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Development of Inquiry-Based Physics Learning Modules on Linear Motion Materials for Senior High School Students

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ABSTRACT

This study aims to produce valid, practical, and effective inquiry-based learning modules to improve students' understanding of the concept of rectilinear motion. This research uses the ADDIE model of Research and Development (R&D). Data collection uses walkthroughs, questionnaires, and tests. The research subjects were students of class X MIPA 2 SMA Negeri 2 Babat Supat. Based on the data analysis, the learning modules developed were stated to be valid, practical, and effective. The results of the expert review obtained an average value of 87.5% which was categorized as very valid, one to one obtained an average value of 88% which was categorized as very practical, the small group obtained an average value of 89.8% which was categorized as very practical, and the field test was obtained the average value of the pre-test was 41.19, and the post-test was 79.04 with an average N-Gain value of 0.64 in the medium category.

Introduction

Learning is a process of interaction between educators and learning resources that takes place in an educative manner, whose job is to build attitudes, knowledge, and skills to achieve the goals set (Agustina et al., 2020). Development of attitudes in learning in the form of a more mature attitude change. The development of knowledge is to improve the academic abilities of students. Then the skills development that is formed is in the form of increasing the ability of expertise in a particular field, usually known as soft skills. Soft skills in question are skills in showing something that has been mastered, such as expertise in conducting experiments or skills in answering questions given by educators. There are several subjects discussed in classroom learning, one of which is physics.

Physics is a branch of Natural Sciences (IPA) that studies natural phenomena and the interactions of these natural phenomena (Maisarah, 2015). The natural phenomena in question include the appearance of lightning when it rains, floods, earthquakes, and the greenhouse effect. Learning physics is not only about fundamental natural phenomena, but some formulas must be solved. The formula is useful for obtaining the calculation results needed to conclude a phenomenon.

Learning is a change in behavior through experience and meaningful interaction resulting from a change or acquisition of knowledge and skills (Nurbati, 2022). The experience gained from learning is like how to think with the environment so that he gets the results from the experience itself (Nasution et al., 2019). Learning is a series of processes to acquire knowledge, understanding, skills, and attitude values as seen from changes in student behavior (Wahyuni, 2022). The process in question is the steps where students can

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find problems, formulate problems and draw conclusions. Based on the description above, learning is a process of changing behavior in which a person makes experience and knowledge as a result that he gets from this experience and knowledge so that he can show a change in behavior.

The learning process cannot run smoothly without someone at school who is in charge of directing and guiding the learning process or the teacher. The teacher has the ability to know each student in the form of mindset, behavior, character, interests and so on. The teacher's knowledge of students becomes the basis for planning learning and choosing the right learning media to help students achieve learning goals. The use of appropriate learning media can increase student learning motivation so that in the end it increases understanding of concepts and student learning outcomes.

Physics is a subject that discusses various phenomena that surround human life. These phenomena are reviewed from various aspects so that new knowledge is obtained based on observations of certain phenomena. Therefore, physics material is very complex and requires various abilities to solve the problems at hand. Therefore, physics teachers are required to have various abilities so that the physics material presented can be understood by students properly.

The ability to use ICT in learning is a requirement to become a professional one. The purpose of using ICT is to help students achieve learning goals by presenting material to students as a whole and fun. The use of ICT in learning allows material to be presented in various formats such as videos, images or animations which can improve students' understanding of concepts.

The use of ICT can also increase student involvement in learning activities through interactions between students and the media used. Interaction in learning using ICT through a series of activities means to guide students to find a physics concept. Activities carried out by students in inquiry learning can train various aspects of students' abilities cognitive, affective and psychomotor. Inquiry learning can be an effective alternative learning model to avoid student learning saturation so as to increase students' understanding of concepts.

The development of ICT provides various advantages in physics learning activities. ICT can make learning activities fun by involving students in discovery activities so that students are involved in thinking activities effectively and efficiently. The presence of ICT also allows print learning resources to become digital learning resources that can be distributed to students via social media or computer or smartphone devices. Thus, the availability of learning resources in the form of electronic modules helps students in learning so that they can improve students' understanding of concepts. Conversely, the lack of learning media can hinder the process of teaching and learning activities so that students' understanding of the material presented is low.

Based on the results of interviews with physics subject teachers, it can be seen that the average result of assignment scores and student test scores is 50. The student learning outcomes are still below the minimum completeness criteria (KKM) score of 75. This is because the learning process has not been optimal develop student abilities that have an impact on the lack of understanding of student motion material. This result is supported by observations on the learning process which shows that students are less active. Therefore, student involvement in the learning process will increase student learning activities.

Therefore, to increase student involvement in the learning process, learning media are needed that can involve students in the learning process. Student involvement in the learning process can be a student learning experience in acquiring knowledge. Knowledge obtained through a learning process will be more permanent in students' memories compared to knowledge obtained only by hearing, taking notes or memorizing.

Linear motion is an essential material in physics based on the curriculum applied both the 2013 curriculum and the independent curriculum. However, the subject matter of linear motion is still difficult for students to understand, especially the subject of distance, speed transfer, and determination. Judging from its characteristics, the subject matter of distance, displacement, speed and velocity are vector quantities. In solving vector problems students need good mathematical skills and illustrations of phenomena too. Even though students can memorize the formulas of motion, they are not necessarily able to solve motion problems properly. Because the material motion is not only viewed from the magnitude that can be solved mathematically but it is also influenced by its direction. Therefore, it is necessary to increase students' ability to understand the phenomenon of motion.

Improving students' ability to understand the phenomenon of motion is done by integrating the phenomenon of motion in learning material. The phenomenon of motion is investigated through certain steps to obtain generalization as new knowledge for students. Thus students are directly involved in discovering the concept of motion that they experience in everyday life.

The development of ICT in learning opens opportunities to develop teaching materials based on phenomena experienced by students. The teaching materials used so far only present routine problems that are solved using mathematical equations without the support of adequate explanations of phenomena or free-motion diagrams of objects. Teaching materials like this only require students to memorize formulas. Therefore, it takes a teaching material that can display phenomena that can be solved by students and is easy to get.

The teaching material in question is an inquiry-based physics learning module. The inquiry-based physics learning module is a module that contains motion material presented based on inquiry steps that can be distributed to students via social media or smartphones. The inquiry-based physics learning module emphasizes students' critical thinking and finding their own answers to the problems in question (Triandini et al., 2021). In the inquiry-based physics module students are guided to seek and find solutions to the problems they face themselves. The problem given is of course a problem that can be solved by students.

Modules are teaching materials that are packaged in a complete and systematic manner accompanied by a learning plan to help students achieve learning objectives using language that is easy to understand (Gumay et al., 2020; Siregar et al., 2022). The inquiry-based physics learning module is used as a guide for students and teachers to learn.

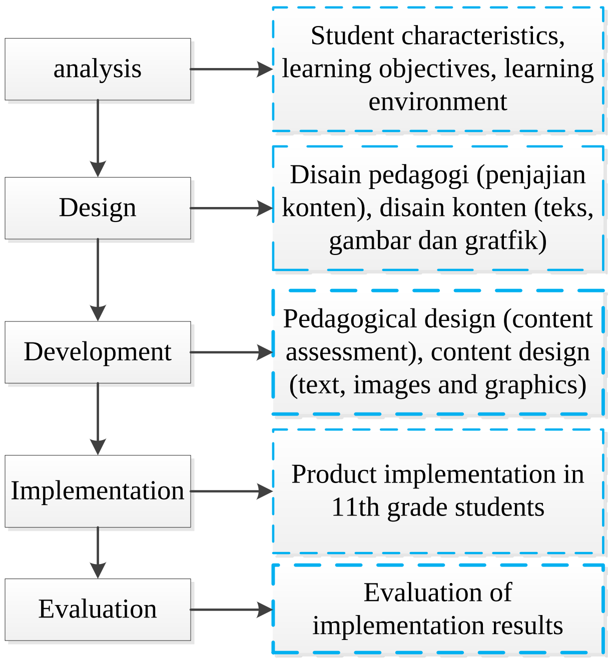
Based on some of the descriptions above, inquiry-based modules can provide opportunities for students to learn independently. The use of inquiry-based modules can change the learning process which was initially teacher-centered, then changed to student-centered learning. Therefore, this study aims to develop an inquiry-based physics learning module on linear motion material to improve students' understanding of concepts.

Method

The research method used is the ADDIE model of R&D (Reseach and Development) research which is one of the systematic learning design models. The development of teaching materials using the ADDIE model has been carried out by many researchers (Syarah Syahiddah et al., 2021; Wilujeng & Rohman, 2021). The model used is the ADDIE model which consists of; 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation. The first step is the analysis of learning objectives, student characteristics, and learning environment, the second is the module content design which consists of pedagogical design and content design. The pedagogy used in conveying the content is inquiry, the third is developing the module content according to the inquiry steps, the implementation of the module in eleventh grade students and the fifth is evaluating the results of the implementation of inquiry-based learning modules. The steps for developing the module are shown in Figure 1.

Figure 1

The Research Flowchart for the Development of Inquiry-Based Physics Module Uses the ADDIE Model



The Addie model is often used to design learning in education and training(Yao, 2021). Addi's model includes five steps that are interconnected with each other from analysis to evaluation where these five steps are easy to do in module development. Therefore, teachers can easily develop learning content that fits the characteristics of students so that it can be used to guide students to self-study. Student learning activities are guided by the presentation of material according to the inquiry steps.

The research subjects were tenth grade students at a public high school in South Sumatra, totaling 21 students. The sampling technique uses a purposive sampling technique based on the results of discussions and suggestions from the class teacher. The data collected is in the form of qualitative data and quantitative data. There are three data collection methods in this study, namely:

1. *Walkthrough*to determine the validity of the resulting module based on expert opinionSource. Product evaluation was carried out by three experts consisting of two experts from tertiary institutions and one teacher. The instrument used is in the form of several statements that are adjusted to the resulting module. At the end, a room for expert comments is given to provide suggestions and recommendations that are not included in the questions. Assessment of inquiry-based physics learning modules by experts by giving a score on each item with a range of one to five. Questionnaire analysis at the walkthrough stage uses quantitative analysis which is presented in the form of the average value of expert responses.

2. Questionnaire used to determine the user's response to the resulting module. The questionnaire was used in the one-to-one and small group trials. The test results provide an overview of students' responses to the module. Therefore the results at this stage state the level of practicality of the module based on user opinions, in this case students. Questionnaire analysis uses a Likert scale which states the percentage of user responses to the product produced. Students give a score to each statement from strongly disagree to strongly agree with a score range of one to five.

3. The test is used to measure students' understanding of the concept of motion before and after using the resulting module (Sudaryono, 2016). The test consists of five questions in the form of an essay.The test instrument before being used was tested to determine the validity of the instrument. Construct validity based on the results of expert judgment. The valid test instrument was then tested on eleventh grade students to determine the validity and reliability of the instrument. Valid and reliable instruments will then be used to collect research data. Analysis of test results data using normalized gain analysis provides an overview of the effectiveness of the module in improving student learning outcomes.

Results and Discussions

The product developed in this study is an inquiry-based physics learning module, especially motion material. The developed module is expected to increase students' understanding of the concept of motion and as a learning resource for students. Module development as an effort to enrich learning resources, especially at the research location school.

Physics learning modules have been developed a lot before using approaches or learning models as a sequence in presenting the material. The objectives of module development also vary according to the context and place where the research is carried out. Development of scientific-based modules to improve students' critical thinking skills (Ulandari et al., 2018). Development of problem solving-based modules to overcome the problem of the absence of modules used during classroom learning (Deti et al., 2021). The development of PBL-based modules can improve students' thinking skills (Lawut et al., 2019). Development of discovery learning-based modules to help students understand concepts and reduce student misconceptions (Mulyar et al., 2018). Implementation of the module from the results of development research in the learning process shows positive results (Shobrina et al., 2020).

Several other researchers have developed inquiry-based physics learning modules such as Anggraeni et al. (2019). Module development equipped with a QR code connected to youtube. The use of QR codes to make it easier for users, namely teachers and students to choose material and media used in learning (Khair et al., 2021). Development of an inquiry-based physics module consisting of several steps, namely, focusing on problems on the phenomena of everyday life, formulating problem solving and experiments as and evaluating the results of problem solving (Setianingsih et al., 2018). These steps are the inquiry steps used in presenting the problem to students.

The application of inquiry can train students to find scientific questions on their own, ask questions to increase students' critical attitudes, find possible solutions, collect evidence as proof of problem solving (Imaduddin & Hidayah, 2019). Inquiry learning focuses on problems and issues related to students' lives (Sari et al., 2020). Application of inquiry in module development as a pedagogic in presenting learning materials so that students acquire knowledge, skills and attitudes (Öztürk & Bayram, 2020). The use of inquiry in modules makes learning activities easier to implement by taking into account various learning environments. The flexibility of using inquiry in learning modules in terms of various disciplines to achieve learning objectives is referred to as the flexibility of inquiry-based science learning.

The application of inquiry in the physics learning module for motion material is adapted from Rafiqah & Dani (2021), as shown in Table 1. Based on the previous inquiry steps, the module development consists of several parts, namely the front page, introduction, presentation of evaluation fund material. The front page consists of a cover, preface, content standards, table of contents, benefits and objectives, concept maps, and a glossary. The introduction consists of descriptions, prerequisites, instructions for using the module, learning objectives, benefits. The presentation of learning material consists of the main materials of movement and scientific work. The evaluation consists of evaluation tests, bibliography and answer keys.

Table1

The Application of the Inquiry Model in the Physics Learning Module

Stage	Description
Stage 1 Orientation	In this section, the module displays the objectives and indicators of learning outcomes, and student activities during the learning process. This activity also motivates students to learn.
Stage 2 Formulate the problem	Presented phenomena around students about motion. Then presented the problems that must be solved by students.
Stage 3 Formulating a hypothesis	Columns are given to write hypotheses according to the problems presented to students.
Stage 4 Collecting data	Students look for information to answer the questions given. The teacher guides by asking questions so that students focus on the problem at hand
Stage 5 Testing the hypothesis	Students collect information, tabulate information, or describe findings that are in accordance with the problems presented. Students are asked to reflect back on the answers given until they are sure of the answers given.
Stage 6: Formulate conclusions	Students discuss and are guided by the teacher to describe their findings as a generalization of the answers to the problems presented. Students compare the answers given with the hypotheses previously proposed.

The material in the module is a compilation of materials obtained from various sources, both print and electronic, both in verbal and visual forms. Material from various sources is rearranged to form a complete material as a student learning resource. The definition or understanding of motion is a general understanding widely used in various books so that it does not experience much change. The selection of material is based on the learning objectives to be achieved. The suitability between objectives and materials is shown in Table 2.

Table2

Design the Contents of an Inquiry-Based Physics Learning Module

Learning Objectives	The Material Presented
Explain the basic concepts of motion	Displays a picture of a train running on the rails  Does your position with your partner sitting beside you change if you sit on the train? Did the position of the train and you guys change from the station where you got on? This question will encourage students to analyze and seek information to answer the questions presented.
Generalize the equations of motion from the information provided	Three students are jogging in a park, the front position is Ahmad, the second position is Hasan and Fahrul is in the back position. If they run from the same position and satar time, based on the following figure, the one with the farthest distance is….  Do they have the same time? Who can run the fastest?

The questions given to students are instructions that must be answered by students to achieve learning objectives. Students seek information from various sources to answer each question given. The desired answer is the student's answer based on the observations of the phenomena presented which are in accordance with the information obtained. Therefore the answers given by students are the findings of the students themselves based on the information and phenomena presented. The student's findings are new knowledge obtained through a series of activities so it is an inquiry activity.

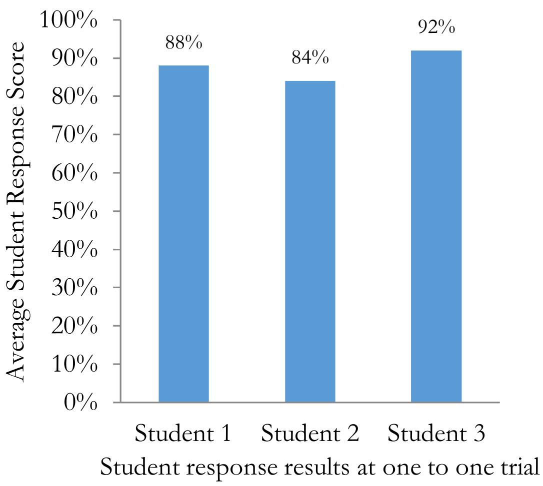
The resulting module product is first validated by a validator to assess the validity and feasibility which consists of three aspects, namely language aspects, learning design aspects, material aspects. The results of the module validation developed with the average response of the validator for each aspect are the language aspect, which is 87.6, the learning design aspect 86.6, and the material aspect 88.3, so the inquiry-based physics learning module is categorized as very valid and feasible to try out (Yuanita, 2015). Even though the product is very valid, the validator still provides suggestions and input to make the module better and in accordance with the inquiry steps.

Based on the opinion of experts that inquiry learning does not provide information or deficiencies to students because definitions are must be found by students. If the definition is given at the beginning of learning it is the same as traditional learning because students will memorize the definition from the teacher without understanding the definition given by the teacher. Recapitulation of validity and serviseability assessment of teaching shown in Table 3.

Table 3
Recapitulation of Validity and Serviceability Assessment of Teaching Materials

No	Validators	Rated aspect		
		Language	Learning Design	Theory
1	Validator 1	96	100	93
2	Validator 2	80	76	86
3	Validator 3	87	84	86
	Average	87.6	86.6	88.3
	Category		Very Valid	

Figure 2
Graph of Average Student Rating Stage One to One

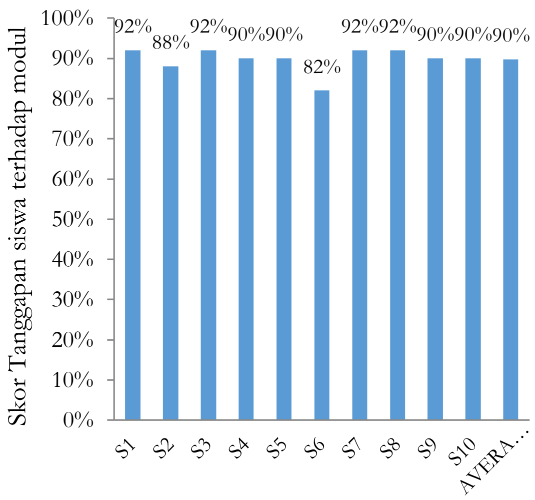


Valid inquiry-based physics learning modules based on expert responses were then tested on a limited basis. The first phase of the trial was one to one involving three students to assess the practicality of the product by filling out a questionnaire. The average results of student responses to the inquiry-based module are shown in Figure 2.

The next stage is a small-scale trial or small group. In the one-to-one trial phase, ten students were involved. All students are given part of the module content and participate in learning using the developed inquiry-based physics learning module. Students answer the questions given in the module.

At the end of the student is given a student response questionnaire to the module used. Students are also given the opportunity to comment on the modules used. In general, students responded to the modules that were developed in good categories. Based on the student's responses, it can be seen that the developed modules can be used for learning. The average student response to the inquiry-based module is shown in Figure 3.

Figure 3
Average Small Group Questionnaire Assessment



Based on Figure 3 it can be seen that the three students responses to the module were good. In the one-to-one trial, students were given a module and asked to read part or all of the module's contents and then asked to fill out a student response questionnaire to the module. At the one-to-one trial stage students are not asked to answer or do learning activities.

Based on observations and discussions with students, it was found that the weakness of the resulting inquiry-based module was the unpreparedness of students to answer each question given. The unpreparedness of students to answer each question because students do not have sufficient learning resources. From these findings, the developed inquiry-based module cannot be used for independent study.

The last stage in this research is the field test stage which is considered to have a category of validity and practicality. Therefore the developed module will be implemented in the learning activities in class. The students involved at this stage were 21 class X MIPA 2 students at a public high school in South Sumatra. The field test aimed to see the potential effect of using inquiry-based module teaching materials on linear motion material. The implementation of the field test is carried out through several stages, namely pretest, product implementation, and posttest. The results of the pretest and posttest were processed to obtain the average N-gain for each student. The summary table for the results of the N-gain categorization is shown in Table 4.

Table4

Category N-Gain Implementation of Student Motion Modules

Average N-gain	N-gain criterion	Total students	N-gain interpretation
0.70	*N-gain*>0.7	11	Tall
	0.3 ≤ N-gain ≤ 0.7	10	Currently
	N-gain< 0.3	0	Low

Table 4 shows that the average N-gain is 0.64 in the moderate category. Most students have an N-gain of more than 0.7 or a high category. The N-gain results show that the inquiry-based module is effective in increasing students' understanding of concepts (Azizah et al., 2019; Noperi et al., 2021; Pahriah & Hendrawani, 2020).

The increased understanding of students' concepts using inquiry-based modules is due to the fact that the material in the module is in accordance with the characteristics of the students. The material presented is in accordance with the level of student knowledge so that students feel challenged to complete all the bills given. On the other hand students do not feel bored because the material presented is too easy. Therefore students can study well and are motivated to learn so that students' understanding of concepts increases.

Based on the results of observations of learning activities using the inquiry module and the results of discussions with the teacher, it was revealed the weaknesses in the application of the inquiry module. One of the weaknesses revealed in the application of inquiry-based modules is students' initial knowledge of the material presented. The teacher must be creative in exploring students' knowledge to explore students' initial knowledge so that it can increase gradually so as to achieve learning objectives.

Conclusion

Based on the research results, a product in the form of a motion material physics learning module has been produced which is valid, practical and has a potential effect. The validity of the module is based on expert judgment which includes aspects of language, materials and technology. The practicality of the module is based on student responses at the one-to-one trial or limited trial stage. The potential effect is based on student learning outcomes at the implementation stage. Product implementation has been carried out and shows that the product can improve students' understanding of concepts.

References

Agustina, A. A., Misdalina, M., & Lefudin, L. (2020). Pengaruh Model Pembelajaran Kooperatif Tipe Team Games Tournament Terhadap Pemahaman Konsep Peserta Didik Pada Pembelajaran Fisika. *Jurnal Pendidikan Fisika*, *8*(2), 186. https://doi.org/10.24127/jpf.v8i2.2673

Anggraeni, I., Faizah, & Septian, D. (2019). Pengembangan Modul Fisika Berbasis Inkuiri Terbimbing Materi Fluida Dinamis. *Jurnal Pendidikan Fisika Dan Sains (JPFS)*, *2*(2), 86–96. http://journal.unucirebon.ac.id/index.php/jpfs

Azizah, L. M., Poernomo, J. B., & Faqih, M. I. (2019). Pengembangan Modul Pembelajaran Fisika Kelas XI MA/SMA Berbasis Guided Inquiry pada Materi Alat-Alat Optik. *Physics Education Research Journal*, *1*(1), 11. https://doi.org/10.21580/perj.2019.1.1.4006

Deti, E. A., Husna, H., & Anaperta, M. (2021). Pengembangan Modul Pembelajaran Berbasis Problem Solving pada Materi Gerak dan Gaya Kelas VIII SMP. *Jurnal Eksakta Pendidikan (Jep)*, *5*(1), 41–50. https://doi.org/10.24036/jep/vol5-iss1/546

Gumay, O. P. U., Ariani, T., & Putri, G. A. (2020). Development of Physics Modules Based on Inquiry in Business and Energy Subjects. *Kasuari: Physics Education Journal*, *3*(1), 46–60.

Imaduddin, M., & Hidayah, F. F. (2019). Redesigning laboratories for pre-service chemistry teachers: From cookbook experiments to inquiry-based science, environment, technology, and society approach. *Journal of Turkish Science Education*, *16*(4), 489–507. https://doi.org/10.36681/tused.2020.3

Khair, J. M., Dasmo, D., & Fatahillah, F. (2021). Pengembangan Modul Praktikum Fisika SMA Berbasis Inkuiri Terbimbing Pokok Bahasan Fluida Dinamis. *SINASIS (Seminar …*, *2*(1), 423–429. http://proceeding.unindra.ac.id/index.php/sinasis/article/view/5378

Lawut, S. Y., Kurniawati, M., & Pratiwi, H. Y. (2019). Pengembangan Modul Ipa Fisika Berbasis Pbl Pada Pokok Bahasan Gerak Lurus Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *RAINSTEK : Jurnal Terapan Sains & Teknologi*, *1*(4), 73–79. https://doi.org/10.21067/jtst.v1i4.4119

Maisarah, S. (2015). Meningkatkan Keterampilan Proses Sains Da. *Jurnal Pendidikan Sains Indonesia*, *03*(01), 218–229.

Mulyar, L. D., Serevina, V., & Budi, A. S. (2018). *Pengembangan Modul Elektronik Model Discovery Learning Materi Hukum Newton Tentang Gerak Dengan Video Stop Motion*. *VII*, SNF2018-PE-129-SNF2018-PE-136. https://doi.org/10.21009/03.snf2018.01.pe.17

Nasution, R. H., Sibuea, A. M., & Mursid, R. (2019). Pengembangan Bahan Ajar Optik Geometri Berbasis Inkuiri Untuk Mahasiswa Pendidikan Fisika. *Jurnal Teknologi Informasi & Komunikasi Dalam Pendidikan*, *5*(1), 52–63. https://doi.org/10.24114/jtikp.v5i1.12522

Noperi, H., Sarwanto, S., & Aminah, N. S. (2021). Pengembangan Modul Ilustratif Berbasis Inkuiri Terbimbing Bermuatan Pendidikan Karakter. *Science, and Physics Education Journal (SPEJ)*, *4*(2), 70–81. https://doi.org/10.31539/spej.v4i2.2392

Nurbati. (2022). Penerapan model pembelajaran kooperatif tipe snowball throwing untuk meningkatkan hasil belajar fisika konsep listrik statis pada siswa kelas xii-ipa.1 sma negeri 1 tanah jambo aye aceh utara. *Jurnal Pendidikan IGI Aceh Utara*, *01*, 111–118.

Öztürk, F. E., & Bayram, Z. (2020). Flexible Inquiry-Based Science Teaching (Fibst): Activity Design for the Electricity Module and Its Applications 1. *JIBA) / Araştırma Temelli Etkinlik Dergisi (ATED)*, *10*(1), 2020. https://orcid.org/0000-

Pahriah, P., & Hendrawani, H. (2020). Efektivitas Modul Inkuiri Dengan Strategi Konflik Kognitif Dalam Meningkatkan Keterampilan Berpikir Kritis Mahasiswa. *Hydrogen: Jurnal Kependidikan Kimia*, *7*(2), 62. https://doi.org/10.33394/hjkk.v7i2.1796

Rafiqah, & Dani, A. U. (2021). Pengembangan Model Pembelajatan Flipped Learning Berbasisi Inkuiri Dalam Mata Kuliah Fisika Dasar. *Jurnal Pendidikan Fisika*, *9*(1), 43–68.

Sari, U., Duygu, E., Şen, Ö. F., & Kirindi, T. (2020). The effects of STEM education on scientific process skills and STEM awareness in simulation based inquiry learning environment. *Journal of Turkish Science Education*, *17*(3), 387–405. https://doi.org/10.36681/tused.2020.34

Setianingsih, E., Sunarno, W., & Sukarmin, S. (2018). Pengembangan Modul Pembelajaran Dinamika Gerak Berbasis Inkuiri Terbimbing Untuk Siswa Kelas X Sma/Ma. *INKUIRI: Jurnal Pendidikan IPA*, *7*(2), 220. https://doi.org/10.20961/inkuiri.v7i2.22978

Shobrina, N. Q., Sakti, I., & Purwanto, A. (2020). Pengembangan Desain Bahan Ajar Fisika Berbasis E-Modul Pada Materi Momentum. *Jurnal Kumparan Fisika*, *3*(1), 33–40. https://doi.org/10.33369/jkf.3.1.33-40

Siregar, H. M., Solfitri, T., & Anggraini, R. D. (2022). Analisis Kebutuhan Modul Kalkulus Integral (Need Analysis of Integral Calculus Module To Improve. *Jurnal Pendidikan Matematika*, *05*(01), 16–26.

Sudaryono. (2016). *Metode Penelitian Pendidikan*. Kencana.

Syarah Syahiddah, D., Dwi Aristya Putra, P., & Supriadi, B. (2021). Pengembangan E-Modul Fisika Berbasis STEM (Science, Technology, Engineering, and Mathematics) Pada Materi Bunyi di SMA/MA. *Jurnal Literasi Pendidikan Fisika*, *2*(1), 1–8. https://doi.org/10.30872/jlpf.v2i1.438

Triandini, W., Kosim, K., & Gunada, I. W. (2021). Pengembangan Modul Fisika Berbasis Guided Inquiry Untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik. *ORBITA: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika*, *7*(1), 90. https://doi.org/10.31764/orbita.v7i1.3953

Ulandari, F. S., Wahyuni, S., & Bachtiar, R. W. (2018). Pengembangan Modul Berbasis Saintifik Untuk

Melatih Kemampuan Berpikir Kritis Pada Materi Gerak Harmonis Di Sman Balung. *Jurnal Pembelajaran Fisika*, *7*(1), 15. https://doi.org/10.19184/jpf.v7i1.7220

Wahyuni, E. (2022). Mengoptimalkan Hasil Prestasi Belajar Mata Pelajaran Fisika Dengan Materi Pembelajaran Gerak Lurus Melalui Synetics Approach. *Jurnal Inovasi Penelitian Dan Pembelajaran Fisika*, *3*(1), 36. https://doi.org/10.26418/jippf.v3i1.51865

Wilujeng, I., & Rohman, A. (2021). Pengembangan Buku Ajar Fisika Modern Berbasis Self-Regulated Learning untuk Pembelajaran dalam Jaringan. *Jurnal Ilmiah Pendidikan Fisika*, *5*(3), 477. https://doi.org/10.20527/jipf.v5i3.4122

Yao, Y. (2021). Blended Teaching Reform of Higher Vocational Education Based on Addie Teaching Design Model. *International Journal of Frontiers in Sociology*, *3*(10), 9–13. https://doi.org/10.25236/IJFS.2021.031002

Yuanita, D. I. (2015). PengembanganPanduan Praktikum Spektroskopi pada Mata Kuliah Fisika Modern. *Jurnal Inovasi Dan Pembelajaran Fisika.*, *2*(1), 77–87. https://ejournal.unsri.ac.id/index.php/jipf/article/view/2357