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Problab-Scratch Goes to School: Design, Teaching and Learning of Probability with Interactive Computer Models

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Abstract: Teaching programming and creating interactive computer models has attracted much attention over the years, mostly the attention of curriculum developers and teachers. ProbLab-Scrach is a series of tasks created to teach probability using interactive computer models using Google Colab and Scratch. This application is a means of facilitating discussions regarding probability material for junior high school students and contextualizing the content. This research aims to produce: (1) learning media developed on probability material at the Junior high school level, (2) level feasibility and student responses to learning media developed. This research is research and development (R&D) which uses the ADDIE model. Development procedures include analysis, design, development, implementation, and evaluation stages. In the implementation stage, thirty participants of 8th grade (13-15 years old) Indonesian students learn probability materials with Google Colab and Scratch based on scenarios authored by the researchers. The results show that it is feasible to facilitate learning probability in Junior High School and have a positive impact on learning outcomes, especially theoretical and empirical probability.

Keywords: Interactive computer models, Probability, Google Colab, Scratch

Introduction

Probability is the mathematical study of the degree of uncertainty in real-life events. Probability is a domain in Mathematics that investigates the measurements of an event's uncertainty, such as the concepts of chance, risk, prize, and randomness, which are directly related to the amount of data obtained and must be decided in an uncertain circumstance (Koparan & Rodríguez-Alveal, 2022; Sari et al., 2023). Understanding probability is essential because, according to the OECD (2016), uncertainty is "a phenomenon at the heart of the mathematical analysis of many problem situations." Uncertainty-based decision-making is more prevalent in modern life. Understanding uncertainty and probability can help students make informed judgments in diverse settings (Bryant & Nunes, 2012; Kennedyet et al., 1991; Wijaya et al., 2021).

Fischbein (2002) proposed that when teaching probability, teachers should not focus solely on procedural skills. Instead, teachers should conduct experiments to provide pupils with experiences that will help them grasp probabilistic circumstances. When the experiment is contextual, it can serve as a useful beginning point for students' learning and assist them enhance their knowledge of mathematical ideas. However, there are times when

experiments require a great deal of repetition as is the case in probability. In some research studies, it has been shown that the utilization of technology can aid knowledge construction (Akpinar & Aslan, 2015; Rina, 2021).

With advancements in technology such as media technologies and the advent of the internet, many different tools of learning by programming and learning by designing were developed and studied for example Google Colab and Scratch can be used to teach in the classroom (Akpinar & Aslan, 2015). In this study, the intention is to bring foundational principles of Scratch and Google Colab into mathematics education in order to build an engaging learning environment for students to study an abstract and unpopular mathematics subject, probability. Google Colab or "Collaboratory" is a digital environment available in the cloud, free of charge and hosted by Google (Da Silva, 2020). And Scratch is a visual programming environment used to teach computer science concepts to middle-school students (Meerbaum-Salant et al., 2010). Many software tools for learning probability are either too complex to learn to be helpful, so students have very limited probability to understand the underlying concepts (Abrahamson et al., 2006; Bar-On & Or-Bach, 1988; Konold, 1993; Memnun, 2008; Wilensky & Resnick, 1999). This research aims to produce: (1) learning media developed on probability material at the Junior high school level, (2) level feasibility and student responses to learning media developed.

Method

This research is research and development (R&D). Research and development in education is related to sustainable development and educational innovation such as learning media (Husamah et al., 2022). Learning media that will be produced in research follows the ADDIE development research procedure (Analysis, Design, Development, Implementation, and Evaluation), because the development model is very suitable for the model is very in accordance with the procedure for developing learning products. ADDIE flow is shown in figure 1. The learning products will use SCRATCH and Google Colab. . In the implementation stage, thirty participants of 8th grade (13-15 years old) Indonesian students learn probability materials with the product based on scenarios authored by the researchers.

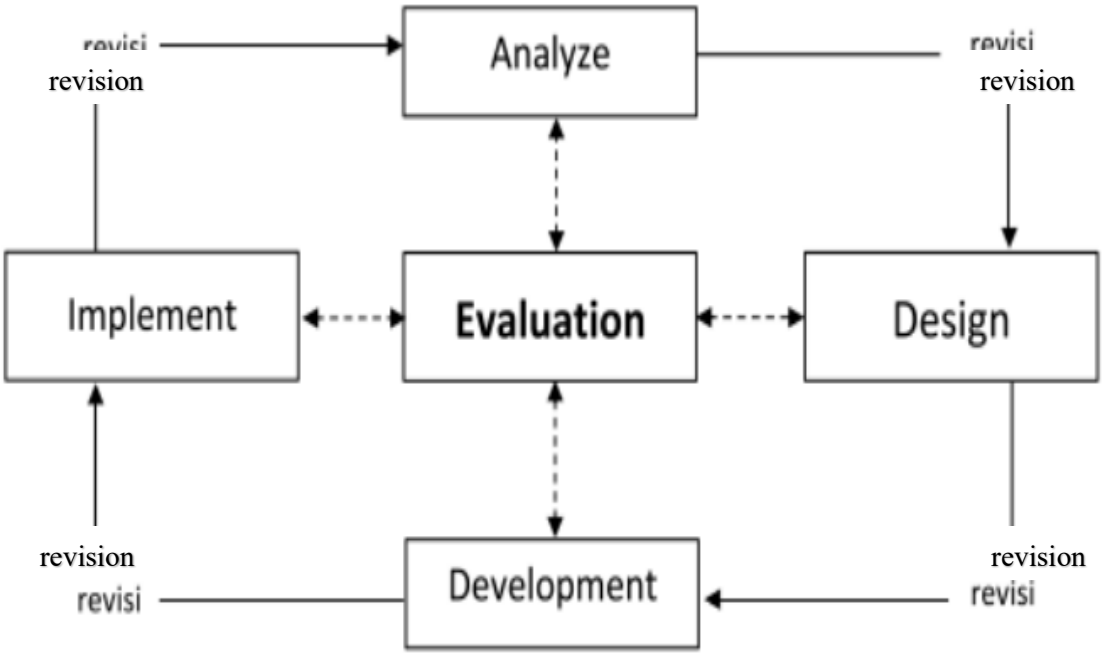


Figure 1. ADDIE model media development process

In general, there are five steps in the ADDIE model, namely Analyze, Design, Develop, Implement, and Evaluate. There are stages or steps that are carried out procedurally, learning design models that are not procedural or cyclical or may start from certain stages, and some are integrated learning design models that start from certain stages, and some are integrative learning design models. The following is a table of the development stages of the ADDIE model of learning design procedurally:

Table 1. Intructional design : The ADDIE approach

ADDIE approach	Concept	Procedural
Analyze	Identifying the causes of problems in learning and pre-planning which is thinking or deciding about the subject or course to be given.	1. Validation 2. Determine instructional objectives 3. Analyzing the learner 4. Auditing possible sources 5. Changing a management plan project
Design	Verify the desired outcome or achievement (learning goals) and determine the method or strategy to be applied	1. Conduct task inventory 2. Create performance objectives 3. Generate test strategy
Develop	Develop and validate learning resources and development materials and strategies supporting materials and strategies that required	1. Produce content 2. Select and develop media supporting media 3. Conducting Formative Revision 4. Conducting Trial Test
Implement	Preparation learning environment, and implementation learning by involving students	1. Engaging students 2. Involving the teacher
Evaluate	Assessing quality products and processes learning	1. Determine evaluation criteria 2. Selecting evaluation tools 3. Conducting revision

Results and Discussion

The development research has produced learning device products of Analysis Design Develop Implementation Evaluation (ADDIE) model that have been tested for validity, practicality, and effectiveness, namely lesson plans for mathematics subjects in class VIII junior high school. The development of learning design begins with analyzing students, lesson plans, material selection to the learning design process. The initial stage carried out is called the self-evaluation stage. The researcher then compiled the learning design development using the ADDIE model in the form of lesson plans. Furthermore, the learning design product that has been developed using the ADDIE model is called the first prototype. The name of this specific prototype is ProbLab-Scratch. The next step is validation by experts and one to one, where validation carried out by experts consists of content experts, linguists, and learning media experts using validation assessment sheets that have been prepared by researchers. The conclusion of the validation of the three experts or experts is that the learning design that has been developed using ADDIE model in terms of content, language, and media is in the valid category (Wulandari et al., 2020).

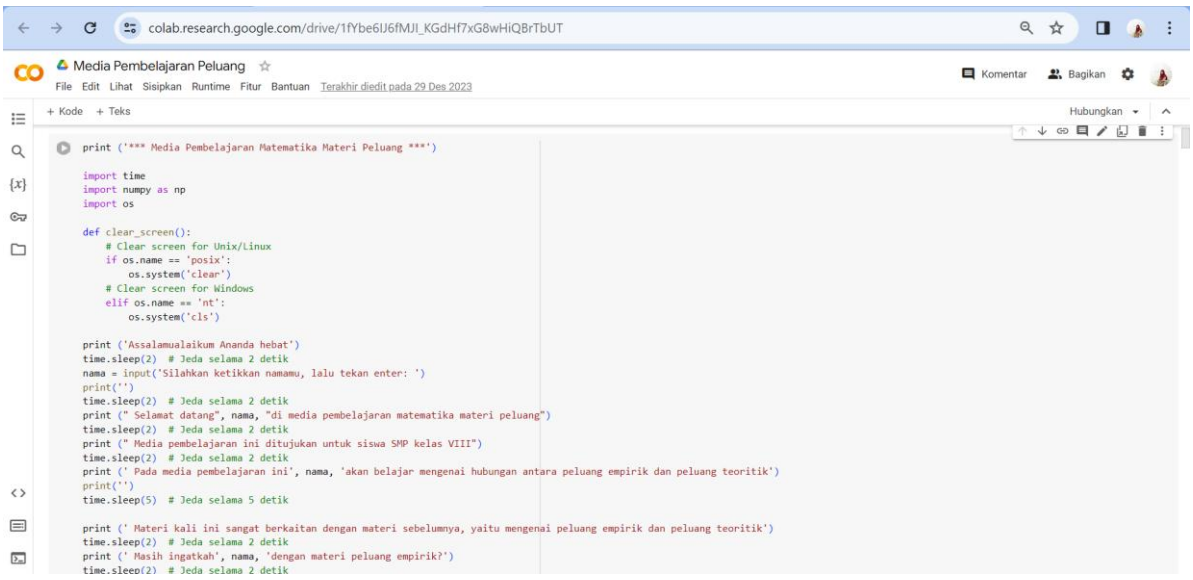
In addition to the validation test against experts or experts, the results of the learning development design were also validated against one to one, namely by involving as many as 3 (three) students with different achievement conditions, namely the first student with good or smart academic achievement, the second student with moderate achievement, and the third student with below average achievement. This trial was conducted with the aim of seeing the practicality and potential effects of the first prototype. The implementation of learning with the three students was given material from the learning design of the ADDIE model (Cahyati et al., 2018). Furthermore, at the end of the learning, the three students were asked to complete the prepared test, and obtained an average score of 81.67 from each of the first student's score of 85, the second student 85, and the third student 75.

Based on the test results, it can be concluded that the first prototype has a potential effect on student learning outcomes because it has reached above the minimum completeness criteria for mathematics subjects set in one of the public schools in Indonesia. Besides being asked to do the third test, students were also asked to fill in a questionnaire to see students' responses to the learning design that had been developed. And from the results of the first prototype in one to one, the questionnaire score category is very good.

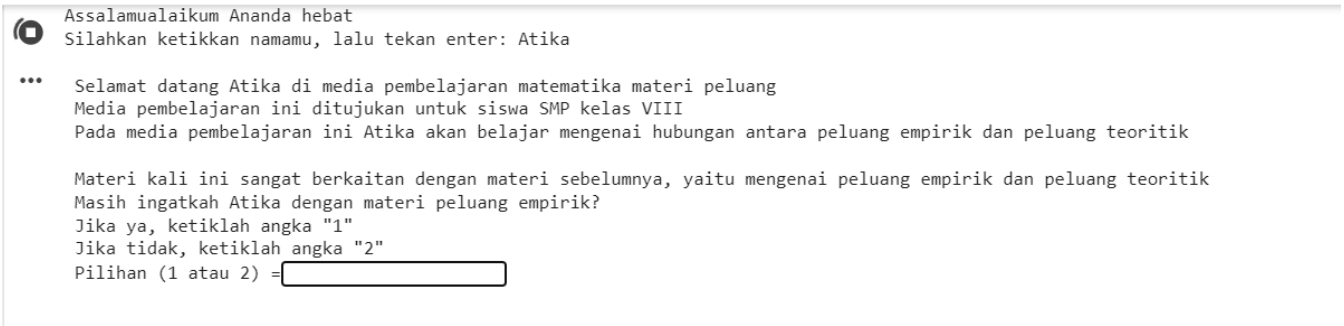
Based on the results of suggestions and input from validators and students that the first prototype learning design is in the valid and practical category, both in terms of material, language, and media, which is in accordance with the rules for making learning designs by following the learning model, namely the ADDIE model and has a potential effect on student learning outcomes (Agustina & Adesti, 2019). Based on the results of validation by

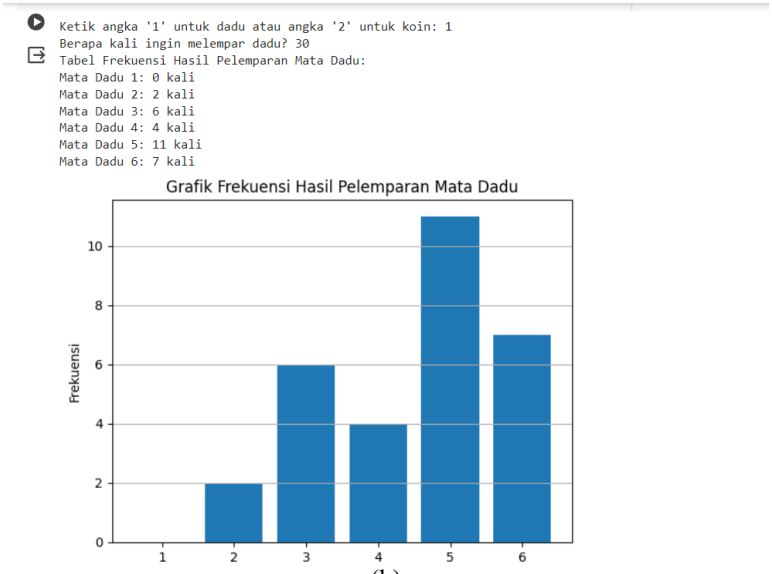
material, language, and media experts as well as input from one to one, namely three students, improvements were made to the learning development design in the form of a lesson plan at this stage called the second prototype which was then tested on small groups, namely students with small groups of each group consisting of 3 (three) students (Hala, 2015) The trial in the small group was the same as the test in one to one by being given learning using it. At the end of the learning in the small group was asked to complete the test that had been prepared, and obtained an average score of 84.67 from each student's score in group one of 88, group two 79, and group three 87.

Based on the test results, it can be concluded that the second prototype ProbLab-Scratch has a potential effect on student learning outcomes because it has reached the minimum completeness criteria for mathematics subjects set in one of the public schools in Indonesia. Besides being asked to do the test, the three groups were also asked to fill out a questionnaire to see students' responses or responses to the learning design that had been developed, while the category of questionnaire scores obtained was very good. Based on the results of validation by experts, one to one, and small groups it can be concluded that the development of the learning design of the ADDIE model has good suitability in terms of material selection, language use, and media. Furthermore, the results of the development of the learning design of ADDIE model are given to the actual research subjects, namely students who are the sample in this study, namely VIII grade students totaling 30 people. So, in general it is concluded that the learning design of the ADDIE model developed from the first and second prototypes ProbLab-Scratch is good and in the category of valid and practical prototypes ProbLab-Scratch. After obtaining a second prototype ProbLab-Scratch that is valid, practical, and has a potential impact on learning outcomes, it is then tested in the field on actual research subjects, namely class VIII. Learning using the results of the learning design of the ADDIE model was carried out for two meetings. The first meeting was held on August 03, 2023 and the second meeting was held on August 09, 2023 with probability material consisting of the definition of probability, the chance of an event and the relationship between theoretical and empirical probability. During the learning process, observations were made to see the activities, filling out questionnaires to see student responses, and evaluations were made to see the learning outcomes. The second prototype ProbLab-Scratch we can see in Figure 2.

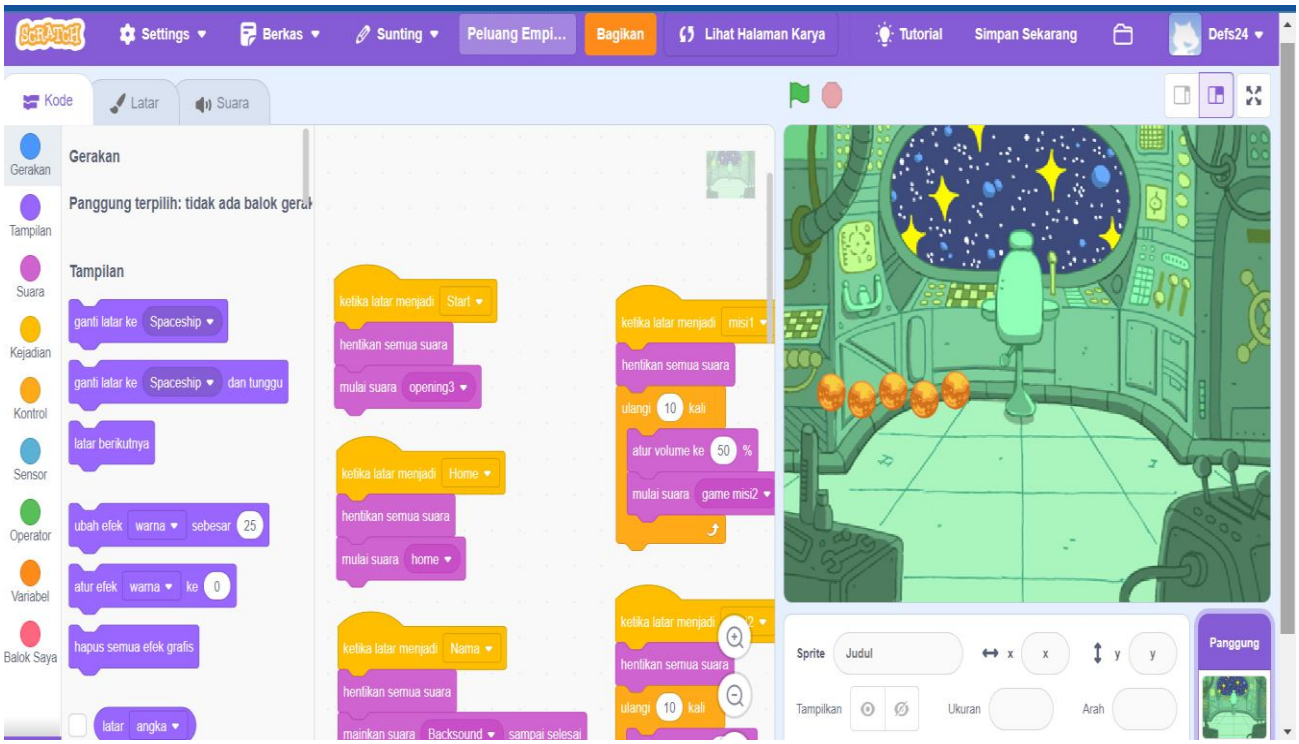


(a)





(b)



(c)

Figure 2. The second prototype ProbLab-SCRATCH. (a) Google Colab (code view), (b) Google Colab (compile view) (c) SCRATCH (code view)

Analysis of learning outcomes during two meetings of the actual sample, namely students. The students were asked to work on test questions that had been prepared as many as 10 questions with types of multiple-choice questions and essays. From the test results obtained an average score of 83 far above the minimum completeness criteria for mathematics subjects set in class VIII. Based on the acquisition of these scores there are 5 (16.13%) students in the very high category, 18 (58.06%) students in the high category, and 8 (25.81) students in the medium category. There are no students in the low and very low categories. So that researchers can conclude that the results of the effectiveness test of the learning design of the Analysis Design Develop Implementation Evaluation (ADDIE) model developed for the field test which is tested for validity and practicality has an impact on student learning activities and results, meaning that the learning design of the Analysis Design Develop Implementation Evaluation (ADDIE) model developed in the effective category.

Conclusion

This development research produces ADDIE model learning device products that are tested for validity, practicality, and effectiveness in class VIII mathematics subjects. The results of the validation test by experts in terms of content, language, and media that the learning design of the ADDIE Analysis Design Develop Implementation Evaluation (ADDIE) model developed in the valid category, by students in one to one and small groups in the practical category, and the results of the field test have an impact on student learning activities and results, meaning that the learning design of the Analysis Design Develop Implementation Evaluation (ADDIE) model developed in the effective category.

Recommendations

This application can use only with google collaboration view and student can see the program. The next project hope can be hosted to website so the student only can see the materials not the whole program

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPESS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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