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Development of A Learning Module Using the Self Organized Learning Environment (SOLE) Model with Augmented Reality Assistance on the Materials of Rotation Dynamics and Equality of Rigid Bodies

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ABSTRACT

This research aims to describe the characteristics of the learning module by using the Self Organized Learning Environment (SOLE) model with the aid of Augmented Reality on the material of rotational dynamics and rigid body equilibrium, to describe the feasibility of the learning module using the Self Organized Learning Environment (SOLE) model with the aid of Augmented Reality on the dynamics material rotation and equilibrium of rigid bodies and describe students' perceptions of the readability of learning modules using the Augmented Reality-assisted Self Organized Learning Environment (SOLE) model on the material of rotational dynamics and rigid body equilibrium. This research method is a Research and Development (R&D) method with a 4D development method modified into 3D, namely define, design and development. The resulting product is a printed learning module using the Self Organized Learning Environment (SOLE) learning model assisted by Augmented Reality video playback made using the Unity 3D application. This module aims to train high school students critical thinking skills. The data samples used in this study were physics teachers and class XI students from three schools. The instruments used in this study were observation sheets, review sheets of learning implementation plan documents, the teacher needs questionnaires, student needs questionnaires, expert team validation questionnaires, and student perceptions questionnaires. Assessment of the validation test questionnaire and students' perceptions were interpreted with a Likert scale. Product validation was carried out by 3 expert validators who were reviewed from 6 aspects, namely content, presentation, critical thinking indicators, language, SOLE model stages, and media. The results obtained from this study indicate that the developed module is included in the very decent category with an average score percentage of 85.96% and students' perceptions of the developed module are in the very good category with an average score percentage of 90.01%.

Keywords: *Augmented Reality (*AR*), Critical Thinking, Module*

A. Introduction

One of the goals of a learning process is the formation of good quality learners. The reality on the ground is very much different, the quality of Indonesian education is currently quite concerning. Based on the results of Trends in International Mathematics and Science Study (2011), the average student answers correctly in the realm of knowing (knowing) by 36%, answering correctly in the realm of applying (applying) by 27 %, and percentage answer correctly in the realm of reasoning (reasoning) by 20%. This indicates that the science capabilities of Indonesian students still have to be improved on all aspects, especially in the aspect of reasoning. Aspects of reasoning have not been optimally trained to students in the science learning process in Indonesia, especially training students to analyze, solve problems, synthesize, make hypotheses, make plans, design experiments, formulate conclusions, make generalis breastmilk, evaluate and consider [1].

Ideal conditions of learning according to the Regulation of the Minister of Education and Culture number 69 of 2013 Basic Framework and Curriculum Structure of High School that the Curriculum 2013 is developed with the improvement of mindset related to learning patterns, among others, namely student-centered learning, interactive learning, networked, active, team-based, multimedia-based, student needs-based, multidisciplinary and critical learning. According to Mundilarto Critical thinking skills are required in studying exact matter such as physics. So that physics learning can be a strong driver of growing attitudes

of curiosity, openness to new ideas and can help students understand the importance of critical thinking in solving problems [2].

The material dynamics of rotation and equilibrium of rigid objects are physical materials that are considered difficult, both by students and teachers. The absorption power in the material is relatively low for the scope of Sukoharjo regency which is 64.36 lower than the province of Central Java which is 70.45 and nationally which is 70.05 [3]. This material is not easy to understand just by memorizing formulas. In line with research conducted by Rosengrant (2009) states that to solve dynamic problems required students' critical thinking skills, namely the ability of students to analyzethe forces working on an object and describe it in the form of free body diagrams [4].

One of the learning suport that can help students in understanding the material is the presence of media or teaching materials. Thedevelopment of important teaching materials is done by teachers so that learning is more effective, efficient and in accordance with the competencies to be achieved. Teachers generally rely on teaching materials that come from publishers, either books or student worksheet for the reason of making teaching materials is a difficult job and takes a long time. The existence of the right source of materials and media is able to improve the quality of learning [5].

Physics learning will be more meaningful and can train students' critical thinking skills if they are able to create learning conditions that make students actively and creatively involved. There are a number of learning models that teachers can choose from and recommend in the 2013 Curriculum. Some of these models are Project-Based Learning (project-based learning), Discovery-Inquiry (learning by discovery), Flipped Classroom (learning by reversing habits in the classroom), Blended Learning (mixed learning) and Self Organized Learning Environment. Each model has its own characteristics, but in the implementation of the 2013 Curriculum has general similarities, namely all models aimed at building student character, developing scientific ways of thinking, building 21st century competencies and student literacy [6].

One learning model that can help students and teachers in the physics learning process to practice critical thinking skills is the Self Organized Learning Environment (SOLE) model. Self Organized Learning Environment (SOLE) learning model emphasizes the self-learning process carried out by anyone who wants to learn by utilizing the internet and smart devices owned by him. In the context of learning conducted in schools, the Self Organized Learning Environment (SOLE) learning model is used by teachers in exploring the depth of material understanding to students by utilizing the curiosity possessed by those student [7]. In accordance with research by Wati ,the Self Organized Learning Environment (SOLE) learning model has the goal of forming competencies (expertise) owned by students. Competencies that are expected to be formed in learners through this Self Organized Learning Environment (SOLE) learning model include: 1)critical and creative thinking, 2) problem-solving skills and 3) communication skills [8].

One study conducted by Mitra showed that by using the Self Organized Learning Environment (SOLE) students can learn earlier than their time, maintain longer learning, and enjoy enough processes to explore their learning more deeply. The results also showed that learners in the group could read da n understanding atahigher level than each individual's level of [9].

Based on Program for International Student Assessment results in 2018, Indonesia's reading literacy was ranked 74 out of 79 countries, for the mathematics category Indonesia was ranked 73 out of 79 countries and for the science performance category was in peringkat 71 out of 79 countries (3). Students' low reading ability is influenced by several factors, for example the condition of delivery of complicated teaching materials increasingly makes students weak and lazy in reading learning [10]. In connection with low interest in reading and critical thinking skills in physics learning, it is necessary to develop teaching materials that can improve critical thinking skills and presentation is packaged attractively.

Modules are made an option because of many advantages including: 1) as a fully owned learning resource for students so that students can learn modules anytime and anywhere, 2) activate the student's sense of sight, hearing and movement, 3) reduce teacher-centered learning and 4) provide a lot of and immediate feedback because in the module there are exercises andanswers so that students can immediately know the level oflearning results [11].

A good learning process should contain interactive, fun, challenging, motivating aspects and provide more space for students to be able to develop creativity and independence, according to the talents and interests of students. Fun learning activities are strongly influenced by various factors, one of which is the selection of learning media used must be able to be interesting for students to learn, interactive when used, but does not reduce the essence of the material delivered.

In addition, in the era of revolution 4.0, there are many new technologies that can be used as a medium of learning to help in the implementation of the 2013 curriculum. The rapid development of information and communication technology, making the dependence of almost every human activityvitas with technological devices. The use of technology in the field of education is one of them is the use of Augmented Reality (AR) technology.

The advantages of Augmented Reality are as follows: 1) More interactive, 2) Effective in use, 3) Can be widely implemented in a variety of media, 4) Simple objoak modeling, as it only features a few objek, 5) Manufacturing that doesn't cost too much, 6) It's easy to [12]. The existence of Augmented Reality as one of the alternative learning media, it is expected that in a learning activity can be more attractive to students.

Based on previous research, the ability of learning modules using the Augmented Reality assisted Self Organized Learning Environment (SOLE) model on rotational dynamics material and rigid object equilibrium has also been demonstrated by research conducted by Isnawati in her research entitled the development of teaching books and Augmented Reality on the concept of digestive systems in high school which shows that the average percentage of teacher response scores of 4.4 (good categories) and average student response scores of 4.27 (good categories) so that teaching books and Augmented Reality are practical categories. From the test of learning results obtained 34 students or 88% of students were able to achieve the value of learning completion criteria so that teaching books and Augmented Reality are effective [13].

In line with this according to Handayani, the learning module can train critical thinking skills evidenced by the results of research that the development of physics learning modules has increased in the moderate category with an N-gain of 0.49 [14]. Furthermore, in line with the research entitled Development of Augmented Reality Technology Assisted Physics Module on Sound Wave Material for senior high school Class XI showed the results of the study that obtained results that the quality of physics modules using Augmented Reality is very good with a percentage value of 95% of material experts, 86.67% from media experts and 90% of physics teachers. The student's response to the physics module earned an 89% percentage with excellent categories [15].

Based on facts in the field as well as relevant research, this study will be conducted by developinglearning modules by using the Self Organized Learning Environment (SOLE) model based on Augmented Reality-assisted Self Organized Learning Environment (SOLE) models on rotation dynamics material and rigid object equilibrium, describing students' feasibility of learning modules by using self-organized learning environment (SOLE) models based on augmented reality dynamics and rigid object equilibrium materials and describing students' perception of the readability of modules that have been developed in training students' critical thinking skills on rotational dynamics and rigid object equilibrium materials.

B. Research Methods

This research uses research and developmentmethods (Research and Development or abbreviated R&D). This research uses 4D development models (Four-D Models) according to Thiagarajan namely define, design, development,and Dissemination [16].

The 4Dresearch and Development steps can be described asstated in the following Figure 1.

Figure 1 Stages of 4D Models

The research was conducted at state high school 4, state high school 5 and state high school 9 Bengkulu City in the 2020/2021 school year. This research is limited to the development stage (Development).

The data collection technique used in this study for the define stage consists of observation techniques, learning implementation plan document review techniques, kuesioner/angket techniques. As for the development stage consists of kuesioner / angket technique. The instruments used are observation sheets, lesson plan review sheets, need questionnaire sheets, validation test questionnaire sheets and perception test questionnaire sheets.

Analytical techniques carried out in this research in the form of quantitative and qualitative data analysis. Data analysis is carried out qualitatively to determine the feasibility of the learning module using the Augmented Reality-assisted Self Organized Learning Environment (SOLE) model on the material of rotation dynamics and the equilibrium of rigid objects produced using the likert scale. In the questionnaire used to measure the feasibility of the module used the Likert Scale. Interval data can be analyzed by calculating the average answer based on the score of each answer from the respondent can be seen at Tabel 1 [17].

Table 1. Likert Scale Interpretation

No.	Interpretasi	Score
1	Very Good (SB)	4
2	Good (B)	3
4	Less Good (KB)	2
5	Very Bad (STB)	1

Furthermore, the interval data can be analyzed by calculating the percentage of answers based on the score of each answer from respondents with the following formula:

$$P_s = \frac{S}{N} \times 100\% \quad (1)$$

Equation (1) has a description i.e. for Ps is the average percentage, S is the score obtained and N is the maximum number of scores. The percentage of perceptions obtained is then interpreted into criteria based on Table 2.

Table 2. Eligibility Level

Percentage	Eligibility Level Criteria
80%-100%	Very Decent/Very Very Good/Strongly Agree
66%-79%	Qualified/Good/Agreed
56%-65%	Less Eligible/Less Well/Less Agreeable
0%-55%	Unfit/Unfit/Disapproval

This research is considered feasible or very feasible if from the processing of data questionnaire generated percentage score between 66% to 100% [18].

C. Result and Discussion

The introduction using observation techniques and questionnaire techniques was carried out at at state high school 4, state high school 5 and state high school 9 in Bengkulu City. Observations show that the real conditions in high school in Bengkulu City still have some problems faced in the learning process. Such problems such as learning resources used by printed books, the absence of additional interesting teaching materials for students to use in addition to printed books obtained in school, guru still often use conventional learning methods, theutilization of the role of information and communication technology is less than optimal because it onlyutilizes PowerPoint or Learning Videos on YouTube. Students find it difficult to understand the material physics.

In line with the results of the analysis of the needs obtained through the filling of questionnaires by students of class XI MIPA at at state high school 4, state high school 5 and state high school 9 in Bengkulu City obtained results that students agree with the statement if the teaching materials used in schools are now not able to facilitate students in understanding physics. Students strongly agree on the existence of other teaching materials as an alternative to teaching materials available today. So that the results of the interpretation of the score of 76.26% (strongly agree) and for physics teachers obtained the results of interpretation of the score 77.92 % (strongly agree) the development of learning modules using the Self Organized Learning Environment (SOLE) model assisted by Augmented Reality on the material dynamics rotation and the equilibrium of rigid objects that can facilitate students learn anywhere and anytime.

The material applied to this study is rotation dynamics and rigid object equilibrium for high school students in grade XI. Material rotation dynamics and the equilibrium of rigid objects were selected in this development research because many events related to problems in everyday life so that it is contextual such as the concept of torque on the doorknob. The application of rotational dynamics events and the equilibrium of rigid objects can be known and found by students directly so that the concept of this material is easier to understand. However, there are some concepts rarely encountered by students directly such as ice dancers

or acrobats. Therefore, in this module uses the help of Augmented Reality in the form of video playback so as to minimize the cause of misconceptions in the concept of rotation dynamics material and the equilibrium of rigid objects.

The format used in the module is the printmodule. The design of the module is adjusted to the characteristics of the module according to Anwar about the characteristics of the module namely Self instructional, Self contained, Stand alone, Adaptive, User friendly and consistency [19]. Modul developed has parts in it that consists of the beginning, the contents and the cover. The beginning of the learning module consists of front cover, front page, foreword, usage instructions, table of contents, drawing list and table list, competency map, indicators and goals, concept map and keywords. Then, in the contents section there is a introduction and 5 learning activities.

Each learning activity is integrated model Self Organized Learning Environment (SOLE) with stage 1) questions in the form of questions or problems 2) investigation in the form of simple experimental activities named exorcisms and 3) reviews in the form of AR video playback. Then, there is material based on learning activities that are equipped with important notifications or notes, examples of problems or polapedia and summaries and there are Step Up questions. Finally, there is a closing section consisting of answer keys, glossaries, bibliography and author history and back cover.

Ar application design is given in the form of a diagram description of the interaction between the user and the system. The user opens the application then the camera scan marker is directed to the marker, then the video thumbnail will appear on the screen. After that, click the play button to play the video or click the pause button to stop the video. Installation of AR applications is poured in the flow chart in Figure 2.

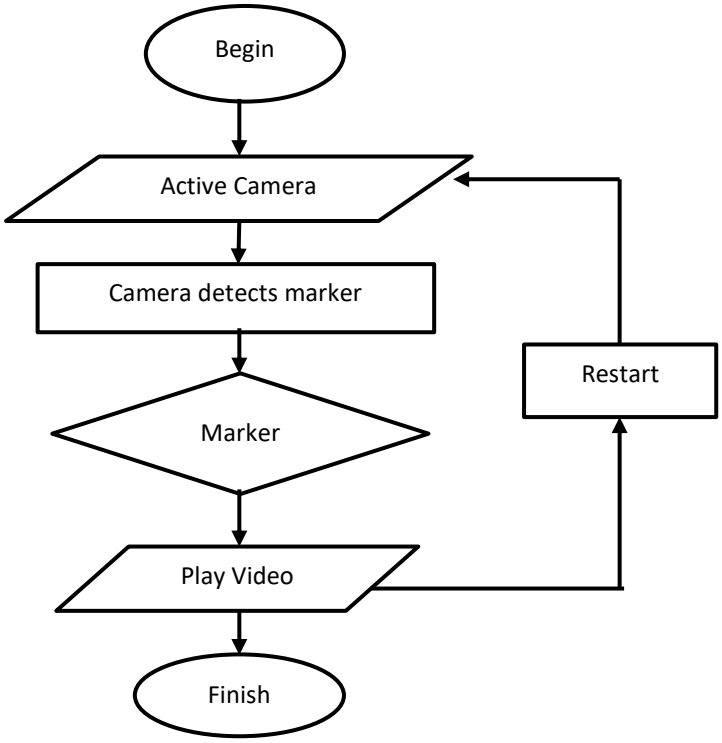

Figure 2 Flow Chart Application Augmented Reality

This learning module has the following characteristics:

1. The learning module developed contains objectives that are clearly formulated in accordance with the ABCD reference (audience, behavior, condition and degree).
2. The learning module developed contains the stages of the Self Organized Learning Environment (SOLE) model by (Sugata Mitra: 2012) which consists of question, investigation and review (review) stages on each learning activity accompanied by a critical thinking skills indicator component.
3. Learning activities developed contain activities that if possible increase the reader's knowledge related to the material dynamics of rotation and equilibrium of rigid objects.

4. The learning modules developed contain exercises that focus on practicing critical thinking skills.
5. Learning modules developed assisted by augmented reality in the form of video playback that is easily accessible without having to connect to the internet.

The use of Augmented Reality in modules developed to support students can learn in their own way or according to their interests. This is in line with the usefulness of modules according to Aditia, namely modules have various uses, among others: a) Students have the opportunity to train themselves to learn independently, b) Learning becomes more interesting because it can be studied outside the classroom and outside of learning hours, c) has the opportunity to express ways of learning that are in accordance with students' abilities and interests, d) have the opportunity to test their own abilities by doing exercises presented in the module, and f) Develop students' ability to interact directly with other learning environments and resources [20]. So, with the addition of Augmented Reality video playback can be an option for students to learn by reading or by watching learning videos. This result is reinforced by Khulsum's research which states that the characteristics of teaching materials must be in accordance with the needs of learners so that teaching materials must be arranged in accordance with the character of the preparation of teaching materials [21].

Based on the results of validation by experts on learning modules using the Self Organized Learning Environment model assisted by Augmented Reality using 35 Statements consisting of material aspects, presentations, critical thinking indicators, language, sole model stages and media that fall into the category are very feasible with an average percentage of 85.96% that can be seen in the following Table 3.

Table 3. Module Validation Test Results

Aspects	*Average Value*	*Category*
Content/Materials	84,17%	Very Worthy
Serving	85,00%	Very Worthy
Indicators of Critical Thinking Skills	86,11%	Very Worthy
Language	85,47%	Very Worthy
SOLE Model Stages	83,33%	Very Worthy
Media	91,67%	Very Worthy
Average	85.96%	Very Worthy

The assessment of the six aspects is represented in a graph of validity test results. Graph of validity test results can be seen in figure 2 Below.

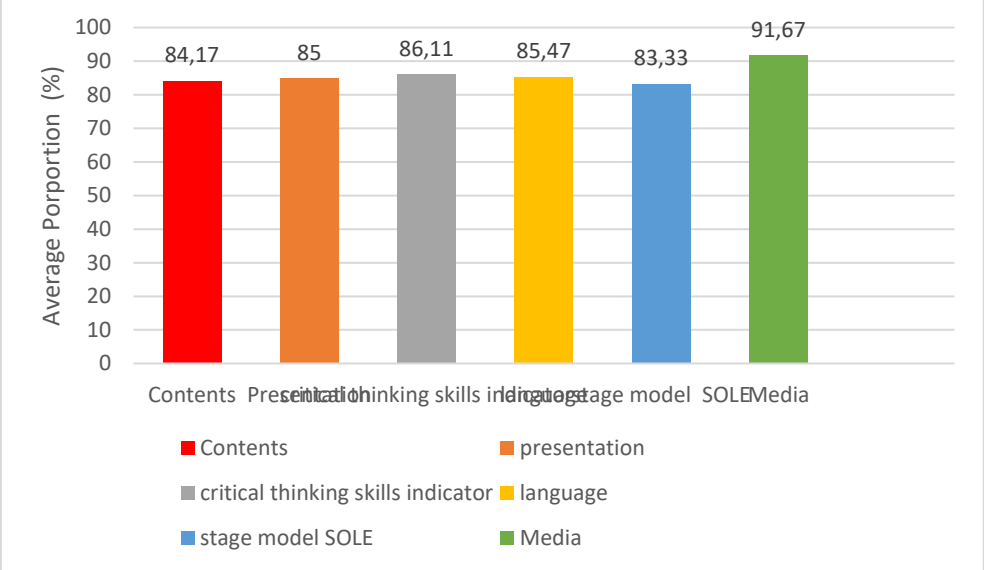

Figure 3. Module Feasibility Graph

One of the results that stands out compared to the results of previous studies is the results of expert validation tests on media aspects, which is 91.67% in the category of very feasible, while the results of research by Khunaeni obtained the results of validation tests on media aspects of 90% are in the category

of very good. Based on the results obtained and referring to other research, the Augmented Reality assisted physics module developed is feasible and can be used in physics learning.

In addition, this module also uses the Self Organized Learning Environment (SOLE) model which aims to train high-level thinking skills. Self Organized Learning Environment (SOLE) learning model has the goal of forming competencies (expertise) owned by students. Competencies that are expected to be formed in learners through this Self Organized Learning Environment (SOLE) learning model include: 1) critical and creative thinking, 2) problem-solving skills and 3) communication skills. The product of the developed modules is devoted to training critical thinking skills. Based on the results of validation tests, it was found that the development of this module is very feasible to meet the aspect of critical thinking indicators with a percentage of 86.11%.

This is reinforced by Scholichah's research showing that high-level thinking with the Self Organized Learning Environment (SOLE) learning model is evident from the finding that learners who study in groups using the internet are able to understand material several levels above it, knowledge found by learners can last longer and can improve the scientific reasoning skills of learners [22].

This research is relevant to the research conducted by Handayani, namely the development of problem-based multirepresentative physicsmodules on rotational dynamics and rigid object equilibrium to improve the critical thinking skills of class XI students. The advantage of this research is that the modules developed already use learning models that are integrated with critical thinking skills such asproblem-basedlearning models. The shortcomings of this study have not supported the development of science and technology and are not interactive [23].

In addition, it is relevant to research on the development of teaching books and Augmented Reality on the concept of the digestive system in high school. The advantage of teaching books developed is that it has supported the development of science and technology and is interactive with the presence of Augmented Reality. However, this teaching book has not used any of the learning models and it is not yet known what teaching book development is used to achieve what competencies.

The weaknesses of this relevant research are a reference to the development of this module. This module was developed with some advantages from previous development, this module already uses a Self Organized Learning Environment (SOLE) learning model that aims to train critical thinking skills and assisted Augmented Reality in accordance with the current development of science and technology. Thus, the ideal conditions of learning are achieved. According to Permendikbud Number 69 of 2013, the ideal conditions of learning are student-centered, interactive, networked learning, actively seeking learning, group learning, multimedia-based learning, needs-based learning, multidisciplinary and critical learning.

Based on the results of the readability test to find out the perception of high school students in class XI bengkulu city, it is known that the aspect of display in the learning modules that have been developed is in the criteria very well with an average percentage of 91. 13%, the presenting aspect in the learning module is within the criteria very well with an average percentage of 90%. 33% and the benefit aspect is within the criteria very well with an average percentage of 88%. 56%.So it can be concluded that each school has a different perception of the readability of learning modules using the Self Organized Learning Environment (SOLE) model assisted by Augmented Reality in the material rotation dynamics and the equilibrium of rigid objects in each aspect is in the category very well with an average percentage of 90.01%. The average end result can be seen in table 4. Here.

Table 4. Readability Final Result

Aspects	Average Value	Criterion
Display	91.13%	Excellent
Presentation of Materials	90.33%	Excellent
Benefit	88.56%	Excellent
Average	90.01%	Excellent

The results of the readability test of the student's perception are represented in a graph of student perception test results. Graph of student perception results can be seen in Gambar 3 Below.

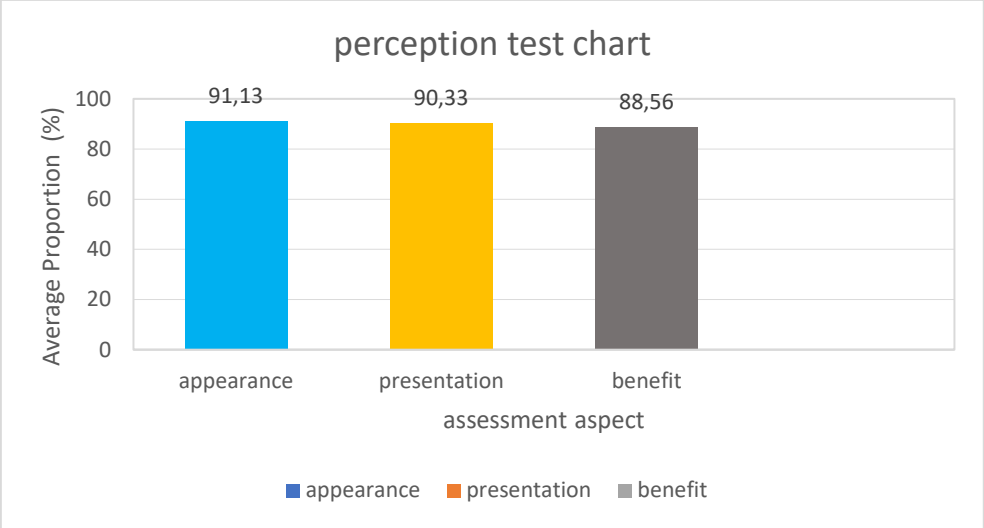

Figure 4. Results of The Perception Test of Every Aspect

This result is obtained because this learning module presents an attractive cover display of text or writing on the module is easy to read, images presented are clear or not blurry, images presented according to the material (not too much / little), the existence of captions on each image presented in the module, gamber presented interesting, videos displayed interesting, Augmented Reality videos in the module easily accessible, symbols or symbols are easy to understand and there is a description on every equation presented in the module. This indicates that students are very interested in the look of the developed modules. From the results of the readability test, it was found that the learning module developed is relevant to the statements of Iskandarwassid and Dadang Sunendar, suggesting that one of the criteria that must be met by teaching materials is to attract the interest of learners and contain illustrations that attract the hearts of student [24].

In the presentation aspect gets a percentage of 90.33% who fall into an excellent category based on this module providing instructions for the use of modules for students, for teachers and instructions to access Augmented Reality videos to make it easier for students to use modules, this module provides learning objectives and concept maps that can make it easier for students to know the picture of the material concept to be studied, there is a summary of important materials and notes (notifications) on each sub-material, this module provides examples of questions (Polapedia) and Exercise questions (Step Up Questions) and answer keys that help students learn independently, this module provides illustration of problems (questions) related to daily life in each sub-material section of the module, this module provides a simple experiment (expperia) that encourages me to discuss with other friends in the investigation section of each sub module of the material and this module provides Augmented Reality video in the revie section w each sub-material module to explain a true concept. This is in accordance with Romansyah's statement that the criteria for the presentation of teaching materials include the inclusion of learning objectives, the fulfillment of learning (sequencing of teaching materials), the withdrawal of interest and attention of learners, the involvement of the activeness of learners, the relationship between teaching materials, problems, and norms of presentation of teaching materials [25].

In terms of benefits of getting a percentage of 88.56% that fall into the category is very good because in this module the existence of questions and illustrations at the beginning of learning activities in the module can encourage me to make predictions about problems in the material rotation dynamics and equilibrium of rigid objects, the existence of investigative activities in the module can encourage me to come up with ideas / solutions about the problems posed in the initial activities of the module and by using this module makes me more interested in studying physics, especially the material of rotation dynamics and the equilibrium of rigid objects. This menunjukkan that the teacher is also interested and feels thatthe learning module as a teaching material can facilitate this is relevant to magdalenathat it should be through teaching materials the teacher will be easierin carrying out learning and students will be more helped and easier in learning. So that from these three aspects it can be concluded that overall the perception of learners towards the readability of this learning module is very good with an average score of 90.01%[23].

The results are obtained because students need learning resources other than books available in school, so students feel interested and enthusiastic about learning physics using a self-organized learning environment

(SOLE) model based on Augmented Reality in the material rotation dynamics and equilibrium of rigid objects that have been developed. This is in line with research by Puspita that the use of teaching materials in the learning process will result in a good response for students [26].

Based on all the data obtained from the questionnaire of learners' perception of the readability of the learning modulethat has been developed it can be concluded that the learning module using the Self Organized Learning Environment (SOLE) model assisted by Augmented Reality on the material rotation dynamics and the equilibrium of rigid objects based on the perception of learners is very good, so according to learners this learning module can be an alternative in helping train critical thinking skills in physics learning.

D. Conclusion

Based on the results of research and development that have been described above, it can be concluded that the characteristics of the module developed contain the stages of the Self Organized Learning Environment (SOLE) model, namely questions, investigations and reviews. This module is also assisted by Augmented Reality video playback in Application format on Smartphones. The module developed is categorized as very feasible based on validation test results by expert judgment and practically obtained an average of 85. 96% and this module is rated very well with an average of 90.01% based on perception tests by students. So it can be concluded that the development of learning modules using the Self Organized Learning Environment (SOLE) model assisted by Augmented Reality in the material of rotation dynamics and the equilibrium of rigid objects can be said to be very feasible and very well used as class XI physics learning materials.

Research on the development of learning modules using the Self Organized Learning Environment (SOLE) model assisted by Augmented Reality on rotational dynamics material and the equilibrium of rigid objects has gained excellent readability perception on three aspects, namely the appearance, presentation and benefits of students. So that this research should be continued or tested in the learning process in class and conduct research on the development of augmented reality assisted learning modules that are more interactive with different learning models and materials.

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References

[1] N. Retnosari, H. Susilo, and H. Suwono, "Pengaruh Model Pembelajaran Inkuiri Terbimbing Berbantuan Multimedia Interaktif Terhadap Berpikir Kritis Siswa Kelas Xi Sma Negeri Di Bojonegoro," *J. Pendidik. Teor. Penelitian, dan Pengemb.*, vol. 1, no. 8, pp. 1529—1535-1535, 2016, doi: 10.17977/jp.v1i8.6635.

[2] S. H. Sulistijo, Sukarmin, and W. Sunarno, "Pembelajaran Fisika dengan Model Inquiry - Student Team Achievement Division (ISTAD) dan Guided Inquiry Ditinjau dari Kemampuan Berpikir Kritis Peserta Didik Seminar Nasional Pendidikan Sains II UKSW 2017 Seminar Nasional Pendidikan Sains II UKSW 2017," pp. 231–240, 2017.

[3] R. A. Handayani, Sukarmin, and Sarwanto, "Pengembangan Modul Fisika Multirepresentasi Berbasis Problem Based Learning Pada Materi Dinamika Rotasi Dan Kesetimbangan Benda Tegar Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa SMA Kelas XI," *J. Pendidik. IPA*, vol. 7, pp. 352–364, 2018.

[4] D. Rosengrant, A. Van Heuvelen, and E. Etkina, "Do students use and understand free-body diagrams?," *Phys. Rev. Spec. Top. - Phys. Educ. Res.*, vol. 5, no. 1, 2009, doi: 10.1103/PhysRevSTPER.5.010108.

[5] Prastowo Andi, *Panduan Kreatif Membuat Bahan Ajar Inovatif*, VIII. Diva Press, 2015.

[6] A. Koesnandar, "Pengembangan Model Pembelajaran Inovatif Berbasis Teknologi Informasi Dan Komunikasi (Tik) Sesuai Kurikulum 2013," *Kwangsan J. Teknol. Pendidik.*, vol. 8, no. 1, p. 33, 2020, doi: 10.31800/jtp.kw.v8n1.p33--61.

[7] Sarifudin Saleh, "Deskripsi Dan Langkah Model Pembelajaran Sole (Self Organized Learning Environment)," 2020, [Online]. Available: https://sibatik.kemdikbud.go.id/inovatif/assets/file_upload/pengantar/pdf/pengantar_1.pdf.

[8] Ni Nyoman Kurnia Wati, "Perangkat Pembelajaran Berbasis E-Learning Di Sekolah Dasar," vol. 1, no. 2, pp. 180–189, 2020.

[9] S. Mitra and E. Crawley, "Effectiveness of Self-Organised Learning by Children: Gateshead Experiments," *J. Educ. Hum. Dev.*, vol. 3, no. 3, pp. 79–88, 2014, doi: 10.15640/jehd.v3n3a6.

[10] M. Tohir, "Hasil PISA Indonesia Tahun 2018 Turun Dibanding Tahun 2015," no. January, pp. 10–12, 2019, doi: 10.31219/osf.io/pcjvx.

[11] dan I. Y. Rizky Amalia, "Seminar Nasional Pendidikan Fisika 2018 Seminar Nasional Pendidikan Fisika 2019," *Penerapan Pendekatan Problem Posing untuk Meningkat. Kemamp. Represent. Vis. Mat. Siswa SMP*, vol. 3, no. 2, pp. 227–234, 2018.

[12] M. dan K. N. Ilmawan, "Pengembangan Media Pembelajaran Pai Berbasis Augmented Reality," *Lentera Pendidik. J. Ilmu Tarb. dan Kegur.*, vol. 21, no. 1, pp. 59–72, 2018, doi: 10.24252/lp.2018v21n1i6.

[13] Amir Isnawati, "Pengembangan Buku Ajar Dan Augmented Reality (Ar) Pada Konsep Sistem Pencernaan," 2017.

[14] & purwati yusuf, widyaningsih, "Pengembangan perangkat pembelajaran Fisika Modern berbasis media laboratorium virtual berdasarkan paradigma pembelajaran abad 21 dan Kurikulum 2013," *Pancar. Pendidik.*, 2015.

[15] L. N. Khunaeni, W. D. Yuniarti, and M. A. Khalif, "Pengembangan Modul Fisika Berbantuan Teknologi Augmented Reality pada Materi Gelombang Bunyi untuk SMA/MA Kelas XI," *Phys. Educ. Res. J.*, vol. 2, no. 2, p. 83, 2020, doi: 10.21580/perj.2020.2.2.6144.

[16] Sugiyono, *Metode Penelitian Pendidikan*. Bandung: Alfabeta Bandung, 2019.

[17] I. Sakti, Y. M. Puspasari, and E. Risdianto, "Pengaruh Model Pembelajaran Langsung (Direct Instruction) Melalui Media Animasi Berbasis Macromedia Flash Terhadap Minat Belajar Dan Pemahaman Konsep Fisika Siswa Di SMA Plus Negeri 7 Kota Bengkulu," *Exacta*, vol. 10, no. 1, pp. 1–10, 2012.

[18] S. Rezeki and I. Ishafit, "Pengembangan Media Pembelajaran Interaktif untuk Sekolah Menengah Atas Kelas XI pada Pokok Bahasan Momentum," *J. Penelit. Pengemb. Pendidik. Fis.*, vol. 3, no. 1, p. 29, 2017, doi: 10.21009/1.03104.

[19] M. Fauzi and D. T, "Pengembangan Media E-Modul Mata Pelajaran Produktif Pokok Bahasan 'Instalasi Jaringan LAN (Local Area Network)' Untuk Siswa Kelas XI Jurusan Teknik Komputer Jaringan Di SMK Negeri 1 Labang Bangkalan Madura," *J. Mhs. Teknol. Pendidik.*, vol. 01, 2015.

[20] M. T. Aditia and N. Muspiroh, "Pengembangan Modul Pembelajaran Berbasis Sains, Lingkungan, Teknologi, Masyarakat Dan Islam (Salingtemasis) Dalam Meningkatkan Hasil Belajar Siswa Pada Konsep Ekosistem Kelas X Di Sma Nu (Nadhatul Ulama) Lemahabang Kabupaten Cirebon," *J. Sci. Educ.*, vol. 2, no. 2, pp. 1–20, 2013.

[21] U. Khulsum, Y. Hudiyono, M. Pendidikan, B. Indonesia, and U. Mulawarman, "Pengembangan Bahan Ajar Menulis Cerpen Dengan Media Storyboard," vol. 1, no. 1, pp. 1–12, 2018.

[22] Scholichah Ana Fatwatush, "Pembelajaran Self-Organised Learning Environment (Sole) Dalam Penyelesaian Tugas Di SMP Negeri 9 Semarang," 2019.

[23] M. Elisabeth Tri Yekti Handayani, Siti Nursetiawati, "Pengembangan Modul Pembelajaran Sanggul Modern," *J. Ilm. Wahana Pendidik. https//jurnal.unibrah.ac.id/index.php/JIWP*, vol. 6, no. 3, pp. 317–322, 2020, doi: 10.5281/zenodo.3360401.

[24] I. Magdalena, T. Sundari, S. Nurkamilah, D. A. Amalia, and U. M. Tangerang, "Analisis bahan ajar," vol. 2, pp. 311–326, 2020.

[25] K. Romansyah, "Pedoman Pemilihan Dan Penyajian Bahan Ajar Mata Pelajaran Bahasa Dan Sastra Indonesia," vol. XVII, no. 2, 2016.
[26] S. D. Puspita, "Respon siswa terhadap modul sistem ekskresi manusia pada pembelajaran biologi kelas xi sma," 2017.