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Profile of Students' Critical Thinking Skills in 3D Module Learning Material on Gas Kinetic Theory with Inquiry Model

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Abstract. The increasingly difficult educational challenges and needs in today's modern world require interactive learning. The research was conducted to know students' critical thinking skills (CTS) in the kinetic gas theory material. Another goal is, as an initial observation, to develop learning methods with guided inquiry learning models assisted by android-based 3D modules in kinetic gas theory material. The research population was all class XI students at Tuban 2 Public High School in 2022/2023 as majoring in Mathematics and Natural Sciences. The research was conducted in 5 classes with the same distribution of questions and questionnaires. As secondary data, the researcher added several articles relevant to the research. The results of this study using several questions on kinetic gas theory material for class X1 were that students needed to be more able to answer each question with indicators of critical thinking. The student's obstacle in answering the questions lies in the need for more understanding of kinetic gas theory material and the not yet maximal use of the method in the current teaching and learning process. The resulting inquiry learning in the future will change the CTS of Tuban 2 Public High School students in the kinetic gas theory.
Keywords: Inquiry, critical thinking, CTS, module, physics

Introduction

Nowadays, technology is developing rapidly. This is a challenge for educational institutions to be able to compete with technology. One's mindset is one aspect that can support one's potential. Indonesia is known as one of the countries with the lowest ranking of the quality of education. Even though education itself is a unique aspect as a special form of the learning process which is defined as psycho-physical activities in personality development (Komariyah, 2018). Indonesian society tends to prioritize education as a formal need. Seeing the increasingly difficult challenges in today's modern world, it is clear that interactive media is needed in education. Efforts to provide interactive education to students can be made with the exciting press, especially in learning physics, assessed as a subject with above-average difficulty. Especially physics, learning that requires media innovation. Physics is a lesson that can emphasize students'

understanding of the environment; things around them can be solved from mathematical concepts in physics. Learning media is essential to learning resources, learning innovation enables students to master technology in the current era (Matsun, 2022). The opportunity to fully use learning media makes students more attractive in exploring knowledge. One learning medium that can be used as an interactive medium is a 3D digital module. A module is a learning tool composed of learning activities, achievements, and objectives (Dwicahyono, 2014; Asrizal, 2020). According to Gunawan (2019), e-modules always involve audio, visuals, and videos that are easily understood to be used as teaching materials. With the existence of a module as a form of interactive media with the utilization of technological developments, it can attract students. However, interactive education is not only influenced by supporting media. However, education is also sought to bring up pedagogical art in teaching skills. The less efficient learning model also influences problems where students feel bored with learning provided. The learning model is an activity design that can implement learning objectives with several stages. One learning model that focuses on student activity is the inquiry learning model. The inquiry model is the application of a method by preparing students in situations and circumstances to carry out full self-experiment so that you are able to see and feel what is happening, want to carry out activities, ask questions, and find your own answers. The guided inquiry learning model provides benefits to students in knowing and deepening their experience directly in learning activities (Ummiy, 2023). Contextual learning with inquiry based on own experience that maximizes material from research results is more memorable to students (Sari, 2020). Students in the guided inquiry learning model, must be able to carry out learning activities with direct experimentation experience. The primary purpose of the guided inquiry model syntax is to provide instructions for students to carry out experiments before discovering concepts (Widya, 2023). Experience is learning that can influence the behavior of specific individuals (Firdanta, 2023). Learning from experience is more pronounced than learning in theory. With a guided approach to students, it is hoped that it will be able to evaluate and develop students' thinking abilities. One of the thinking abilities of students who can increase the capacity of the mindset is the ability of CTS.

In finding a concept, sometimes someone must be able to deepen their thinking, one of them is critical thinking. According to Ennis (1996) in Komariyah (2018), critical thinking is also an effortful ability reflective thinking with a rational thinking system or thinking based on reasoning to determine the main ideas that must be believed, carried out and even accustomed to other. The critical thinking process provides the most general characteristics in reasoning and solving problems (O'Reilly, 2022). Critical thinking skills (CTS) are needed as a strategy to identify problems that also require analytical thinking processes based on data and clear reasons for solving problems (Pratiwi, 2023). Critical thinking aims to train students to evaluate and interpret the information received and to evaluate the application of this information or concept in everyday life (Harahap, 2021). In critical thinking, several indicators must be achieved, among others, clarification as formulating the main points in a problem (basic support), evaluation as building basic skills by expressing facts, analysis is determining logical arguments based on a problem, interpretation namely providing further explanation based on bias with different viewpoints (that's strategies and tactics) and inferences as a result of conclusions (Yusuf, 2022). We know, with maximal skill comes critical thinking which is essential for success in work life experience (Sawitri, 2023). That way, students can produce understanding and thinking skills better than before. So this research is intended to determine students'

CTS in physics material, especially in this kinetic gas theory material research. In addition, it also describes a guided inquiry learning model to improve students' CTS with the help of Android-based 3D digital modules in kinetic gas theory material. The benefits of this research will provide new knowledge related to learning efficiency using the guided inquiry learning model assisted by Android-based 3D digital modules in improving students' critical thinking.

Methods

The research was conducted using quantitative methods based on the data that has been obtained obtained. Quantitative research, namely research that functions to examine samples that produce numbers or numerations and are analyzed statistically (Pramudita, 2023). This study's results were obtained from primary and secondary data sources. According to Sugiarti (2021), secondary data is obtained from journals, articles, theses, and other relevant sources to provide reinforcement of primary data obtained directly through test instruments and interviews. Observation data can be obtained at each meeting with each observer (Ummiy, 2023). Observations were obtained from student questionnaires and teacher interviews.

The population of this research was the grade 11 science students of Tuban 2 Public High school, with a total of 115 students. The research was conducted with of 5 different classes of MIPA students from the same school. The research sample took all students from the entire class with several research stages. To Abdullah (2015) in his book, quantitative research can be carried out in several stages of research as follows,

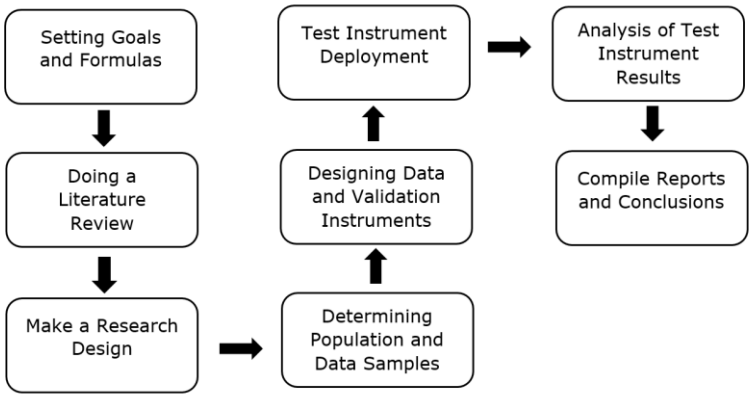

Figure 1. Research Design

The research design uses quantitative research with the true experiment method by giving a pre-test of the kinetic gas theory material with 15 questions. After carrying out the research phase, data processing was carried out using a comparison technique. First, What must be done is a regression test which aims to determine the significance value. The general regression test with a data accuracy rate of 95% has a significance level of 5%. So there are two possibilities namely research design.

a. H0 is accepted if the significance of the T-test is > 0.05
b. H0 is rejected if the significance of the T-test is <0.05

His is related to the hypothesis H0 (research hypothesis) for each response variable with manipulation to determine the relationship between these variables. In comparison, testing the hypothesis with the T-test method aims to determine the effect of the response variable on the manipulation variable. The mean, median, mode, and data accuracy values (data distribution) will be obtained from the existing data distribution. If the hypothesis is not accepted, there is uncertainty in the response to a study. This must be explained in the numerical and descriptive analysis of the data. This is to test the truth and the untruth in hypothesis testing in a random sample of data (Sudj'iono, 2010). Decision-making is taken with the significance value of the comparison table. First, the test was carried out with a regression test to determine the significance level. In addition, the instrument being tested has criteria for critical thinking in physics learning.

According literature study for argumentation of Ennis (Komariyah, 2018) critical thinking indicators are derived from the level of critical activity of students consisting of Table 1.

Table 1. Indicator of CTS on Type for Question

No	Indicator	Information	Number of Question	Score
1	Clarification	Formulate the main issues in a problem	1, 2, and 3	5
2	Evaluation	Build fundamental skills by expressing facts	4, 5, and 6	6
3	Analysis	Determine logical arguments based on a problem	7, 8, and 9	6
4	Interpretation	Provide further explanation based on bias with different points of view	10, 11, and 12	7
5	Inference	Determine the conclusion	13, 14, 15, and 16	7

The goal of critical thinking itself is related to finding intelligent solutions. In Anderson's argument (Lestari, 2014), there is a tendency for critical thinkers to seek the truth by thinking systematically, highly curious, and independently. From the distribution of the instrument questions, it will be obtained to what extent the students of Tuban 2 Public High School can think critically in dealing with physics problems with kinetic gas theory material.

Results and Discussion

Test students' CTS in physics

Based on the results of research data that has been carried out, the test results are obtained, which are distributed to each class. The results of the tests that have been distributed to each class show that the abilities of the student's results are different. From

this, the overall average value of the students can be obtained, which is differentiated through the indicators of each question with their respective maximum scores.

Table 2. Average on Type for Question

Number	Total Value	Average	Number	Total Value	Average
1	583	3.76	9	260	1.67
2	216	1.39	10	220	1.42
3	287	1.85	11	235	1.52
4	358	2.31	12	184	1.18
5	359	2.31	13	179	1.15
6	384	2.47	14	214	1.38
7	348	2.24	15	76	0.49
8	305	1.97	16	114	0.73

Of the 115 students in the MIPA class at Tuban 2 Public High School. It indicated that the students still needed to be fully able to answer the questions correctly. This can be seen from the average value of questions answered correctly in each indicator. This means that from all the questions, students have not mastered the theory of critical thinking on kinetic gas theory problems. Table 2 shows that the lowest score is obtained on question number 15, and the highest is on number 1. The level of difficulty of the questions influences the level of student scores. In the inference stage of critical thinking, students will determine conclusions from the generalization results, and this makes students have to think harder to find the answer (Komariyah, 2018). So, it is necessary to analyze the items adjusted to the average student's answers. In addition, from the research conducted, the distribution of the abilities of male and female students can be seen in the following diagram.

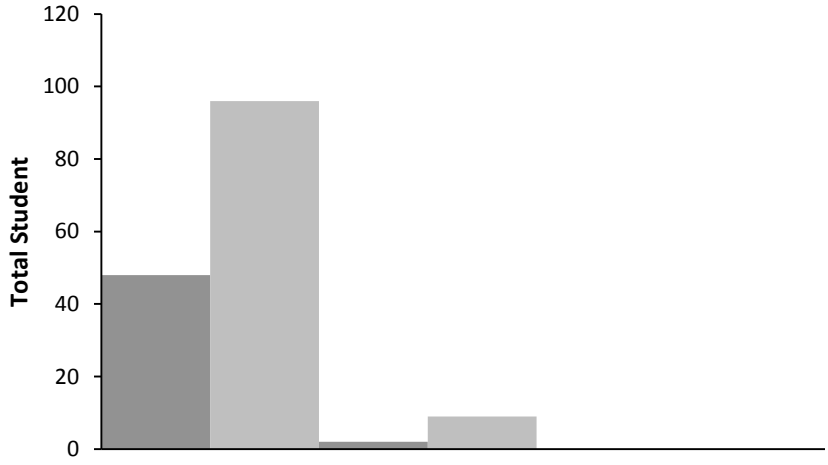

Figure 2. Comparison of many students and category score questions

Based on the distribution of the diagram above, the ability of female students to think critically in dealing with kinetic gas theory material tends to be better than male students. The acquisition of the skills of male and female students also shows that,

overall, students need to be able to answer questions correctly. This is especially true for questions with complex critical thinking indicators, as evidenced by the low average score and the absence of students who get high marks working on the questions. The existence of indicators for each question is intended to map critical thinking. Through necessary thinking skills, it can train students to find facts and sort out concepts that can be implemented in solving problems in everyday life as well as testing information and considering opinions and ideas that will be implemented in solving issues (Sapria, 2011). If it is differentiated from the questions that contain each indicator, then here it can be seen in the following Figure 3.

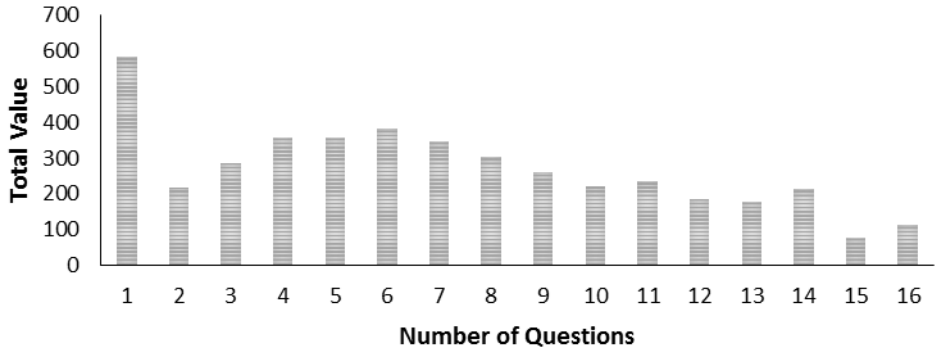

Figure 3. The relationship between total value and number of questions

In carrying out the tasks completed on each question, a total of 16 questions, students experienced many difficulties finding answers. These results were obtained from the responses of students in critical thinking, which included,

1. Clarification, So students are expected to formulate the basic problems in the statement. The results of the answers will answer the principle of simple problem formulation in the issues discussed.

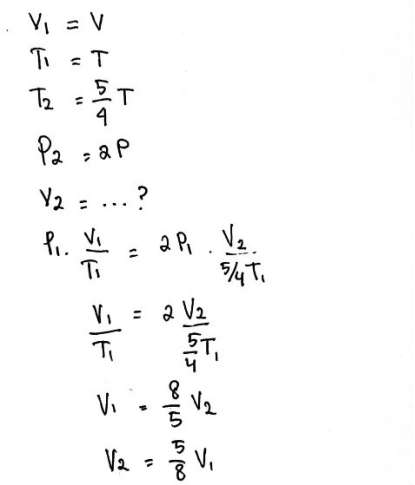

Figure 4. Example of student answer on indicator clarification

Most students can answer questions with these indicators, and this is because clarifying the problem does not require an analysis of issues/problems. It is sufficient to understand the purpose of the questions.

2. Evaluation, find out the facts from the statements given. This intends to process students' deep thoughts regarding a situation in a problem. Students must provide answers according to the circumstances associated with the given problem.

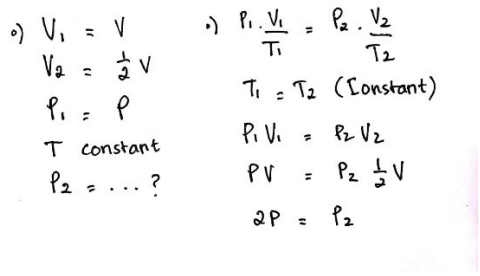

Figure 5. Example of student answer on indicator evaluation

In this indicator, besides finding the purpose of the questions, students also have to think more about some of the problems that must be solved from word problems. Most students can answer questions with the appropriate formula but must catch up on several things that become points in the problem. As shown in Figure 4, this means that in the problem, there is a constant temperature requirement, but there are still students who have not included these conditions, so the answers are not complete until the end.

3. Analysis, determine logical arguments that are relevant to the problem. In every situation, sometimes the formula used is different. In this case, so students are expected to determine an identical formula from the existing problem.

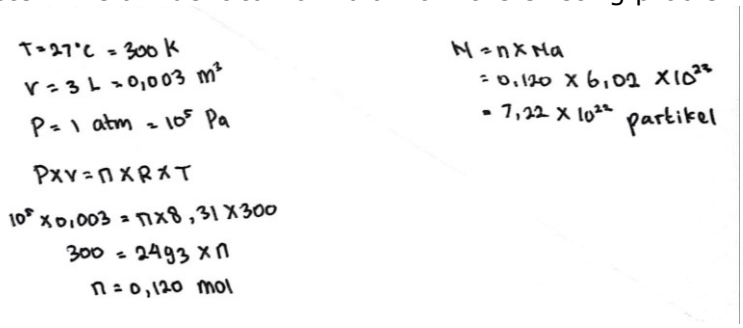

Figure 6. Example of student answer on indicator analysis

Determining logical arguments with the problem analysis stage beforehand also takes time. Students need help to answer questions with this indicator. Most problems are due to the need for complex answers because several quantities are implicitly stated in a problem. So that students have to find out for themselves, solve problems and use formulas.

4. Interpretation, give further explanations based on bias with different points of view—interpretation as a differentiator or even further formula derivation in a problem. Students must be able to distinguish levels in answering questions.

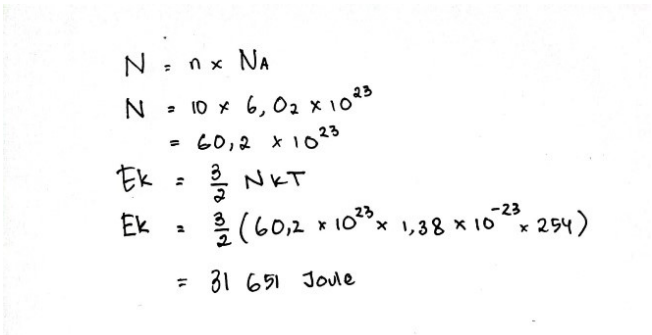

Figure 7. Example of student answer on indicator interpretation

The intended further explanation is the determination of multilevel ideas, as seen in the answers in Figure 6 above that students work on questions with two answers at once. This means that several things also need to be known before finding the answer desired by the question (objective).

5. Inference, find conclusions from a number of complex problems. In this case, students are expected to be able to determine conclusions with the data provided. Both sequential and separate data.

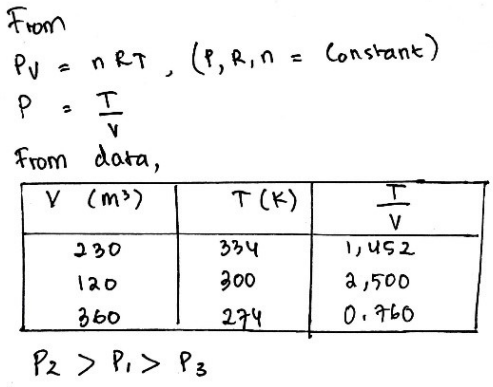

Figure 8. Example of student answer on indicator inference

Given data, where students must answer questions based on the data distributed. In this case, the conclusion goes through several stages, the first is the stage of data analysis, and the next is the clarification of the correct formula to answer the question, so the last stage is the generalization of the purpose of the problem.

From the data on the distribution of indicators through the question instrument, critical thinking learning is needed to upgrade students' thinking power. Students have yet once they can think critically. This ability should emerge if learning experiences are applied in the learning system. Fostering the development of students' critical thinking is essential due to higher education, and in several countries, increasing necessary thinking skills is included in the goals of learning and teaching (Wahyudi, 2019). Apart from the average value of each question, which was generated from the distribution of questions in the five classes, the results were also obtained from the interest in learning and testimonials from distributing questionnaires that researchers distributed to each student

Table 3. Student questionnaire results

Statement	Indicators (%)			
	1	2	3	4
Students' interest in using android-based modules for gas kinetic theory material in physics learning	0	10.86	73	15
Difficulty in understanding physics learning	6.52	70.28	23.18	-
The difficulties in understanding the kinetic theory of gases	2.89	57.24	39.85	-
Android-based modules can improve students' critical thinking in the future	15.21	84.78	-	-

Teacher Interview

In the previous state of the physics learning process, the student's interest in learning tended to be expected. This was said directly by the principal of Tuban 2 Public High School as a physics teacher for class X1 MIPA. This is due to using methods that could have been more effective before. Using conventional methods in learning physics is less interactive with students, making learning less attractive. In addition, the physics learning carried out still needs to involve exploring digital technology. So, students must familiarize themselves with Android digital module technology in physics learning. It is very suitable to carry out learning activities that prioritize direct experience in concluding material, such as using the guided inquiry method. With the previous considerations, guided inquiry learning using Android-based 3D module media can be implemented at Tuban 2 Public High School. Indicators of critical thinking will make students more competent in learning physics. What is being considered is where it is necessary to include the appropriate learning syntax in implementation. This is important to obtain students' goals and learning outcomes fully.

In the results of interviews with physics subject teachers and the analysis of questionnaires given to students after carrying out physics learning, an in-depth study is needed regarding learning outcomes with critical thinking indicators. The results of this research are that in critical thinking, there are stages that students must go through. In critical thinking, several indicators must be achieved: clarification, evaluation, analysis, interpretation, and inference (Yusuf, 2022). Testing questions on clarifying indicators as a discussion of the main issues (basic support) influences students to find the formulation of the problem being discussed more easily. Meanwhile, the most difficult part of answering questions can be seen in questions with interpretation and inference indicators. This is because interpreting a problem requires basic knowledge and more complex generalizations.

Related Research

Table 4. Literature study of the last five years

Author (Year)	Tittle	Sample Characteristics	Findings
Harjilah, N., Medriati, R. and Hamdani, D.,	The Effect of the Guided Inquiry Model on CTS in Physics Subjects	In using the Purposive amplification technique at SMAN 3 Bengkulu City. The	Significant results in the model taught affect students' CTS in the application of work and

(2019)		class chosen was Class X MIPA III by applying the Direct Instruction model and class X MIPA IV applied the guided inquiry model.	energy materials, which can be seen from the 94.2% improve students' CTS.
Suana, W., Istiana, P. and Maharta, N. (2019)	The Effect of Applying Blended Learning in the Guided Inquiry Model on Static Electricity Material on Students' Critical Thinking Ability	Kalianda 1 Public High School, South Lampung with the entire student population of class XII MIA and research samples of class XII MIA 1 which totaling 32 students and class XII MIA 2 which totaling 28 students, odd semester of the year teaching 2018/2019	Blended application learning can improve students' critical thinking skills; when the value of the n-gain results being compared is always large in both the experimental and control classes, then it is visible and influence class's blended learning on thinking skills critically seen from the calculation of the effect size obtained a value of 1.3 with big category.
Agustin, L., Haryanto, Z. and Efwinda, S., (2020)	The Effect of the Guided Inquiry Learning Model on the Critical Thinking Ability of Grade XI Students of SMA Negeri 9 Samarinda	All Students XI IPA 3 SMAN 9 Samarinda as a whole	This learning has an impact on students' CTS especially. We can know this from the whole inquiry learning process that is well implemented.
Wastiti, L. and Sulur, S. (2020)	The Effect of STEM-Thinking Maps on the Guided Inquiry Learning Model on the Critical Thinking Ability of Class XI Students in the Material of Temperature and Heat	For the sample population used are all students integrated in mathematics and science of class XI at MAN 1 MALANG which consisted of two classes, namely class MIA 3 as the control class and class MIA 2 as the experimental class.	CTS on temperature and heat materials that use STEM-assisted Thinking Maps in guided inquiry learning has advantages compared to students who study guided inquiry without STEM and Thinking Maps.
Thesa Irene Sari S., Nurdin S., Karya S. (2021)	Development of Physics Teaching Materials with a Guided Inquiry Model to Improve High School Students' CTS	The research population at Erlangga Pematangsiantar Private High School was all class XI students.	The results of this research are that the guided inquiry method can improve students' CTS. This can be seen from the results of the N-Gain Guided Inquiry teaching materials that are capable of being developed improve student response
Melly Indah Sugiarti, Dwikoranto (2021)	Improving Students' Critical Thinking Ability Through Schoology-Assisted Blended Inquiry Learning In Physical Learning: Literature Review	This research was carried out by collecting relevant scientifically studied articles following the research objectives.	In critical thinking less natural owned by students, however, it takes a process of habituation through learning activities in class. The schoology-assisted blended inquiry learning can be used for breakthroughs and even new alternatives in improving critical thinking for students.
Ariska, A., Simanullang, A.F. and Lumbangaol,	The Effect of the Guided Inquiry Learning Model on Students' Physics CTS	This data was taken from a sample at Tamansiswa Private High School in	An impact of learning using the guided inquiry learning model in improving students' CTS in

S.T., (2022)	at Tamansiswa Tapian Dolok Private High School, TA 2022/2023	Tapian Dolok with 2022/2023 academic year with a number of 60 student subjects.	both classes (experimental and control). This can be seen from the results sheet of applying the guided inquiry model. In the instrument the application of the guided inquiry learning method can to produce here show an increase of 87% which is classified as very good. From these results the increase that occurred was significant where students' CTS increased.
Arpiawan, N., Syahrial, A. and Sutrio, S., (2022)	Development of Guided Inquiry Model Learning Tools to Improve High School Students' Critical Thinking Ability in Physics	To test validity, it can be done by presenting the resulting learning device designs, as well as validation questionnaires, to a group of experts consisting of three physics education lecturers and three physics subject instructors.	The guided inquiry model developed relevant to learning because the product validity results are valid and effective. The response value for predicting the practicality of the learning device shows an excellent response.
Wahyuni, E.T., Mayasari, T. and Kurniadi, E (2023)	Application of Guided Inquiry and Use of Flipbook Media to Improve Students' Critical Thinking Ability	For the sample population used are students class XI MIA 3 MAN 1 Madiun City	Application of guided inquiry learning instruments with the help of flipbooks is considered effective in improving CTS because students take an active role in building their knowledge while learning takes place.
Ramona, R., Oktavianty, E. and Sitompul, S.S (2023)	Improving CTS Using the ABSI Learning Model on Heat.	This research is an observation before the experiment using a one group design, namely the pretest-posttest design. As many as 33 students from XI IPA 5 SMA Negeri 3 Pontianak became the research subjects.	Skill upgrade critical thinking occurs significantly by obtaining a normalized gain value of 0.57, classified as moderate. This is because the optimal ABSI model in improving CTS, which is 100%, is classified as very high Good.

Based on several articles analyzed with the same problem, there are results from relevant research that show the importance of learning with the inquiry method to improve students' CTS. Apart from that, media or instruments developed by a teacher become one of the supports so that students can be more attractive in the teaching and learning process. The learning process attempts to emphasize interests, abilities, character, and processes so that learning can be carried out and goals achieved, which requires support from the teaching materials used (Idayanti, 2023). If we observe the implementation of the instruments tested on students, overall, the students still have not mastered the kinetic gas theory material tested well. Apart from this, the distribution of critical thinking indicators for each element of the question has not been able to be answered thoroughly by students. This is related to the ability to solve problems that cannot be separated from and are always tied to a lack of critical thinking talent, which is

influenced by cognitive style (Yasir, 2023). CTS should increase with better learning innovations. This is the reason why many students need help with physics materials. Of course, the teacher as a teacher must have breakthroughs to create comfort in the classroom so that the learning implemented in schools ensures better quality in critical thinking.

Conclusion

This research was conducted to determine students' interests and abilities in kinetic gas theory material and develop learning using inquiry methods assisted by 3D digital Android modules to improve CTS. The test instruments' results were that students did not master kinetic gas theory material using conventional physics learning methods. Apart from that, students are less able to answer each question with critical thinking indicators. The essential indicators of thinking in the instrument include clarification, evaluation, analysis, interpretation, and inference. Students' difficulties in answering questions lie in their need to understand the concept of kinetic gas theory material as well as the use of less-than-optimal methods in the current teaching and learning process. So, in the future, the innovation of 3D module media with inquiry learning will change the critical thinking skills of Tuban 2 State High School students in the kinetic theory of gases. Through interactive learning using the inquiry method, students can improve their critical thinking with the help of digital modules. The increase in critical thinking obtained by students is supported by more interactive media so that learning is more meaningful.

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