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Development of Straight Motion Kinematics Learning Module Based on Educational Robotics and Guided Inquiry

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Abstrak

Penelitian ini bertujuan untuk mengembangkan modul pembelajaran kinematika gerak lurus berbasis educational robotics dan model inkuiri terbimbing untuk mengatasi permasalahan yang terjadi dalam pembelajaran kinematika. Penelitian ini menjawab tantangan umum dalam pembelajaran kinematika, seperti motivasi yang rendah, miskonsepsi, dan kesulitan dalam memvisualisasikan gerak, dengan mengintegrasikan teknologi robotik (Roblock) dan pemrograman blok (mBlock) untuk memberikan pengalaman belajar yang konkret dan interaktif. Penelitian ini menggunakan model ADDIE (Analysis, Design, Development, Implementation, Evaluation) dengan tidak melakukan tahap Implementation dikarenakan waktu yang terbatas. Hasil penelitian menunjukkan bahwa modul yang dikembangkan mencapai validitas tinggi, dengan skor validasi ahli materi 97,3% dan validasi ahli media 93,6%, yang menunjukkan kesiapan yang sangat baik untuk digunakan di kelas. Modul ini secara efektif menggabungkan penjelasan teoritis dengan eksperimen robotik langsung, memfasilitasi pembelajaran aktif melalui tahap-tahap inkuiri terbimbing (identifikasi masalah, perumusan hipotesis, eksperimen, analisis data, dan kesimpulan). Kekuatan utama termasuk ketersediaan format ganda (cetak dan digital), alur pembelajaran yang terstruktur, dan keselarasan dengan Kurikulum Merdeka, yang menekankan keterampilan abad ke-21 seperti berpikir kritis dan kolaborasi. Studi ini menyimpulkan bahwa modul berbasis robotika ini menawarkan solusi inovatif untuk mengajarkan kinematika, mengubah konsep abstrak menjadi pengalaman belajar yang nyata.

Kata Kunci: *Educational robotics*; Inkuiri terbimbing; Kinematika gerak lurus; Kurikulum merdeka; Modul pembelajaran

Abstract

This research aims to develop a learning module for kinematics of straight motion based on educational robotics and guided inquiry model to overcome the problems that occur in kinematics learning. This research addresses common challenges in kinematics learning, such as low motivation, misconceptions, and difficulty in visualizing motion, by integrating robotic technology (Roblock) and block programming (mBlock) to provide a concrete and interactive learning experience. This research uses the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) by not doing the Implementation stage due to limited time. The results showed that the developed module achieved high validity, with a material expert validation score of 97.3% and media expert validation of 93.6%, indicating excellent readiness for use in the classroom. The module effectively combines theoretical explanations with hands-on robotic experiments, facilitating active learning through the stages of guided inquiry (problem identification, hypothesis formulation, experimentation, data analysis, and conclusion). Key strengths include the availability of multiple formats (print and digital), structured learning flow, and alignment with the Independent Curriculum, which emphasizes 21st century skills such as critical thinking and collaboration. The study concludes that this robotics-based module offers an innovative solution for teaching kinematics, transforming abstract concepts into tangible learning experiences.

Keywords: *Educational robotics; Guided inquiry; Independent curriculum; Kinematics of straight motion; Learning module*

Introduction

Learning kinematics of straight motion often faces challenges, one of which is low student motivation which results in students' difficulty in solving problems (Santoso et al., 2020). In addition, many students experience misconceptions in understanding the basic concepts of motion, coupled with the lack of practice problems, so that their understanding is hampered (Febrina & Nada, 2021). This problem is even more complex because students have difficulty visualizing motion, even though visual representation is very important in learning physics (Sari et al., 2023). As a result, without the right approach, student learning outcomes tend to be not optimal.

Based on discussions with physics teachers in several schools in Jambi, it was found that students' motivation in learning kinematics of straight motion is still low. For example, at SMAN Titian Teras Jambi, the tight schedule and monotonous learning methods make students quickly tired and lose interest. While at SMAS Xaverius 1 Jambi, although students' concept understanding was relatively good, the lack of variety in learning models and media made them less motivated to learn actively.

Several solutions have been tried to improve student motivation and understanding, such as the use of problem based learning (PBL) which is proven to help concept understanding and train critical thinking skills (Azzahra et al., 2023). However, PBL is considered too complicated for some students. There is also a CIRC model that encourages interactive learning (Sugianti et al., 2017), but this model does not emphasize the conceptual aspects of physics. Therefore, a new approach that is more applicable is needed, so that students can more easily connect concepts with real situations.

Seeing this need, the research wants to develop an educational robotics-based straight motion kinematics learning module with a guided inquiry learning model. This module integrates a mobile robot (Roblock) programmed using block programming through the mBlock application to visualize kinematics concepts concretely. As stated by Poletti (2023) and Uslu et al (2023), this approach not only makes learning more interactive, but also trains students' analytical and problem-solving skills through hands-on experiments. With a user-friendly interface, students can easily program the robot to simulate various concepts of straight motion, bridging the understanding between theory and practice.

This development objective is in line with the independent curriculum which emphasizes the importance of innovative teaching materials (Priantini et al., 2022). By utilizing robotics, learning becomes more explorative and interesting, while helping students understand physics concepts more concretely.

Modules were chosen as teaching materials because they are independent, students can learn in a self instructional, self contained, and stand alone manner (Harahap et al., 2024). This robotics-based module is designed to be easy to use while engaging students in meaningful activities, such as designing robots and solving real problems. This approach not only increases student engagement but also encourages deeper learning (Chaidi et al., 2021).

The guided inquiry model was chosen because it is very compatible with the independent curriculum, especially in practicing science process skills. Through stages such as problem presentation, hypothesis formulation, experimentation, data analysis, and conclusion (Zuba, 2019), this model encourages students to be actively involved in learning. This approach not only strengthens the understanding of the concept of kinematics of straight motion, but also develops scientific abilities that are the focus of the independent Curriculum.

Thus, the development of this module is expected to be an effective solution to increase student motivation and understanding in learning kinematics of straight motion.

Method

This study uses the research and development (R&D) method by adopting the ADDIE development model. This model offers a systematic approach through five main stages: 1). Analysis, 2). Design, 3), Development, 4). Implementation, 5). Evaluation (Branch, 2009).

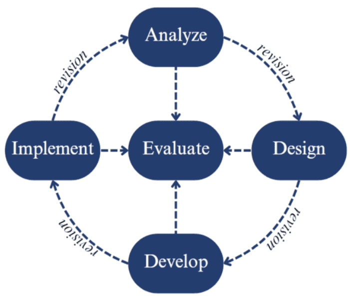


Figure 1. ADDIE Branch Stages

This study used the ADDIE model in module development because of its structured framework, allowing thorough evaluation at each stage to produce a valid and relevant product (Waruwu, 2024). In this study, the development process only reached the development stage due to limited research time, but rigorous evaluation by experts was still carried out at each phase of product analysis, design, and development to ensure the feasibility of the module before it was implemented in the classroom. This approach allows for continuous improvement while ensuring the quality of the module as teaching material even though it has not gone through direct field trials. The module development procedure in each R&D phase can be seen in Figure 2.

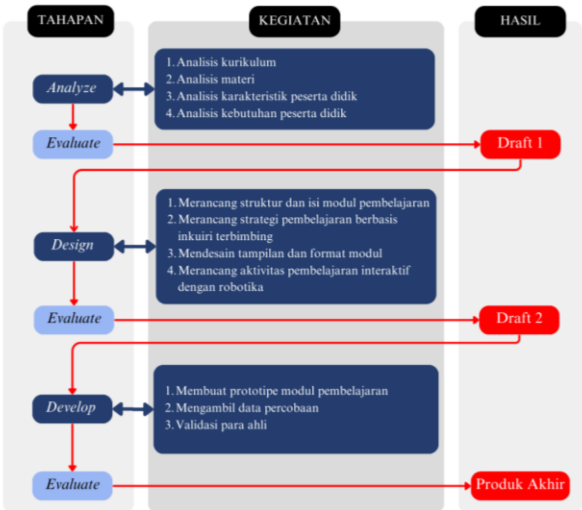


Figure 2: Module Development Procedure

This study used different data collection techniques at each stage of development. At the analysis stage, data was collected through open-ended interviews with physics teachers and analyzing literature studies from various academic sources. The design stage involved focus group discussions (FGD) with a team of experts to refine the module design. Furthermore, the development stage used material and media expert validation questionnaires, while the evaluation process at each stage was carried out through FGD between the expert team and the developer to ensure the quality of the module at each stage.

This study applied different data analysis approaches for each stage of development. In the analysis phase, data from interviews with physics teachers were processed using thematic analysis techniques, this method allows researchers to identify important patterns and key themes that emerge from interview transcripts (Heriyanto, 2018). Meanwhile, for data derived from literature studies, researchers used content analysis to select and filter relevant information from various written sources such as textbooks and scientific articles (Sofiah et al., 2020).

At the module design stage, data obtained from focus group discussions (FGD) with a team of experts were analyzed using a descriptive qualitative approach. This analysis aims to evaluate the suitability of the module design with the principles of educational robotics-based learning and guided inquiry models.

In the development phase, data from material and media expert validation results were analyzed quantitatively descriptively referring to the likert scale (Sugiyono, 2016). This analysis technique involves calculating the validator's assessment score which is then converted into a percentage. The results of the calculation were then interpreted based on the validity criteria (Nesri & Kristanto, 2020):

Table 1. Module Validity Criteria

No	Percentage	Validity Criteria
1.	$85\% < P \leq 100\%$	Very valid
2.	$70\% < P \leq 85\%$	Valid
3.	$50\% < P \leq 70\%$	Less valid
4.	$P \leq 50\%$	Invalid

To measure the level of validity and feasibility of the module, the percentage score calculation is carried out using the formula (Fortuna et al., 2022).

$$P = \frac{Ts}{Ms} \times 100\%$$

Description:
P = Percentage score
Ts = Total score
Ms = Maximum score

At the evaluation stage, FGD data with experts and the development team were analyzed qualitatively to assess and improve the module. This process was repeated throughout the development to ensure the final module was valid and ready to be used in learning.

Result and Discussion

The results of the development of this educational robotics-based straight motion kinematics learning module are presented systematically in accordance with the stages of the ADDIE model used. This section will describe in detail the process and achievements of each development phase, starting from:

1. Analyze

At the analysis stage, several in-depth studies were conducted including:

a. Curriculum and materials analysis

The analysis of curriculum and materials refers to the academic review book of the independent curriculum (Wahyudin et al., 2024); high school physics teacher's manual grade XI, and the results of physics teacher interviews. The full results can be seen in Tables 2 and 3 below:

Table 2. Curriculum Analysis

Curriculum Components	Relevance to Research
Objectives: Meaningful learning, character development (Pancasila), creativity (cipta, rasa, karsa).	The robotics & guided inquiry-based module supports meaningful learning, creativity, and critical thinking according to the Pancasila Student Profile.
Characteristics: Constructivism (learning-relearning-unlearning), integrated assessment.	Guided inquiry facilitates knowledge construction through robotic experimentation plus formative assessment.
Foundation: Industrial Revolution 4.0, 21st century skills (technology, collaboration).	Educational robotics trains technological literacy and 21st century skills.
Pancasila Student Profile: Critical, creative, independent.	The kinematics module is designed to develop these dimensions through a robotics project.
Evaluation: Continuous assessment (competency, character).	Formative assessment during robotic experiments fits this principle.

Table 3. Material Analysis

Aspect	Brief Description
Material Characteristics	a. Presented systematically: example concepts: graphics/calculations. b. Descriptive & applicative with real examples.
Depth of Material	a. Coverage: Basic definitions (distance, velocity, acceleration), graph analysis, GLB/GLBB equations. b. Focus on basic concepts and simple applications.
Learning Objectives	a. Analyzing the magnitude of straight motion (GLB/GLBB). b. Interpreting graphs. c. Apply concepts in problem solving.
Learning Scheme	a. Subchapter A (4 JP): Frame of reference, position, definition of motion. b. Subchapter B (6 JP): Distance/displacement, velocity, acceleration. c. Subchapter C (6 JP): GLB, GLBB, parabolic motion.

Based on a review of the independent curriculum, this robotics and guided inquiry-based module fulfills the three main principles of the curriculum: 1). meaningful learning through concrete experiments with robots that develop the Pancasila Learner Profile, 2). constructivist approach where students construct knowledge through stages of inquiry, and 3). development of 21st century skills such as technological literacy and collaboration through robot programming activities. This module is specifically designed to support the formative assessment that characterizes the independent curriculum, with integrated assessment during the experimental process.

The straight motion kinematics material in the module is organized hierarchically from basic concepts (position, distance) to GLB/GLBB analysis, with the most time allocation for motion quantities (6 JP) and motion analysis (6 JP). The applicative characteristics of the material are realized through the design of robotics activities, such as programming robots to simulate GLB (fixed speed) and GLBB (constant acceleration), so that abstract concepts can be understood visually and practically. The division of subchapters in the module follows the curriculum learning scheme but is enriched with robotics experiments that strengthen conceptual understanding as well as students' analytical skills.

b. Analyze learner characteristics and needs

The analysis of learner characteristics and needs refers to the 21st century learner characteristics book (Barus et al., 2023) and the results of open interviews with physics teachers. The full results can be seen in Table 4 and 5 below:

Table 4. Analysis of Learner Characteristics

Characteristics	Description	Relevance to Research
High Digital Literacy	Ability to use digital tools and online platforms to learn	Robotics-based module utilizes students' digital expertise through technological experimentation
Creativity & Innovation	Ability to think out-of-box and create new solutions	Guided inquiry encourages creative exploration of straight motion parameters through robots
Critical Thinking	Ability to analyze problems and evaluate evidence	Robotic experiments train motion data analysis to verify physics concepts
Collaboration	Teamwork skills in a multidisciplinary environment	Group projects designing robot trajectories develop communication and teamwork
Information Literacy	Ability to critically assess and utilize information	Students compare robot experimental data with theoretical references

Table 5. Learner Needs Analysis

Needs	Description	Implementation in Module
Digital Technology	The need to master digital tools for learning	Integration of educational robots and digital simulation in kinematics material
Contextualized Learning	The need to connect theory with real applications	Design straight motion experiments using robots with real-world scenarios
Collaboration	Teamwork skill development needs	Group activities to design and test robot performance
Learning Independence	The need to manage the learning process independently	Guided inquiry phase that allows individual exploration of motion parameters
Data Literacy	The need to verify information through empirical data	Procedures for analyzing data from robot experiments to confirm concepts

Based on the analysis of learner characteristics, table 4. This robotics and guided inquiry-based module is specifically designed to utilize students' digital literacy in operating robotic devices. The experimental approach through robots also accommodates students' creativity and critical thinking characteristics, where they can explore various parameters of straight motion directly. Collaborative activities in the robotics project match the teamwork characteristics of 21st century learners, while the process of comparing experimental data with physics theory supports the development of information literacy.

Learner needs analysis, table 5. shows that this module meets several key learning needs. The integration of robotics technology addresses the need for mastery of digital tools, while the design of experiments with real-world scenarios meets the demands of contextual learning. The structure of group activities in the module is designed to develop collaboration skills, while the guided inquiry phase provides room for independent learning. The experimental data analysis procedure included in the module directly develops students' data literacy according to 21st century learning needs.

2. Design

The development process at the design stage produces several main components that are interrelated. The following are the results and discussion of each activity at the design stage:

a. Module content structure design

This learning module is designed with a structure that integrates theoretical concepts and practical applications harmoniously, starting with an introduction that describes the context and learning objectives, as shown in Figure 3.

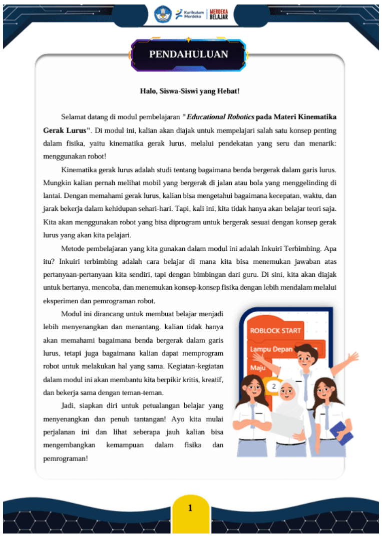


Figure 3: Introduction section of the module

The next section introduces the Roblock device and mBlock programming as the basis for technical skills.

Figure 4. Instructions for use section

The module structure also contains a concept map presented visually to guide the learning flow and there are also learning objectives.

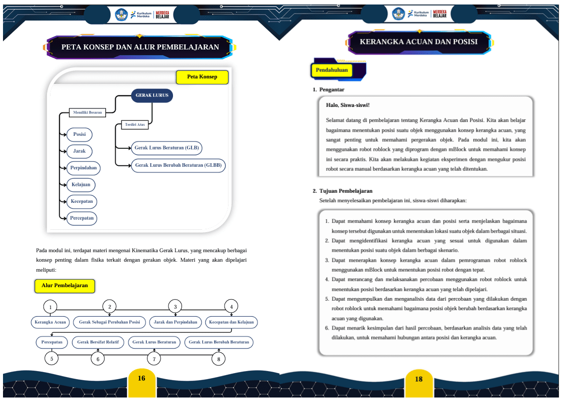


Figure 5. Concept Map, Learning Flow and Learning Objectives Section

The core part of the module, namely learning activities, is packaged through the syntax of the inquiry learning model with robotic activities, as shown in Figures 6 and 7.

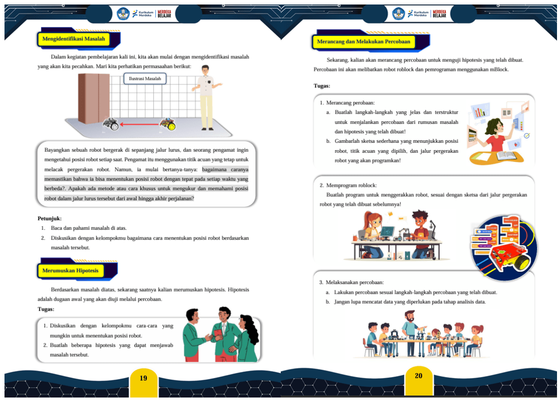
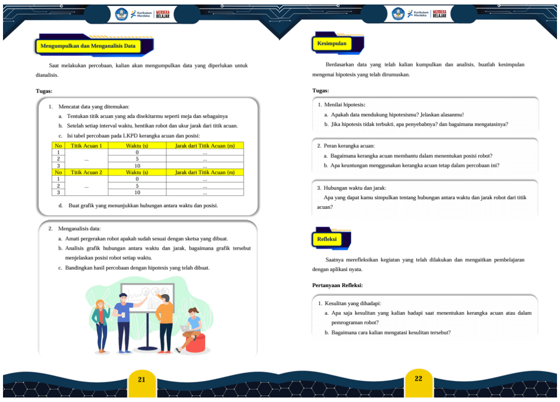


Figure 6. Identify, Hypothesize, Design and Conduct Experiments section



Mengumpulkan dan Menganalisis Data

Saat melakukan percobaan, kalian akan mengumpulkan data yang diperlukan untuk dianalisis.

Tugas:

1. Mencatat data yang ditemukan:
   a. Tentukan titik acuan yang ada disekitarmu seperti meja dan sebagainya
   b. Setelah setiap interval waktu, hentikan robot dan ukur jarak dari titik acuan.
   c. Isi tabel percobaan pada LKPD kerangka acuan dan posisi:

No	Titik Acuan 1	Waktu (s)	Jarak dari Titik Acuan (m)
1	...	0	...
2		5	...
3		10	...
No	Titik Acuan 2	Waktu (s)	Jarak dari Titik Acuan (m)
1	...	0	...
2		5	...
3		10	...

   d. Buat grafik yang menunjukkan hubungan antara waktu dan posisi.

2. Menganalisis data:
   a. Amati pergerakan robot apakah sudah sesuai dengan sketsa yang dibuat.
   b. Analisis grafik hubungan antara waktu dan jarak, bagaimana grafik tersebut menjelaskan posisi robot setiap waktu.
   c. Bandingkan hasil percobaan dengan hipotesis yang telah dibuat.

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Kesimpulan

Berdasarkan data yang telah kalian kumpulkan dan analisis, buatlah kesimpulan mengenai hipotesis yang telah dirumuskan.

Tugas:

1. Menilai hipotesis:
   a. Apakah data mendukung hipotesismu? Jelaskan alasanmu!
   b. Jika hipotesis tidak terbukti, apa penyebabnya? dan bagaimana mengatasinya?
2. Peran kerangka acuan:
   a. Bagaimana kerangka acuan membantu dalam menentukan posisi robot?
   b. Apa keuntungan menggunakan kerangka acuan tetap dalam percobaan ini?
3. Hubungan waktu dan jarak:
   Apa yang dapat kamu simpulkan tentang hubungan antara waktu dan jarak robot dari titik acuan?

Refleksi

Saatnya merefleksikan kegiatan yang telah dilakukan dan mengaitkan pembelajaran dengan aplikasi nyata.

Pertanyaan Refleksi:

1. Kesulitan yang dihadapi:
   a. Apa saja kesulitan yang kalian hadapi saat menentukan kerangka acuan atau dalam pemrograman robot?
   b. Bagaimana cara kalian mengatasi kesulitan tersebut?

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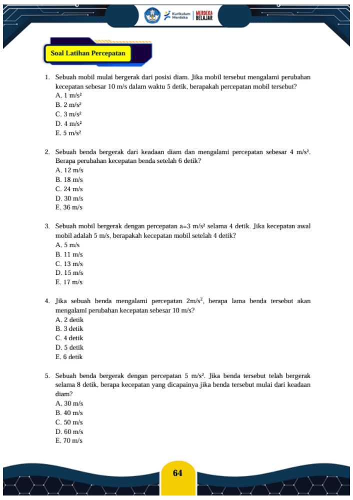
Figure 7. Collecting and Analyzing data, Conclusions, and Reflection

The assessments are comprehensively designed to include practice questions to measure conceptual understanding.



Soal Latihan Percepatan

1. Sebuah mobil mulai bergerak dari posisi diam. Jika mobil tersebut mengalami perubahan kecepatan sebesar 10 m/s dalam waktu 5 detik, berapakah percepatan mobil tersebut?
   A. 1 m/s^2
   B. 2 m/s^2
   C. 3 m/s^2
   D. 4 m/s^2
   E. 5 m/s^2
2. Sebuah benda bergerak dari keadaan diam dan mengalami percepatan sebesar 4 m/s^2. Berapa perubahan kecepatan benda setelah 6 detik?
   A. 12 m/s
   B. 18 m/s
   C. 24 m/s
   D. 30 m/s
   E. 36 m/s
3. Sebuah mobil bergerak dengan percepatan a=3 m/s^2 selama 4 detik. Jika kecepatan awal mobil adalah 5 m/s, berapakah kecepatan mobil setelah 4 detik?
   A. 5 m/s
   B. 11 m/s
   C. 13 m/s
   D. 15 m/s
   E. 17 m/s
4. Jika sebuah benda mengalami percepatan 2m/s^2, berapa lama benda tersebut akan mengalami perubahan kecepatan sebesar 10 m/s?
   A. 2 detik
   B. 3 detik
   C. 4 detik
   D. 5 detik
   E. 6 detik
5. Sebuah benda bergerak dengan percepatan 5 m/s^2. Jika benda tersebut telah bergerak selama 8 detik, berapa kecepatan yang dicapainya jika benda tersebut mulai dari keadaan diam?
   A. 30 m/s
   B. 40 m/s
   C. 50 m/s
   D. 60 m/s
   E. 70 m/s

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Figure 8. Exercise Question

At the end there is a bibliography as a learning reference.

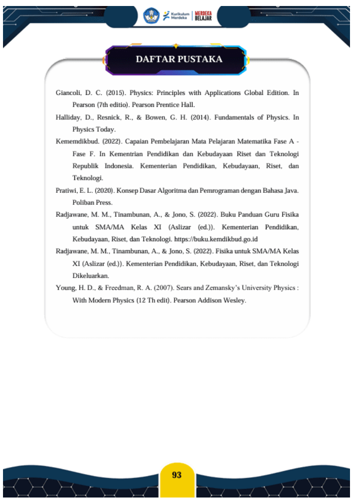

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Figure 9. Bibliography

This overall structure creates a coherent learning flow from understanding basic concepts to application in real experiments, blending theoretical and practical approaches in a balanced way to facilitate a deep and meaningful learning experience.

b. Design of module appearance and format

This module is designed to be attractive and easy to understand. Using bright colors and a neat layout, the module combines theoretical explanations with practical guidance on robotics.

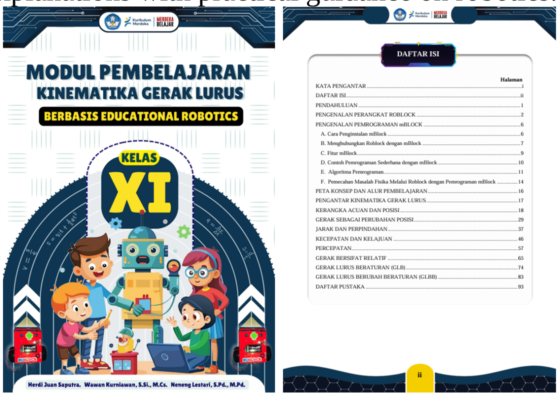

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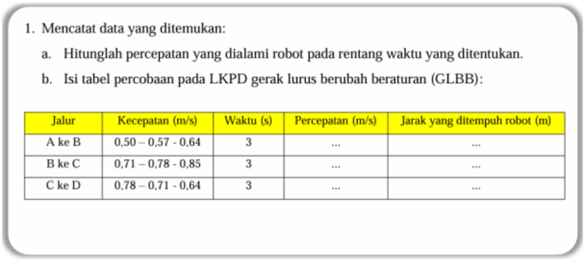
Figure 10. Module Cover and Content Design

Each page is organized to guide students to learn physics concepts while experimenting directly with the robot. The design is made simple but functional, so that students can focus on learning without confusion.

c. Designing interactive robotics-based activities

The module provides interesting practical activities where students program the robot to move following a specific scheme.



1. Mencatat data yang ditemukan:
   a. Hitunglah percepatan yang dialami robot pada rentang waktu yang ditentukan.
   b. Isi tabel percobaan pada LKPD gerak lurus berubah beraturan (GLBB):

Jalur	Kecepatan (m/s)	Waktu (s)	Percepatan (m/s)	Jarak yang ditempuh robot (m)
A ke B	0,50 – 0,57 - 0,64	3	...	...
B ke C	0,71 – 0,78 - 0,85	3	...	...
C ke D	0,78 – 0,71 - 0,64	3	...	...

Figure 11. GLBB Material Experiment Table

From the experiment table, the hypothesis that has previously been made, students test the hypothesis through the experiment table provided, then translate the analysis results obtained into the mBlock program. Figure 11 is an example of the mBlock program and the robot movement scheme from point A to B.

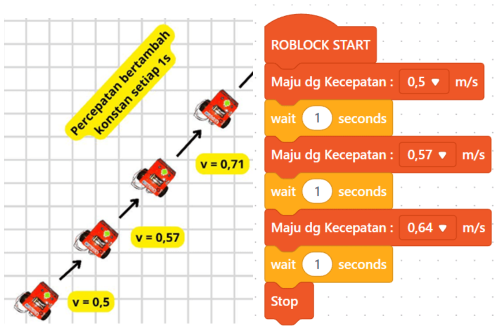


Figure 12. mBlock Program and Robot Movement Scheme

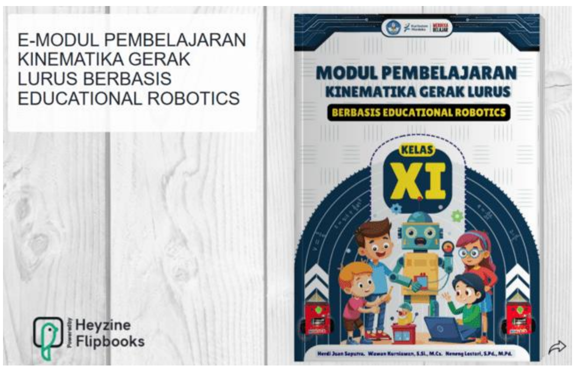
This activity not only trains programming skills, but also strengthens conceptual understanding of the relationship between motion parameters (distance, speed, acceleration) through direct experimentation. The design of these activities allows students to experience an authentic learning process, where physics theories are applied in real situations through the medium of robotics. Each concept in the module is complemented by similar activities tailored to the characteristics of the material, ensuring comprehensive and thorough learning.

3. Development

The development stage is a critical phase in this research, where the initial ideas and designs are realized into real products. In this stage, there are three main activities carried out sequentially:

a. Module Prototyping

Module prototypes were made in two versions (student and teacher) and two formats (print and electronic).



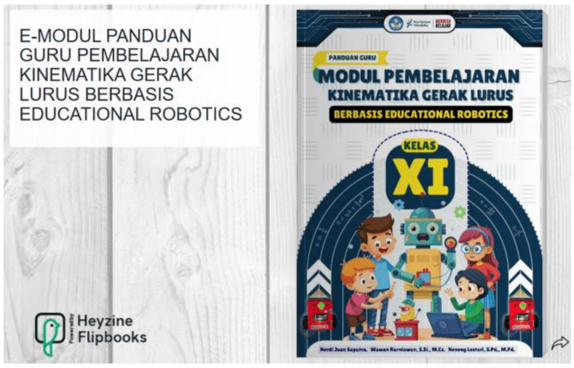


Figure 13. Student E-Module and Teacher Guide Versions

The printed version is designed with a clear and visually appealing layout, while the e-version offers the advantage of interactive features such as video tutorials that can be played directly and flexible accessibility. The difference between the teacher and student versions of the module lies in the more complex explanations related to the use of the module and the presence of complete teaching instructions.

b. Experimental Data Collection

Necessary data such as speed needs to be known in order to create customized programming code for learning activities, the data is measured through a series of direct experiments and calculation results.

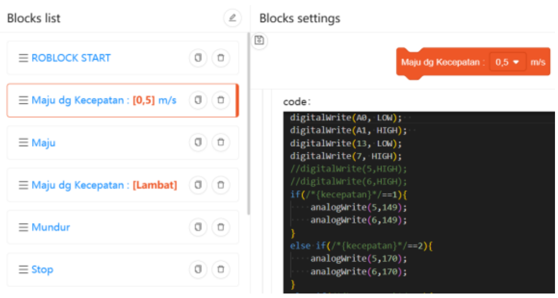


Figure 14. Setting the block code against the required speed

The necessary data collection also involves physics education students, to use the module like students at school, and provide valuable input on the effectiveness of the robot in learning and the possibility of technical problems when using the robot.

Gambar 15. Experimental Data Collection

c. Module Validation

The module has gone through a validation process by material experts and media experts, each involving two validators, following the module validation results:

Table 6. Material Expert Validation Stage 1

Aspects	Percentage V.1	Percentage V.2	Average	Ket.
Quality of Content and Purpose	77,8%	76,4%	77,1%	Valid
Quality Learning	90,9%	93,2%	92%	Very Valid
Average	84,4%	84,8%	84,6%	Valid
Ket.	Valid	Valid		

The validation results show that the developed learning module has met the eligibility criteria with an Average Percentage of 84.6%. In particular, the Aspects of learning quality obtained the highest score of 92% (Very valid), indicating that the design of robotics-based learning activities and the guided inquiry approach applied has succeeded in creating a good learning experience.

Meanwhile, the content and objective quality Aspects scored 77.1% (valid), indicating that although it has met the eligibility standards, there is still room for improvement especially in terms of the depth of the material and the clarity of the learning objectives. The small difference between the validator 1 and 2 versions (84.4%) and (84.8%) confirmed the consistency of the module quality throughout the development process.

Table 7. Material Expert Validation Stage 2

Aspects	Percentage V.1	Percentage V.2	Average	Ket.
Quality of Content and Purpose	93,1%	95,8%	94,5%	Very valid
Quality Learning	100%	100%	100%	Very Valid
Average	96,6%	97,9%	97,3%	Very valid
Ket.	Very valid	Very valid		

The results of the second stage validation showed a significant increase in all Aspects of the module, with the average feasibility reaching 97.3% (Very valid), where the Aspects of content quality and objectives increased to 94.5% (from 77.1% previously) and learning quality reached perfection (100%). This increase proves that the revision based on the first stage validator's input has succeeded in improving the module. The consistency of the “Very valid” ratings on both versions (96.6% and 97.9%) as well as the perfect achievement on the learning Aspects confirm the readiness of the module to be implemented in the field.

Table 8. Media Expert Validation Stage 1

Aspects	Percentage V.1	Percentage V.2	Average	Ket.
Integrity	62,5%	70,8%	66,7%	Less Valid
Balance	68,8%	68,8%	68,8%	Less Valid
Letter Shape	84,4%	78,1%	81,3%	Valid
Color	79,2%	79,2%	79,2%	Valid
Language	68,8%	81,3%	74,9%	Valid
Average	72,7%	75,6%	74,2%	Valid
Ket.	Valid	Valid		

The results of the first stage of media expert validation showed that the module obtained an average feasibility of 74.2% (valid category), with several Aspects that still require improvement. Aspects of cohesiveness and balance scored below 70% (66.7% and 68.8% respectively), indicating the need for improvement in terms of design consistency and layout of visual components. However, the letterform (81.3%), color (79.2%), and language (74.9%) Aspects have reached the valid category, indicating that the basic elements of graphic design and material delivery have met the standards. Overall, these results provide an important basis for making thorough revisions before entering the next validation stage.

Table 9. Media Expert Validation Stage 2

Aspects	Percentage		Average	Ket.
	V.1	V.2		
Integrity	100%	95,8%	97,9%	Very valid
Balance	93,8%	87,5%	90,7%	Very valid
Letter Shape	96,9%	90,6%	93,8%	Very valid
Color	91,7%	91,7%	91,7%	Very Valid
Language	93,8%	93,8%	93,8%	Very Valid
Average	95,2%	91,9%	93,6%	Very Valid
Ket.	Very valid	Very valid		

The results of the second stage validation showed a significant improvement in all Aspects of the media module with an average of 93.6% (Very valid), where the Aspects of integration reached 97.9% (an increase of 31.2 points from stage 1) and balance 90.7% (an increase of 21.9 points), proving the effectiveness of revisions based on the previous stage feedback. Improved consistency is evident from the minimal difference between validator 1 (95.2%) and validator 2 (91.9%), with the Aspects of letterform (93.8%), color (91.7%), and language (93.8%) stable in the Very valid category. The final Average score of 93.6% (only 6.4% from perfection) indicates that the module has met the high quality standards of learning media and is ready for use.

4. Evaluation

Evaluation of the analysis stage revealed the importance of deepening the material to ensure the suitability of the learning content with the technical capabilities of the robot used. The team carried out a thorough revision of the analysis of physics concepts and their relationship with robotics experiments, especially in terms of material depth and tool readiness. Some adjustments were made to the CP and TP to match the kinematics theory and its practical application through robots.

The design stage evaluation received various improvement inputs from the development team. Significant changes were made to the module layout to improve navigation, including reorganizing the flow of learning activities. Visual aspects were also enhanced by adjusting the color palette, adding icon markers, and improving typography to improve readability.

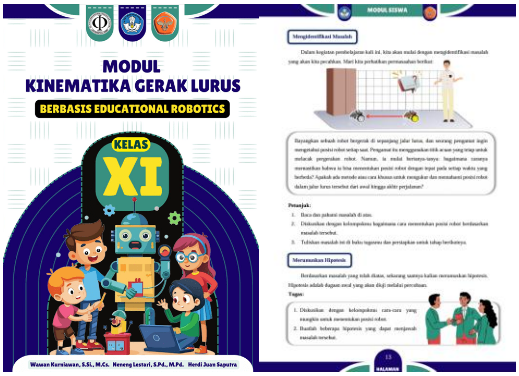


Figure 16. Module Before Evaluation

Figure 17. Module After Evaluation

The content structure was overhauled to make it more systematic, with an emphasis on linking conceptual explanations and learning activities with robotics.

Evaluation of the develop stage revealed several technical problems during the pilot test. The main problems included the instability of the robot's movement due to the unstable robot wheels, as well as the deviation of the speed measurement results compared to theoretical calculations. The results of the evaluation with the development team have resolved these issues.

Conclusion

The development of a straight motion kinematics learning module based on educational robotics and guided inquiry model has successfully created a product that meets the eligibility standards Very valid based on the assessment of material experts (97.3%) and media experts (93.6%). This module effectively integrates robotics technology (Roblock) and mBlock programming to visualize abstract concepts into concrete learning experiences, while developing 21st century skills such as critical thinking, creativity, and collaboration. The advantages of the final product lie in the availability of print and digital versions with interactive features, complete guides for teachers and students, and robotics activities relevant to all concepts of kinematics of straight motion. For further implementation, teacher training in robotics utilization, further development of experimental variations, and research on the effectiveness of the module in improving learning outcomes are recommended. This product is not only an innovative learning solution for kinematics material, but also a pioneer in the integration of educational robotics in physics learning in Indonesia that is ready to be applied in the school environment.

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