
# The Development of RBL-STEM learning materials to improve Student's Computational Thinking Skills in Solving REDS problems and It's application on forecasting horizontal farming using ANN

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## Article Info

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**Abstract**
Computational thinking skills involve the process of problem-solving, system design, and understanding human behavior by translating its fundamental concepts into computer science. The indicators of computational thinking include formulation, representation, algorithms, automation, and generalization. To enhance higher-order thinking skills, we implemented RBL-integrated learning with STEM. The developed materials meet the criteria of validity, practicality, and effectiveness. The validity results for each learning tool are as follows: Face-to-Face Plan, 3.6; Student Worksheets, 3.5; and Learning Outcome Test, 3.6. The observation results indicate excellent implementation of the learning process. Approximately 85% or 17 students successfully completed the course, and the average student activity score meets the criteria for active participation. The students also responded positively to the materials and the learning experience. In the pre-test results, 20% of the students were categorized as high-level, 55% as medium-level, and 25% as low-level. However, in the post-test results, the percentage of high-level students increased to 60%, medium-level decreased to 25%, and low-level decreased to 15%. The paired samples T-test showed that the p-value for the pre-test and post-test is 0.000001485, which is less than 0.05. Therefore, it can be concluded that there is a significant difference in the average computational skills test scores of the students.

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**Keywords:** Computational Thinking, RBL-STEM, Resolving Efficient Dominating Set

## Introduction

Education is one of the means to advance human resources as it is a fundamental necessity for individuals to uphold human civilization and compete in the progress of time. One of the educational subjects in college is the introduction to computational thinking skills, which is considered a higher-order thinking skill. Computational thinking is defined as an approach to problem-solving and creating solutions using information processing agents (Wing, as cited in Satria *et al*., 2023) [3]. Computational thinking is not only important in the process of computer programming but also in various disciplines, including mathematics, for problem-solving techniques, as it encompasses various skills and techniques that train students to formulate problems by breaking them down into smaller solvable parts. Moreover, through computational thinking, students are stimulated to think creatively in solving problems (Angeli and Giannakos, 2020) [2].

In fact, Lecturer often still employ monotonous teaching methods, such as solving mathematical problems using formulas, and then students simply copy and memorize those formulas to find the correct answers during exams. Such teaching methods make students less interested and engaged in developing computational thinking skills, which consequently leads to low computational thinking skills among students (Supiarmo, Mardhiyatir rahmah, and Turmudi, 2021) [11]. This is in line with research findings (Marcelino *et al*., 2018) [4] that the current learning approaches limit students from developing computational thinking processes. One of the instructional models in mathematics that has been widely discussed in recent years is the Research-Based Learning model.

The Research-Based Learning (RBL) model can be utilized in higher education because RBL is based on incorporating previous research into the learning process and aims to help students build strong intellectual skills and practical connections between research boundaries and student learning. Therefore, RBL plays a crucial role in enhancing students' thinking skills, particularly computational thinking. Pratiwi has also conducted research on the effect of the Problem-Based Learning model on students' Computational Thinking Mathematics skills. The research findings indicate that students' mathematical computational thinking skills using this model are higher compared to students using conventional learning models (Pratiwi and Akbar, 2022) [7]. Hence, the implementation of the RBL model, which utilizes authentic learning, problem-solving, cooperative learning, contextual (hands-on and minds-on), and inquiry-based approaches rooted in constructivist philosophy (Mauliana and Dewi, 2020) [5], will enhance students' thinking skills. In addition to RBL, addressing these issues can also be maximized by linking them to discipline-specific problems in the field of Science, Technology, Engineering, and Mathematics (STEM).

STEM is an educational approach that combines two or more fields of knowledge, which are science, technology, engineering, and mathematics (Utami in Andini *et al*., 2022) [1]. A form of educational reform that can assist educators in producing skilled professionals is through the STEM approach. This reform represents an adaptation in education to compete with the progress of the times. Therefore, students need complex knowledge that can integrate various aspects into a connected whole. In STEM, each aspect has its own characteristics, and by combining these four aspects, students can solve problems in a much more comprehensive manner. The integration of the RBL model with the STEM approach is expected to provide a solution to students' needs in enhancing computational thinking skills, problem-solving abilities, innovation, independence, creativity, logical thinking, and technological literacy. STEM has been utilized by Sufirman *et al*. (2022) [10], who stated that the development of RBL-STEM learning materials can improve students' metaliteracy skills and demonstrate a significant impact on student learning outcomes between pre-tests and post-tests. However, this research will focus more on enhancing students' computational thinking skills, which differs from Sufirman's study. The research conducted by Ridlo *et al*. (2021) [8] also revealed that research-based learning integrated with STEM has a significant influence on computational thinking abilities. Additionally, Susi Rahayu (2023) [12] supports these findings, explaining that students who learn in traditional classroom settings tend to remain passive and lack motivation to reach their full potential.

The progress of education is closely tied to government intervention, particularly in curriculum regulation. Indonesia also has legislation that addresses the national education system, namely Republic of Indonesia Law No. 20 of 2003. One of the subjects that students must learn is mathematics. There are many branches of mathematics that can be applied in everyday life, such as graph theory. Graphs were first discovered by Leonhard Euler, a Swiss mathematician who studied graphs to solve problems in the city of Königsberg in 1736. The study of graphs has attracted many researchers to further develop it. One of the discussions is Resolving Efficient Dominating Set (REDS), which is often interpreted as an efficient distinguishing dominant collection. In solving problems related to REDS, students are trained to generate ideas, develop strategies based on existing knowledge, and formulate and develop mathematical proofs for the given problem. In graph theory, the aspect of proof is essential. Therefore, students' proof skills are necessary for developing graphs and solving REDS problems. Additionally, an important topic related to graphs is Artificial Neural Networks (ANNs) or Jaringan Syaraf Tiruan (JST) in Indonesian.

According to Weiya Xu & J-F. Shao (in Hidayat *et al*., 2022) [3], Artificial Neural Networks (ANNs) are flexible computational systems that possess the ability to capture the nonlinear and complex underlying characteristics of any process, similar to biological neural networks. ANNs represent the interconnectedness of the entire system along with adjustable numerical weights based on the training process, making the model adaptive to inputs and outputs to handle problems with a large number of variables that are difficult to simplify. Moreover, ANNs are suitable for inverse modeling when the numerical relationship between input and output variables is unknown and cannot be determined. Therefore, ANNs are highly suitable for modeling the complex behavior of many geotechnical engineering problems, which inherently exhibit extreme variability, such as soil stability or agriculture. Another application in agriculture is the automated time forecasting system for horizontal agricultural irrigation. In this case, plants are represented as nodes, and the relationships between two plants are represented as edges. One way to optimize the precision of water supply is by scheduling irrigation. To achieve this, knowledge about when irrigation should be performed and how much water should be supplied is essential.

## Method

The stages used in this research are based on the development of the 4D Model by Thiagarajan, which consists of the definition stage, design stage, development stage, and deployment stage. The 4D Model can be seen in Figure 1. In addition to using the 4D Model, statistical analysis in this research employed paired t-test using the R application, which can be accessed online through https://statslab-rshiny.fmipa.unej.ac.id/RProg/BasicStat/.

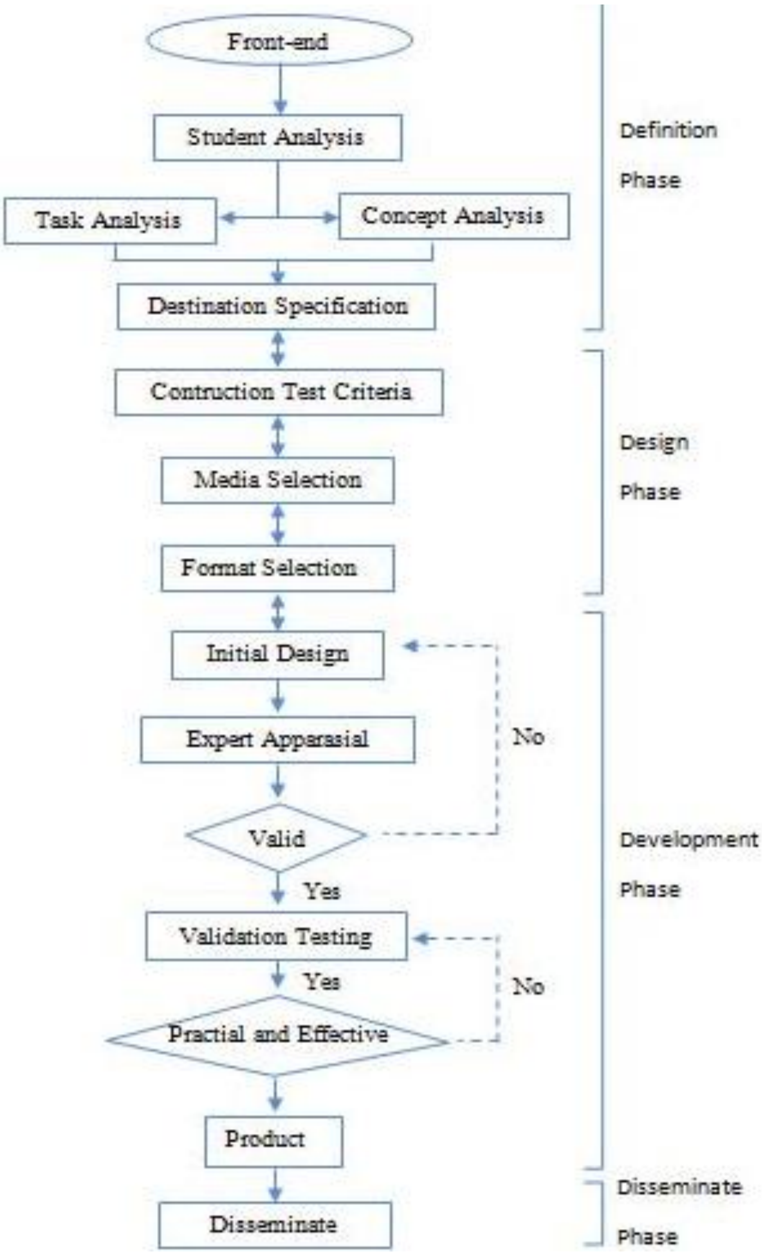


**Fig 1:** Design of 4D model

**Research Findings**

This research utilizes the RBL-STEM model, which allows students to learn and develop knowledge and skills in the fields of science, technology, engineering, and mathematics. The STEM aspects in this study are presented in Figure 3. The description of the STEM components is as follows: In the field of Science, students are expected to understand the presented problems related to the automated time forecasting of horizontal agricultural irrigation to determine which plants require less or more water. In the Technology aspect, students are encouraged to use the internet to seek definitions and solutions to the provided problems. Additionally, they can search and study the latest research on REDS topics. In the Engineering aspect, students are expected to develop the REDS topic in various graphs and solve problems related to automated time forecasting in horizontal agriculture. Finally, in the Mathematics aspect, students can apply the concept of REDS to various graphs and construct graphs for plants, including labeling graph points, determining sets and cardinalities of points, identifying graph edges, and determining dominant points in the graph.

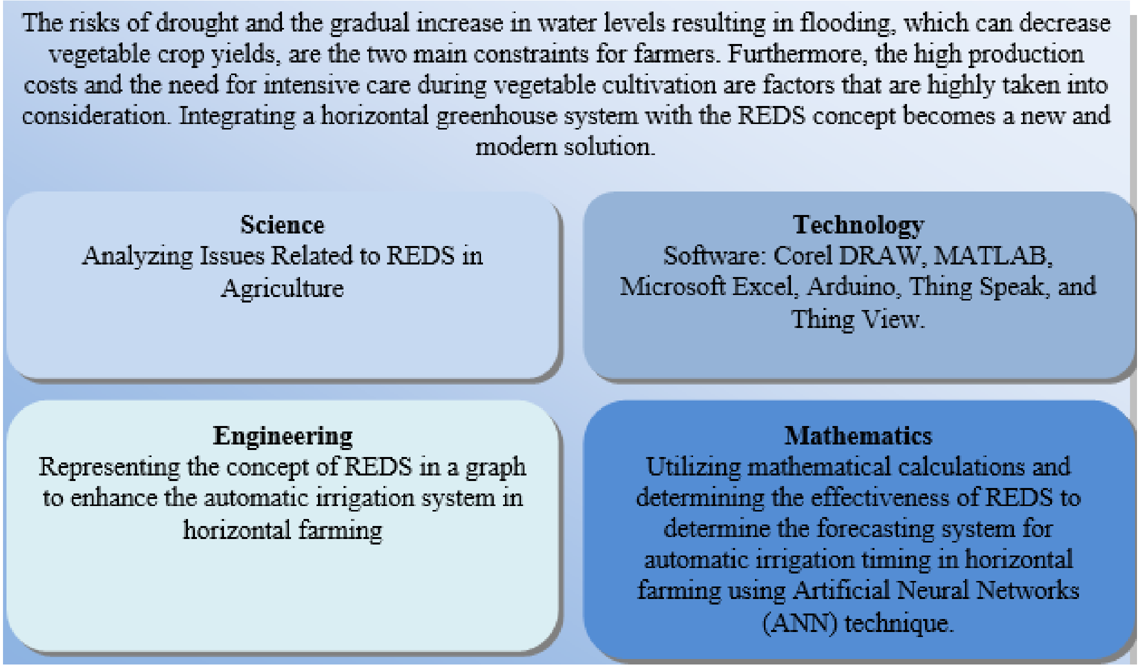


**Fig 2:** STEM Spect in research

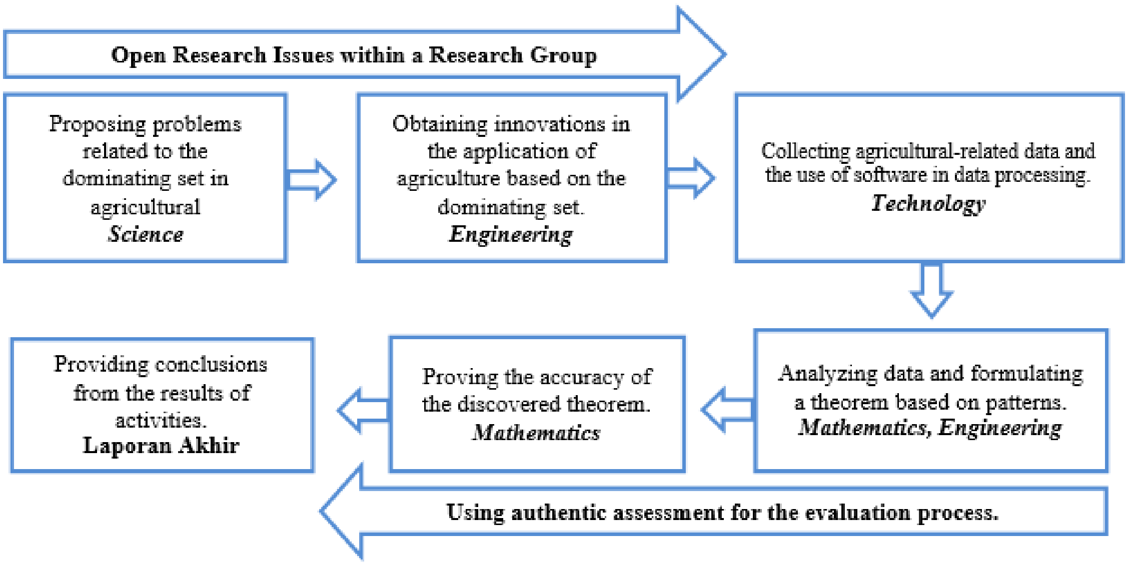


**Fig 3:** Stages of RBL-TEM in Research

The expected outcomes of the research based on the problem of automatic irrigation timing in plants include the placement of sensors and types of plants using the concept of REDS. The determination of the minimum number of sensors is based on the concept of efficient differentiating dominating set, and the automatic irrigation timing is forecasted using an artificial neural network. The RBL-STEM model in this research involves the following stages: (a) Addressing the problem of determining the number of sensors to be placed in horizontal farming and clustering plant types based on point representations in the graph; (b) Making breakthroughs using a neural network, graph theory, and the REDS concept; (c) Collecting data to solve the presented problem; (d) Developing sensor placement and plant arrangements based on the REDS concept; (e) Conducting experimental testing of the generated plant placement; (f) Reporting the research findings and observing the students' computational skills.
The first stage is the definition stage, which consists of initial-final analysis, student analysis, concept analysis, and task analysis. The initial analysis is conducted to determine the problems in the development of learning materials, aiming to provide solutions for students who face obstacles in classroom learning. The concept of efficient differentiating dominating set is chosen as the research topic because it combines two new topics, namely differentiating set and efficient differentiating set. Learning about this topic is expected to broaden students' insights and serve as a reference for their final projects. The next stage is student analysis. Students in the Discrete Mathematics class have shown the ability to understand the problems and concepts given, although they initially found the concept of efficient differentiating dominating set a bit challenging due to its novelty. Task analysis aims to identify the main skills required in learning that align with the curriculum. Meanwhile, concept analysis is carried out to systematically identify, elaborate, and organize the concepts that students learn regarding the topic of efficient differentiating dominating set. The results of the concept analysis can be

seen in Figure 4.

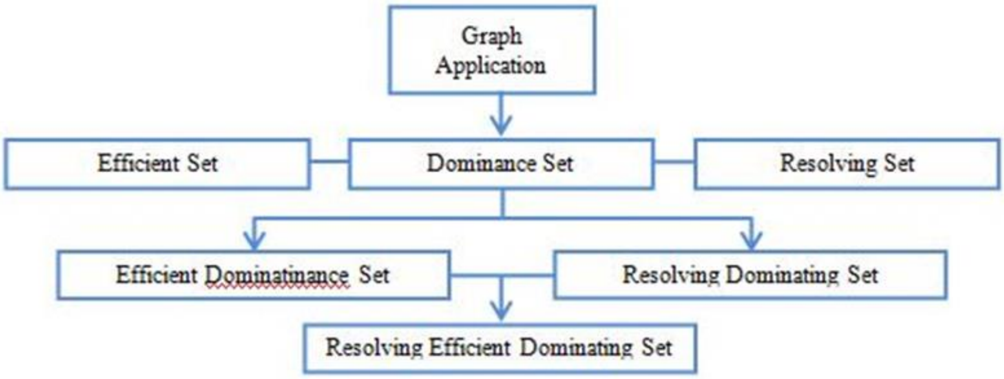


**Fig 4:** Resolving Efficient Dominating Set

The second stage is the design stage, which consists of four steps: test development criteria, media selection, format selection, and initial design. The cover of the LKM (Learning Module) and THB (Textbook) can be seen in Figure 5.


**Fig.5**. LKM and THB Page Cover

The next stage is the development stage. In the development stage, all the developed materials are validated by validators and revised based on their feedback. The materials are validated by two validators who are lecturers in the Mathematics Education Study Program at the Faculty of Teacher Training and Education, Jember University. The overall validation results indicate that all the learning materials, including RTM (Rational Teaching Materials), LKM (Learning Module), and THB (Textbook), can be used with minor revisions. The RTM validation result obtained a score of 3.6, the LKM validation result was 3.5, and the THB validation result was 3.6. Based on the validation results, it can be concluded that the learning materials are valid. The validation results for the three learning materials can be seen in Table 1.

**Table 1:** Summary of Validation Results for RTM, LKM, and THB

| Aspects assessed | RTM | | LKM | | THB | |
|---|---|---|---|---|---|---|
| | Mean | Average Presentation | Average Score | Average Presentation | Average Score | Average Presentation |
| Format | 4 | 100% | 3.6 | 90% | 3.75 | 94% |
| Content | 3.5 | 88% | 3,5 | 88% | 3.6 | 89% |
| Language and Writing | 3.5 | 88% | 3.3 | 83% | 3.5 | 88% |
| Avergae Score for the entire aspects | 3.6 | 90% | 3.5 | 88% | 3.6 | 90% |

After the tool is deemed valid, the next step is to conduct a field test of the tool to assess its practicality and effectiveness. The practicality of the learning tool is evaluated by analyzing the learning activities of students and teachers during the teaching and learning process. The analysis of student and teacher activities is based on observation sheets of the learning process, which are assessed by five observers selected from students of the Mathematics Education Program at Ibrahimy University. Based on the summarized score, the overall average score obtained is 3.8, with a percentage of 94%, indicating that the tool meets the criteria for practicality. The summary of observations on the implementation of the learning process can be seen in Table 2.

**Table 2:** Summary of Observations on the Implementation of the Learning Process

| No | Aspect assessed | Observer | | | | | Mean | Percentage |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| | **1. Activity** | | | | | | | |
| 1. | Overall Implementation level of the learning stages | 4 | 4 | 4 | 4 | 3 | 3.8 | 95% |
| 2. | The implementation of the sequence of learning activities reflects research-based learning with a focus on computational skills. | 4 | 4 | 3 | 4 | 4 | 3.8 | 95% |
| | **2. Social System** | | | | | | | |
| 1. | Level of implementation of the desired situation (atmosphere) (group formation, discussions, asking questions, debating, expressing opinions, mutual respect in work): | 4 | 3 | 4 | 4 | 4 | 3.8 | 95% |
| 2. | Level of implementation of interactions in learning (student-student and student-teacher): | 4 | 3 | 3 | 4 | 4 | 3.6 | 90% |
| 3. | The implementation of the lecturer's behavior in embodying the principles and concepts of combinatorics in research-based learning | 3 | 4 | 4 | 3 | 4 | 3.6 | 90% |
| | **3. Reaction Principal and management** | | | | | | | |
| 1. | The teacher's implementation in accommodating and providing opportunities for students to ask questions, express opinions, and provide feedback | 4 | 4 | 4 | 4 | 4 | 4 | 100% |
| 2. | The level of implementation of the lecturer's behavior in providing assistance, guidance, and mentoring to students in learning | 4 | 3 | 3 | 3 | 4 | 3.4 | 85% |
| 3. | The level of implementation of the lecturer's behavior in providing motivation during learning | 4 | 4 | 4 | 4 | 4 | 4 | 100% |
| 4. | The level of implementation of the teacher's behavior in actively involving students in learning | 4 | 4 | 4 | 4 | 4 | 4 | 100% |
| 5. | The level of implementation of the lecturer in facilitating student learning | 3 | 4 | 3 | 4 | 4 | 3.6 | 90% |
| | **Average of overall score** | | | | | | 3.8 | |
| | **The average percentage of the overall score** | | | | | | 94% | |

After the tool is deemed practical, it will be tested for its effectiveness. The effectiveness test can be determined based on three criteria: student learning outcomes, analysis of student activities, and student response results. The first criterion is learning outcome achievement. From the collected student answers, it was found that 17 students obtained scores above 60, which means that 85% of students achieved the passing grade and met one of the criteria for an effective tool. Therefore, it can be concluded that the developed tool is effective. The second criterion is the analysis of student activities, which is obtained from the Student Activity Observation Sheet. Based on the summarized scores, the overall average score obtained is 3.7, with a percentage of 93%. This indicates that the tool meets the criteria for practicality. The summary of the student activity observation sheets can be seen in Table 3.

**Table 3:** Summary of Student Activity Observation Sheets

| No | Aspect Assessed | Observer | | | | | Mean | Percentage |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| | **1. Introduction** | | | | | | | |
| 1. | Students show attention and motivation towards the presentation of learning objectives. | 4 | 4 | 4 | 3 | 3 | 3.6 | 90% |
| 2. | Students listen to the lecturer's explanation regarding the subject matter to be learned. | 4 | 3 | 3 | 4 | 3 | 3.4 | 85% |
| | **2. Core Activity** | | | | | | | |
| 1. | Students create groups | 4 | 4 | 4 | 4 | 4 | 4 | 100% |
| 2. | Students show attention and motivation towards the presentation of research journals as references | 3 | 3 | 3 | 4 | 4 | 3.4 | 85% |
| 3. | Students gather data through discussions | 4 | 4 | 4 | 3 | 4 | 3.8 | 95% |
| 4. | Students present the data gather from Student Worksheet | 4 | 4 | 4 | 4 | 4 | 4 | 100% |
| 5. | Students analyze data gather from Student Worksheet | 4 | 4 | 3 | 4 | 4 | 3.8 | 95% |
| 6. | Students present the results of the discussion | 4 | 3 | 4 | 3 | 4 | 3.6 | 90% |
| 7. | Students take the pre-test and post-test enthusiastically | 4 | 4 | 4 | 4 | 4 | 4 | 100% |
| | **3. Closing** | | | | | | | |
| 1. | Students are able to draw conclusions from the learning activities | 3 | 4 | 3 | 4 | 3 | 3.4 | 85% |
| | **Average of the overall score** | | | | | | 3.7 | |
| | **The average percentage of the overall score** | | | | | | 93% | |

The third criterion is student response results. The student response results are obtained by distributing student questionnaires in hardcopy form. A total of 20 students completed the questionnaire, the lowest percentage of positive responses, with 83%, was observed in questions related to the learning atmosphere and teaching methods. On the other hand, the highest positive response was found in the novelty of the LKM (Learning Module) device. This could be attributed to the fact that the topics covered in the LKM were relatively new for the students in the Mathematics Education Program at Ibrahimy University, specifically regarding REDS and ANN (Artificial Neural Networks). Overall, the average percentage of positive responses to the questions is 91%, while the negative percentage is 9%. This indicates that the majority of students responded positively to the learning and instructional materials presented. Therefore, it can be concluded that the three criteria for an effective learning tool have been met. The summary of the student response questionnaire data can be seen in Table 4.

**Table 4:** Summary of Student Response Questionnaire Data

| No | Aspect Assessed | Number of Answers | | Answer Percentage | |
|---|---|---|---|---|---|
| | | Yes | No | Yes | No |
| 1. | Did you enjoy the following learning components: | | | | |
| | Learning materials | 22 | 1 | 96% | 4% |
| | Student worksheet | 22 | 1 | 96% | 4% |
| | Learning atmosphere | 20 | 3 | 87% | 13% |
| | Teaching Method | 22 | 1 | 96% | 4% |
| 2. | Are the following learning components new? | | | | |
| | Learning materials | 22 | 2 | 96% | 9% |
| | Student worksheet | 21 | 2 | 91% | 9% |
| | Learning atmosphere | 19 | 4 | 83% | 17% |
| | Teaching Method | 19 | 4 | 83% | 17% |
| 3. | Are you interested in following this lesson? | 21 | 2 | 91% | 9% |
| 4. | Can you clearly understand the language used in: | | | | |
| | Student worksheet | 21 | 2 | 91% | 9% |
| | Final research test question sheet | 22 | 1 | 96% | 4% |
| 5. | Can you understand the meaning of each question/problem presented in: | | | | |
| | Student worksheet | 21 | 2 | 91% | 9% |
| | Final research test question sheet | 22 | 1 | 96% | 4% |
| 6. | Are you interested in the appearance (writing, pictures, and the location of the pictures) on: | | | | |
| | Student worksheet | 21 | 2 | 91% | 9% |
| | Final research test question sheet | 20 | 3 | 87% | 13% |
| 7. | Do you like discussing with group members to solve problems by exchanging answers? | 21 | 2 | 91% | 9% |
| **Mean** | | 21 | 2 | 91% | 9% |

The final stage is dissemination. The materials that will be disseminated include pre-tests, post-tests, and the LKM (Learning Module) with a research-based learning model using the STEM approach. The dissemination in this research will be conducted among mathematics education lecturers. Additionally, it will be uploaded on the internet, including social media platforms, by providing a Google Drive link. These efforts aim to assess the effectiveness of the developed materials in the learning process and to gather feedback, corrections, suggestions, and evaluations to improve the developed learning materials.

The THB (Textbook) pre-test and post-test results are then analyzed. The data analysis is presented using (a) graphs showing the distribution of pre-test and post-test scores of students, (b) the distribution of students' computational skill levels can be seen in Figure 6. The percentage of students' computational skill levels is depicted in Figure 7.

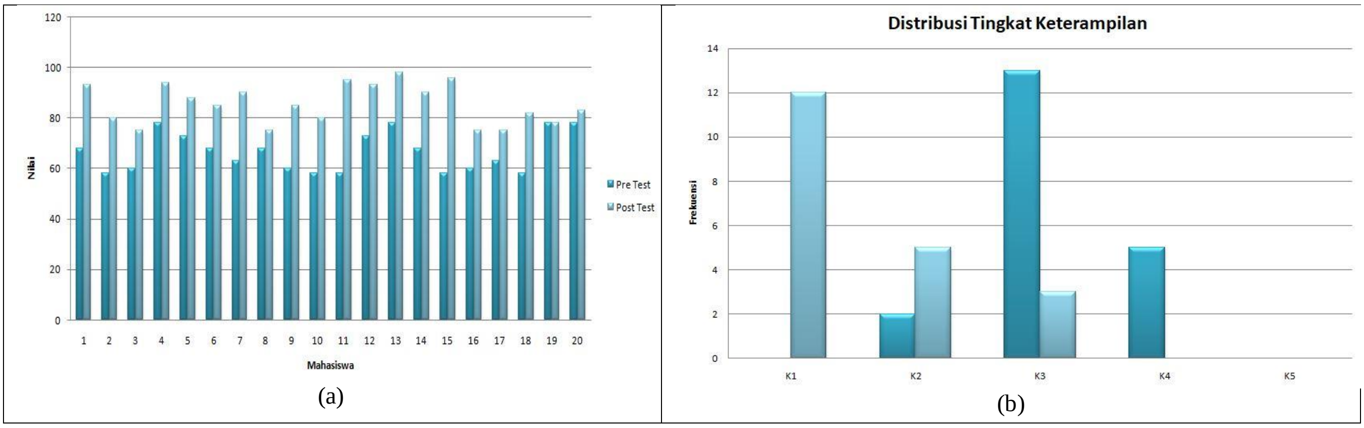


**Fig 6:** (a) Graph of the distribution of pre-test and post-test scores of students. (b) Distribution of students' computational skill levels

Based on the graph of the distribution of pre-test and post-test scores, it can be concluded that the lowest pre-test score is 58, and the highest pre-test score is 78. On the other hand, for the post-test, the lowest score is 60, and the highest score is 98. Regarding the distribution of students' computational skill levels, the pre-test results indicate that K1 students were absent, K2 were 2 students, K3 were 13 students, K4 were 5 students and K5 students were absent, while the post-test results of K1 were 12 students, K2 were 5 students, K3 were 3 students and K4, K5 were absent.K3.

Next, a normality test was conducted as a requirement for performing a paired sample t-test. This statistical test was performed using the online software "onliner-shiny" at http://statslab-rshiny.fmipa.unej.ac.id/RProg/BasicStat/. The results of the normality test are presented in Figure 7.

| statistic | p.value | method | data.name |
|---|---|---|---|
| 0.91 | 0.07 | Shapiro-Wilk normality test | datasetInput()[, input$var.y] |
| 0.91 | 0.07 | Shapiro-Wilk normality test | datasetInput()[, input$var.y] |

**Fig 7:** The results of normality test

Based on the results of the normality test shown in Figure 8, it indicates that the pre-test and post-test scores follow a normal distribution as the p-value is 0.07 > 0.05. The final test conducted is the paired samples t-test, which is presented in Figure 8.

```
Uji-T 2-Kelompok Berpasangan: Data= IMPOR Y1= Post.Test Y2= Pre.Test

        Paired t-test

data:  datasetInput()[, input$var.yt2p1] and datasetInput()[, input$var.yt2p2]
t = 6.871, df = 19, p-value = 1.485e-06
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 10.63936 19.96064
sample estimates:
mean difference
           15.3
```

**Fig 8:** The results of paired sample t-test

Based on the results of the paired samples t-test, the p-value for the comparison between pre-test and post-test scores is 1.485 x 10^-06 (0.000001485) < 0.05. Therefore, it can be concluded that there is a significant difference in the mean scores of students' computational skill tests.

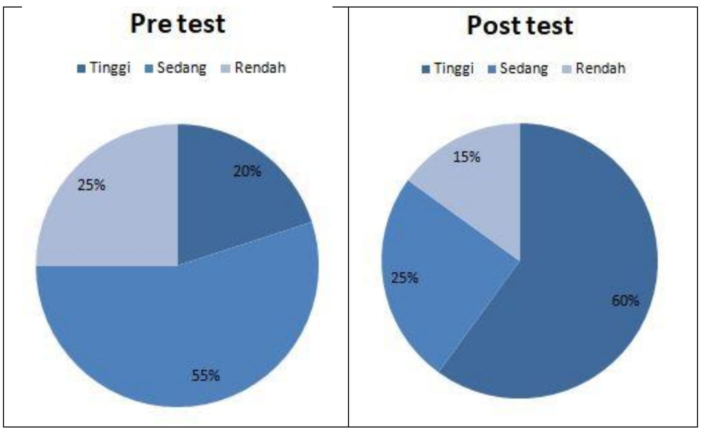


**Fig 9:** Percentage of students' computational skill levels

In the pre-test results, only 20% of students were categorized as having a high level of computational skills, 55% were categorized as having a moderate level, and 25% were categorized as having a low level. However, in the post-test results, the percentage of students categorized as having a high level increased to 60%, the percentage of students categorized as having a moderate level remained at 25%, and the percentage of students categorized as having a low level decreased to 15%.

**Discussion**

The research-based STEM learning tool that has been developed should meet reliable, beneficial, and efficient standards. Additionally, the tool has been verified by two validators from the Faculty of Mathematics Education at the University of Jember. The validation results indicate that this teaching tool is deemed valid, useful, and efficient. To enhance student motivation, improve learning outcomes, and enable students to apply what they have learned in real-world situations, this research-based learning model is recommended for implementation in education. When compared to students who undergo conventional learning, students who engage in research-based learning are expected to be more engaged, creative, and capable of critical thinking. This is consistent with the research findings by Mursyidah (2023) that RBL-STEM learning has a positive impact on students. Moreover, computational thinking has become one of the essential skills to be nurtured from an early stage because, in the era of information, Industry 4.0, or Society 5.0, humans live in both the physical world and the digital world surrounded by the Internet of Things (IoT), Big Data, and Artificial Intelligence. It has been proven that implementing the RBL-STEM learning model significantly enhances students' computational thinking abilities.

## Conclusion

Education is one of the means to advance human resources, as it is a fundamental need for humans to uphold civilization itself and to compete in the progress of time. A form of reform in education that can help educators create skilled professionals is the RBL-STEM learning model. This reform represents an adaptation in education to compete with the progress of time. One of the subjects in higher education is the introduction to computational thinking skills, which is one of the higher-order thinking skills. Computational thinking is defined as an approach to problem-solving and creating solutions using techniques that train students to formulate problems by breaking them down into smaller, manageable parts. In higher education, RBL is based on the provision of previous research when learning begins and aims to help students build strong intellectual skills and practical connections between the boundaries of research and student learning. Therefore, RBL plays a crucial role in enhancing students' thinking skills, especially computational thinking. In addition to RBL, these issues can also be maximized by linking them to problems in the disciplines of Science, Technology, Engineering, Mathematics (STEM).

The developed learning tool is expected to enhance students' thinking skills and contribute to the success of the learning process. The developed tool has met the criteria of being valid, practical, and effective. The validity scores obtained for each component are 3.6 for the lesson plan, 3.5 for student worksheets, and 3.6 for the learning outcome tests. The observation results indicate a 3.8 score for the implementation of the learning process, with a percentage of 94%. Around 85% of students (17 students) have successfully completed the learning activities, the average score for student activity is 93%, and 91% of students have provided positive responses. In the pre-test, only 20% of students were categorized as having a high level of computational skills, 55% were categorized as having a moderate level, and 25% were categorized as having a low level. However, in the post-test, the percentage of students categorized as having a high level increased to 60%, while the moderate level remained at 25% and the low level decreased to 15%. The results of the paired samples t-test indicate that the p-value for the comparison between pre-test and post-test scores is $0.000001485 < 0.05$. Therefore, it can be concluded that there is a significant difference in the mean scores of students' computational skill tests.

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## References

1. Andini Risma, Endang Retno, Mintarsih. Kemampuan Berpikir Kritis Matematis Siswa Pada Model Problem-Based Learning Berbantuan Bahan Ajar Dengan Pendekatan STEM. PRISMA, Prosiding Seminar Nasional Matematika. 2022; 5(1): 467–74.
2. Angeli Charoula, Michail Giannakos. Computational Thinking Education: Issues and Challenges. Computers in Human Behavior, 2020, 105.
3. Hidayat Risaldi, *et al*. Analisis Kestabilan Lereng Menggunakan Artificial Neural Network : Sebuah Tinjauan Pustaka, 2022, 209-15.
4. Marcelino Maria José, *et al*. Learning Computational Thinking and Scratch at Distance. Computers in Human Behavior. 2018; 80:470-77.
5. Mauliana Anik, Retno Mustika Dewi. Pengembangan Media Pembelajaran Berbasis Problem Based Learning Pada Mata Pelajaran Ekonomi. Jurnal Pendidikan Ekonomi (JUPE). 2020; 01:15-19.
6. Mursyidah Indah Lutfiyatul. Development of RBL-STEM Learning Tools to Improve Students' Computational Thinking Skills Solving Rainbow Antimagic Coloring Problems and Their Application to Traffic Flow Problems with Spatial Temporal Graph Neural Network. International Journal of Current Science Research and Review, 2023, 06(01).
7. Pratiwi Gita Lestari, Budhi Akbar. Pengaruh Model Problem Based Learning Terhadap Keterampilan Computational Thinking Matematis Siswa Kelas Iv SDN Kebon Bawang, 2022, 03 Jakarta. 08.
8. Ridlo ZR, *et al*. The Effectiveness of Research-Based Learning Model of Teaching Integrated with Computer Simulation in Astronomy Course in Improving Student Computational Thinking Skills. Journal of Physics: Conference Series, 2021, 1839(1).
9. Satria Erwinsyah, *et al*. Pengembangan Media Interaktif Pemograman Berpikir Komputasional. 2023; 4:660-71.
10. Sufirman Sufirman, Dafik Dafik, Arif Fatahillah. Pengembangan Perangkat Pembelajaran RBL-STEM Untuk Meningkatkan Metaliterasi Siswa Menerapkan Konsep Relasi Fungsi Dalam Menyelesaikan Masalah Dekorasi Teselasi Wallpaper. Cgant Journal of Mathematics and Applications, 2022, 3(1).
11. Supiarmo M Gunawan, Liny Mardhiyatirrahmah, Turmudi Turmudi. Pemberian Scaffolding Untuk Memperbaiki Proses Berpikir Komputasional Siswa dalam Memecahkan Masalah Matematika. Jurnal Cendekia: Jurnal Pendidikan Matematika. 2021; 5(1):368-82.
12. Susi Rahayu, Aniek. Peningkatan Aktifitas Dan Hasil Belajar Siswa Dalam Pembelajaran Matematika Pada Pokok Bahasan SPTDV Menggunakan Model Pembelajaran Kooperatif Tipe Jigsaw SMA Negeri 1 Jember. Learning: Jurnal Inovasi Penelitian Pendidikan dan Pembelajaran. 2023; 3(1):54-59.