills (Permanasari, 2016). Based on the learning outcomes during the COVID-19 pandemic in the odd semester of the 2021/2022 academic year, only a few students got good grades, and there were still many students in mathematics subjects, especially in the material on measuring speed, distance, and time who scored below KKM (Yustitia et al., 2021).

Mathematics learning materials about measuring speed, distance, and time with a simple e-module guide are expected to improve student's critical thinking skills (Acesta et al., 2021). Learning through the development of mathematics teaching aids is expected to develop students' critical thinking skills in solving problems of speed, distance, and time (Utomo et al., 2021). Therefore, STEM-based learning as transdisciplinary learning is an integration process from multidisciplinary to deal with the problems of learning mathematics (Rachamatika et al., 2021). Based on the background of the problem and various previous studies, the researchers developed STEM-based teaching aids with the topic "Development of STEM-Based Distance and Time Speed Props to Improve Critical Thinking Ability of Elementary School Students in Depok City".

Findings from field studies reveal Tamiya game technology as a tool to improve learning success as well as low-cost teaching aids to provide information during the COVID-19 pandemic so that when students process information and communicate less than optimally. Thus, the next researcher developed a mathematical teaching aid in the form of a Tamiya car to calculate speed, distance, and time so that students' critical thinking skills could be increased.

Method

This study uses the Research and Development (R&D) methodology. The goal is to develop an Android-based application with the technology capabilities of Tamiya props to prove the problem of distance, speed, and time. ADDIE research according to Taylor, (2004) (Taylor, 2004) is an acronym for (1) analyzing (2) design (3) developing (4) implementing, and (5) evaluating. The instrument used to measure product quality is a questionnaire. The questionnaire consisted of an expert validation questionnaire and a teacher questionnaire. The expert validation questionnaire was adapted from development research conducted by Almaiah, Masila, Jalil, & Man (Almaiah et al., 2016).

While the teacher response questionnaire was adapted from Cheng & Tsai (Cheng & Tsai, 2013). (Saiful et al., 2019) The validation of teaching aids was carried out using expert validation of content, teaching aids, and practice. The instruments used are questionnaires and validation sheets. As for the product assessment, the categories are very feasible, feasible, quite feasible, and not feasible. Aspects of expert validation measured in this study are 1) System Quality consisting of functionality, accessibility, interactivity, ease of use, and interface design; 2) Service Quality consists of availability, personalization, responsiveness; 3) Quality of Information which consists of the use of content and adequacy of content; Then 4) aspects that are assessed in the Tamiya teaching aid system to prove the problem of distance, speed, and time material consisting of application performance, 3D models, marker quality, and information delivery. While the aspects of user response in this study include use in learning which consists of satisfaction, enjoyment, entertainment, relief, motivation; and usability consisting of effectiveness, efficiency, and safety. The results of expert validity in the form of suggestions and inputs were analyzed using qualitative descriptive techniques while the results of the questionnaire assessment in the form of scores from each expert were analyzed using quantitative descriptive techniques with the Sugioyno formula as follows (Sugiyono, 2018):

$$\frac{\sum Number\ of\ Questionnaire\ Answers}{N\ Number\ of\ Questionnaire\ Items} \times 100\%P$$

Description
P: Value percentage
N: Number of Questionnaire Items

The calculation results are then identified with the standard assessment category and a decision is made for product revision. The categories of assessment standards are presented in Table 1

Table 1. Decision Making for Revision (Sugiyono, 2011)

Achievement Level	Qualification	Explanation
81-100	Well worth it	Not Revised
61-80	Proper to use	Not Revised
41-60	Enough	Fixed
21-40	Bad	Fixed
0-20	Very bad	Fixed

The participants involved are 1 (one) teaching aid expert, 1 (one) material expert, 1 (one) linguist, 4 (person) grade 5 teachers.

Results and Discussion

The results of the research are in the form of teaching aids for Tamiya teaching aids to prove the problem of distance, speed, and time material using Tamiya-type toy cars that are driven by battery power and drive on a predetermined track or track length. The track and the cars will be installed with sensors measuring speed, time, and distance which will be visible on the display or screen connected to the sensors on the track of the Tamiya toy cars. The researcher explains the tools, in theory, then the students sketch the work steps according to the picture above and begin to prepare materials and project tools for making math props speed, distance, and time and determine colleagues who can prepare the materials.

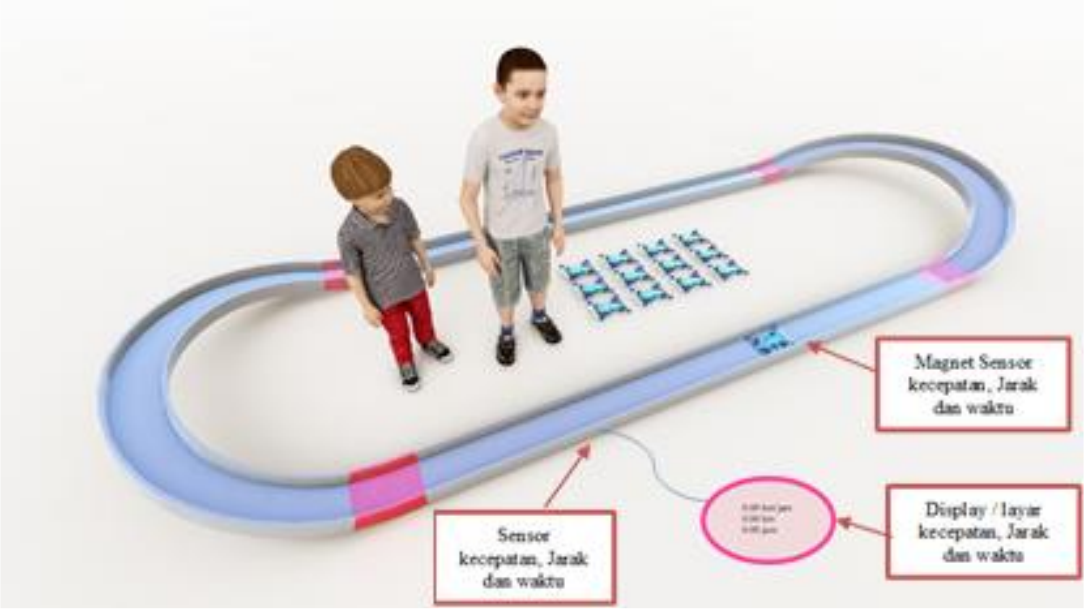

Figure 1. Tamiya teaching aid model for math lessons

The ADDIE model is reflected as the abbreviation of the letters A = analysis, D = design, D = development, I = implementation, and E = evaluation. A detailed description of the stages in this research are as follows:

Preliminary Stage (Analysis)

Preliminary studies are carried out either through needs analysis or field research with previous research studies. This preliminary study was carried out first with an analysis of needs during the pandemic, namely by studying distance learning and now better known as (BDR) students learning from home found problems with difficulties for students or teachers in conveying material, speed, distance, and time. Learning mathematics both online and face-to-face requires appropriate guidance and teaching aids, not only concerning relevant theories, concepts, and research results to support preliminary studies in the field. The literature studied is related to the study of STEM-based learning where students are invited to be active and creative and innovative. Preliminary studies were conducted to determine the basic problems and needs in the development of teaching aids. The props in the form of Tamiya-type toy cars are to prove the problem of distance, speed, and time based on STEM at SDN Pondokcina 1 Depok City.

Design & Development Stage

The design stage is the design stage of the Tamiya teaching aid prototype to prove the problem of distance, speed, and time material. The design stage goes through several stages: Making Criteria Reference Tests, Selection of teaching aids, Selection of Formats, Initial Product Design. The stage of designing a data collection instrument that contains items that measure the quality of teaching aids. This questionnaire was adopted from Almaiah, Masila, Jalil, & Man, while the questionnaire to collect data from material experts and teaching aid system experts was adapted and developed by the researcher. The quality of teaching aids is seen from System Quality, Service Quality, and Information Quality. The props are in the form of Tamiya-type toy cars to prove the matter of distance, speed, and time.

TABLE 2. The grid of aspects of the assessment of the Tamiya mathematics teaching aids

No.	Dimension	Aspect	Description
1	System Quality	Utility	Tamiya props can be used for accuracy of calculations as proof of distance and time material
		Accessibility	Ease of use of teaching aids by students
		Interactivity	The ability of props to facilitate various interactions with other users
		Easy to use	Ease of application for users
		Interface design	The attractiveness of the layout and interface design of the props for its users
2	Service quality	Availability	Ease of teaching aids to be accessed anytime and anywhere
		Personalization	The ability of teaching aids to provide learning
		Responsiveness	resources related to student needs
3	Information Quality	Content Use	The suitability of the props when they were used
		Content Adequacy	Accuracy and ease of information for students to understand
4	Tamiya props for proving speed and time distance material problems (Quality System)	Performance	Adequacy of content according to the level of education of students
		Game models	The ability of the application to run smoothly on student smartphone devices
		Marker Quality	Game model capabilities emerge, follow marker movements, and support interactivity with users.
		Information delivery	The quality of the markers in the information detected by the props

In addition to the validator assessment instrument, a teacher response instrument was also developed. The assessed aspect of the teacher response questionnaire is the experience of using teaching aids. Teaching aids to carry out learning mathematics teaching aids. Of course, these teaching aids make it easier for learning students to solve material problems of speed, distance, and time. Tamia props are widely liked because they are suitable for the games of class V elementary school children. The process of developing Tamiya props begins with an analysis of the distance, speed, and time material and various problems to solve it. Then proceed with the development of indicators for validation instruments used as a basic reference for designing mathematical teaching aids. The design of Tamiya props is made contextually so that it can be related to the daily lives of students.

The development stage is the evaluation stage of the teaching aid prototype carried out by an expert validator. Expert validators consist of teaching aid experts, material experts, and language experts. The validators are those who have expertise in each of the assessed fields so that the results of the validator's evaluation can be scientifically justified in every aspect. Validator evaluation results are shown in Table 3 to Table 5.

TABLE 3. The results of the material expert's assessment in every aspect

Dimension	Aspek	Score in Every Aspect	Max Score	Percentage
System Quality	Utility	8	10	83
	Accessibility	12	15	80
	Interactivity	13	15	86
	Easy to use	10	12	85
	Interface design	13	16	81.25
Average System quality				83.05
System	Availability	9	12	75
	Personalized	10	12	83
	Responsiveness	7	8	87.5
Average Total Service Quality		26	32	81.83
Total		82	100	82.44

It can be seen in the table above that the material expert gave a score close to the maximum on the system quality dimension consisting of five aspects with an average aspect of 83.05 %. Based on the results, the material has been carried out, it can run smoothly in learning mathematics on the subject of speed, distance, and time. This mathematical teaching aid is under the material problems of speed, distance, and time. Furthermore, props don't need too much syntax, ads, or settings. The interface design aspect shows that the personalization aspect which scores almost the maximum indicates that the teaching aids have a high ability to provide student learning resources. The material is displayed in e-module format. The teaching aids simulate various questions that are difficult for students to find in a real environment. Thus, teaching aids make it easier for students to learn and understand the material. The responsiveness aspect measures the speed at which the props perform when running. A high score indicates that the props can run quickly during operation. Overall, the teaching aids have a high system quality and service quality with a score of 82, 44%.

TABLE 4. The results of the assessment of Linguists in each aspect

Dimension	Aspect	Score in Every Aspect	Max Score	Percentage
Information Quality	Material use	22	25	88
	Language	21	24	87.5
	Compatibility			
Total		43	49	87.75

The table above shows the results of the evaluation of teaching aids by material experts. Material experts assess teaching aids with a focus on the quality of the information conveyed. Teaching aids have quality information if the information conveyed through teaching aids is useful for students. In addition, the information conveyed is under the education level of the students. Based on the assessment of the material expert, it can be seen that the total score given by the linguist is 87.75%. This score belongs to the very good category so it does not need to be revised.

TABLE 5. The results of the expert assessment of media tools in every aspect.

Dimension	Aspect	Score	Max Score	Percentage
Tamia props system to prove the matter of distance speed and time material	Performance props	18	20	90
		14	16	87.5
		19	20	79.16
		6	8	75
Total		51	60	85

The table above presents data on the assessment of mathematics teaching aids by teaching aid experts (media). Tamiya props experts to prove material issues distance speed and time assess the performance of the application during use. The results of the Tamiya teaching aids expert's assessment to prove the speed and time distance material problems showed that the percentage of scores obtained from the Tamiya teaching aids system experts to prove the speed and time distance material problems was 85% included in the Very Good category. Obtaining this score indicates that the teaching aids are under the criteria seen from the aspect of the Tamiya teaching aid system to prove the problem of distance, speed, and time material including the application performance when run is very good and the model has good resolution quality so it does not crack. The markers are of excellent quality as they have a detection rate higher than 80%. The information presented at the time of use is also understandable.

After the validation process, the next step is to test the practitioner's response. Response tests were carried out to 3 teachers of class V learning Mathematics. The results of the teacher response trials are presented in the table below which shows the data on the response test results for the use of applications by teachers. Aspects that are assessed are user experience and usability. User experience assesses the teacher's experience when using the app. The results of the assessment showed that the teacher felt happy and entertained while running the Tamiya. The application can also increase learning motivation. The usability aspect assesses the user's response in terms of effectiveness when used, or, for efficiency and safety. In addition, the icon is also easy to remember. The results of the assessment showed that the teacher's test score of 86, 93% were included in the very good category.

Table 6. The results of the teacher's response to the product

Dimension	Aspek	Score	Max Score	Percentage
User	Satisfaction	18	20	90
	Entertainment Enjoyment	21	24	87.5
	Help	19	24	79.1
	Motivation	19	24	79.1
	Support creativity, Reward	21	24	87.5
		22	24	91
Experience	Effectiveness Efficiency	20	24	83.33
	Security	22	24	91
	Utilities	22	24	91
	Learning ability	32	36	88.8
	Memory	31	36	86.11
		32	36	88.8
Utility		279	320	86.93

Tamiya teaching aids to prove the problem of speed and time distance material are very useful in the learning process during the pandemic can increase student independence (Herlandy et al., 2020) referring to the reference, the essence of learning aids is to help students learn more actively. Then, students are stimulated to find concepts independently even without the presence of the teacher. Finally, the Tamiya props to prove the problem of speed and time distance material can provide learning anytime and anywhere (flexibility). The advantage of teaching aids compared to other learning aids is that they can visualize abstract concepts into concrete concepts and seem to be understood. Many scientific objects are so small that they are difficult to see directly or even so large that they are impossible to present in class. By utilizing props based on Tamiya props to prove the problem of material distance, speed and time provide a solution to these problems. The disadvantage of the Tamiya teaching aid technology-based math aids to prove the problem of distance, velocity and time are that its operation still requires additional design and application. The system does not support auto-update. If there are improvements or additions must start from scratch. Making these props must be made carefully in designing requires special skills.

Conclusion

Research and Development Research and development (R&D) develops a product in the form of a mathematics teaching aid, namely Tamiya as a problem-solving material for speed, distance, and time in elementary schools. The development model used to develop the product consists of analysis, design, development, implementation, and evaluation. The evaluation results show the quality of teaching aids by material experts is classified as the very good category with a score of 82, 44%. The quality of teaching aids by linguists is classified as very good with a category score of 87.75%. The quality of teaching aids by media tool experts is classified as very good with a category score of 85%. The results of the teacher's response test are included in the very good category with a score of 86.93%. Based on the percentage of score acquisition, it can be concluded that the teaching aids for solving problems on the matter of distance, speed, and time are suitable for use in learning activities.

References

Acesta, A., Sumantri, M. S., Fahrurrozi, F., Iasha, V., & Setiawan, B. (2021). Natural Scıence Learnıng Module Based on Multıple Intellıgences in Elementary Schools. *Psychology and Education Journal*, *58*(4), 739–749.

Almaiah, M. A., Jalil, M. @. M. A., & Man, M. (2016). Empirical investigation to explore factors that achieve high quality of mobile learning system based on students' perspectives. Engineering Science and Technology, an International Journal, 19(3), 1314–1320. https://doi.org/10.1016/j.jestch.2016.03.004

Asrifah, S., Solihatin, E., Arif, A., Rusmono, & Iasha, V. (2020). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Hasil Belajar Pendidikan Pancasila Dan Kewarganegaraan Siswa Kelas V SDN Pondok Pinang 05. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan*, *16*(30 SE-), 183–193. https://doi.org/10.36456/bp.vol16.no30.a2719

Bakırcı, H., & Karışan, D. (2017). Investigating the Preservice Primary School, Mathematics and Science Teachers' STEM Awareness. Journal of Education and Training Studies, 6(1), 32. https://doi.org/10.11114/jets.v6i1.2807

Cheng, K. H., & Tsai, C. C. (2013). Affordances of Augmented Reality in Science Learning: Suggestions for Future Research. Journal of Science Education and Technology, 22(4), 449–462. https://doi.org/10.1007/s10956-012-9405-9

Dkk, S. R. (2020). the Stem Approach: The Development of Rectangular.

Graphs, R. A., Graphs, R. A., Mathematics, P., Primary, E., & Education, M. (n.d.). Reasoning about graphs in.

Herlandy, P. B., Nur, R., & Syofiah, A. (2020). Preliminary research: augmented reality and its implementation in the basic moves group of the tapak suci putera muhammadiyah martial arts. 1, 152–157.

Hott, B. L., Dibbs, R. A., Naizer, G., Raymond, L., Reid, C. C., & Martin, A. (2019). Practitioner Perceptions of Algebra Strategy and Intervention Use to Support Students With Mathematics Difficulty or Disability in Rural Texas. Rural Special Education Quarterly, 38(1), 3–14. https://doi.org/10.1177/8756870518795494

Irawan, S., & Iasha, V. (2021). Core Learning Model and Mathematical Disposition, Against Mathematics Problem Solving Ability of Elementary School Students. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan*, *17*(2), 122–129.

Rachamatika, T., M. Syarif Sumantri, Agung Purwanto, Jatu Wahyu Wicaksono, Alrahmat Arif, & Vina Iasha. (2021). Pengaruh Model Pembelajaran Dan Kemandirian Belajar Terhadap Kemampuan Berpikir Kritis IPA Siswa Kelas V SDN Di Jakarta Timur. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan*, *17*(1 SE-), 59–69. https://doi.org/10.36456/bp.vol17.no1.a3162

Permanasari, A. (2016). STEM Education: Inovasi dalam Pembelajaran Sains. Prosiding Seminar Nasional Pendidikan Sains, 2016–2023.

Saiful, A., Farid, M., Suminar, T., Wringinjajar, N., & Tengah, J. (2019). Jurnal Pendidikan Dasar Pengembangan Mobile Learning Pendidikan Matematika Realistis di sekolah dasar. 8(2), 169–175

Sari, Y., Luvita, R. D., Cahyaningtyas, A. P., Iasha, V., & Setiawan, B. (2020). Pengaruh Metode Pembelajaran Struktural Analitik Sitentik terhadap Kemampuan Menulis Permulaan di Sekolah Dasar. *Jurnal Basicedu*, *4*(4), 1125–1133.

Setiawan, B., Apri Irianto, S. H., & Rusminati, S. H. (2021). *DASAR-DASAR PENDIDIKAN: Kajian Teoritis Untuk Mahasiswa PGSD*. CV Pena Persada.

Sudrajat, A., Meiliana Lovienica, & Vina Iasha. (2021). Pengaruh Model Resource Based Learning Terhadap Hasil Belajar Ilmu Pengetahuan Sosial (IPS) Siswa Kelas IV SD Sekolah Dasar. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan*, *17*(1 SE-), 70–75. https://doi.org/10.36456/bp.vol17.no1.a3217

Sugiyono. (2011). Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif dan R&D). Alfabeta.

Sugiyono. (2018). Metode penelitian Kuantitatif, Kualitatif, dan R&D. Alfabeta.

Taylor, L. (2004). Educational Theories and Instructional Design Models. Their Place in Simulation. Health.

Utomo, G. M., Setiawan, B., Rachmadtullah, R., & Iasha, V. (2021). What Kind of Learning Media do You Want? Need Analysis On Elementary School Online Learning. *Jurnal Basicedu*, *5*(5), 4299–4305.

Yustitia, V., Fanny, A. M., Kusmaharti, D., & Setiawan, B. (2021). Aplikasi Pembelajaran Tematik Berbasis TIK: PPM Bagi Guru SD Hang Tuah X Sedati. *Manggali; Vol 1 No 2 (2021): ManggaliDO - 10.31331/Manggali.V1i2.1692* . http://e-journal.ivet.ac.id/index.php/manggali/article/view/1692

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