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# Designing a Thermochemistry E-Module Based on the Trait Treatment Interaction Educational Model for Madrasah Aliyah Students

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**Abstract**

Planning and carrying out investigations (PCOI) among students are still low, and teachers pay less attention to differences in the abilities of each student, so they have not achieved optimal results. This research aims to develop of a chemistry e-module using the trait treatment interaction (TTI) model to increase valid, practical, and effective's PCOI capabilities. TTI is considered an ideal learning model because it can accommodate and value individual differences among students. The research framework employed in this study follows a research and development method with a define, design, development, and disseminate (4D) model. The results indicate that the high validity level achieved an average score of 84.3% in terms of materials, language, and media aspects. The practicality test of the products also received an average score of 86.2%. The product's effectiveness is categorized as very effective, with students' test results averaging 82.3%. The e-module is deemed valid, practical, and effective in enhancing PCOI capabilities.

Keywords: e-module, planning and carrying out investigations, thermochemistry, trait treatment interaction

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## 1. Introduction

The 21st century is experiencing lots of changes and also in centuries, this request for quality, source, power, and human beings. The change in pattern in education in the 21st century is felt at the moment this is one of the characteristics of the era of globalization called the era of openness, as proven by the development of knowledge (science) and technology (Hasibuan & Prastowo, 2019). Technology helps educators streamline time spent studying students, making it easier to catch material knowledge (Pratiwi et al., 2022). Every student has different characteristics (Fahmi et al., 2020). Difference between students is what is called the difference between students (Kubat, 2018). No individuals are the same although human beings are born twins (Zagoto et al., 2019). Individual differences can be defined and interpreted through various methods (Mollon et al., 2017). Paying attention and considering the different characteristics of students in activity study can fulfil the need students will study with suitable methods needs individual differences (Kubat, 2018); (Lee, 2013). Individual differences in characteristics among students influenced by genetics and environment, such as intelligence, talent, skill,

mentality, and so on give rise to group differences (Crosswaite & Asbury, 2019); (Mollon et al., 2017); (Sackett et al., 2017). Therefore, there are classified students with high ability and also available students who have slow ability (slow learners). Individual differences possessed by students are what demand educators to notice the differences in the learning process (Aswirna, 2018).

The use of learning models proves its effectiveness in increasing the quality of activity of study teaching because it involves the participation of active students in the learning process (Octavia, 2020). Therefore educators need the ability to choose an appropriate and effective learning model that can notice differences in individuals or characteristics participants educate.

Trait Treatment Interaction (TTI) is said to be the expected learning model that can accommodate and appreciate individual differences between students (Fahmi et al., 2020). Objective implementation TTI leads to further improvement of good for the ability student (Aswirna et al., 2022). Therefore, this is in line with goals and planning curriculum so that with the method objective teaching can also be achieved.

The use of learning media must be considered good by the teacher for the sake of supporting and motivating study students. Activity study teaching can involve technology for packing material to be taught. The selection of media as a source of study can enrich the experience and help readiness students to get the material to be taught at the next meeting (Puspitasari, 2019).

Learning chemistry must give a real learning experience for students. Experience study can in a way directly convey meaningful learning for students, so students can understand the concepts studied (Astutik et al., 2020). Besides that, one of the important things that can support progress in learning science is scientific reasoning.

Standard American science was transformed to become the Next Generation Science Standard (NGSS), a mandatory standard achieved by students in learning science. Standard news about the ability students expect can change skills basics and past knowledge, not only in the US but also in Indonesia, because of its similar characteristics to the 2013 curriculum. This NGSS consists of three dimensions: Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCI), and concepts across combined sectors in framework education K-12 science (Harris et al., 2017); (Duncan & Cavera, 2015); (Sani et al., 2018). There are eight aspects of each SEPs that are achieved by students during the study of science following the level of class and characteristics of material taught (Cahyanti et al., 2019); (Bybee, 2014). Aspect SEPs specifically bring focus to learning where students are in a way actively involved in activity scientific. Components in SEPs have connections with each other related to or not only guide students in understanding material teaching but also guide them in developing skills for actively involved in knowledge science (Sukarmin et al., 2021). Science and engineering practices there like defining problems, planning and executing investigations, as well as analyzing and interpreting data which constitutes behaviour carried out by scientists and engineers for investigation and solving problems in the real world (Wang et al., 2023).

Planning and Carrying out Investigation (PCOI) is part of the dimensions of Science and Engineering Practices (SEPs) that can train students at school to understand science more, which is a problem skill in the 21st century (Bansu et al., 2023). Based on NGSS, PCOI does practice planning investigation scientific in a way individual and collaborative. Investigation scientific can be done to describe something phenomenon, testing theory or model about a method that works naturally. Investigation can work to motivate the interests and desires of students to study science, give rise to related attitudes and dispositions with autonomous and

owning learners' motivation, as well increase the ability to think and learn student (Hume & Coll, 2008).

The problem in the learning process is still there is a lack of notice of differences in the abilities of students in learning. Therefore, educators must pay attention to differences in students' abilities so that they can learn more actively. Besides that, still many teachers haven't controlled the method of developing teaching materials, so in carrying out the learning process many are conventional. Impact of learning conventional includes more teacher activities and vice versa students are not enough active because more tend to become listeners (Magdalena et al., 2020). Besides that, in the field teaching materials only focus on material, lack of contextual and monotonous as well as no there is knowledge scientific in solving problems in teaching materials (Nurhasnah & Sari, 2020).

Most students consider chemistry to be a difficult lesson to study (Astalini et al., 2018). Therefore that is a needed alternative to making lesson chemistry more enjoyable, necessary to create something exercise that makes learning more meaningful (Amalia et al., 2020).

Students still often feel difficulty in performing SEPs PCOI (Hume & Coll, 2008); (Wu & Hsieh, 2006). Student process skills are in the category of low so PCOI is still in the category of weak (Windriyana et al., 2019). Based on interviews with participant students in class XI IPA MAN *Kota* Solok obtained information that educators tend to learn theory and formulas during learning hours in chemistry so their learning is a little boring which makes students lack motivation. Based on information, students seldom get knowledge about application chemistry in the real world and students are not motivated enough to study chemistry. Student process skills are in the category of low so PCOI is still in the category of weak (Windriyana et al., 2019). So, it's difficult for students to carry out these SEPs, including PCOI, which is something teachers challenge to overcome.

The effective learning model used for individuals following abilities possessed by students is the TTI model (Aswirna & Harahap, 2020). The application of the TTI learning model will not succeed If no accompanied by the use of adequate learning media. One of the teaching materials that can be used is the e-module. E-module serves material study independently organized in a way systematic into learning units smallest for reaching objective learning; particular ones are presented in electronic format contained therein there is animation, audio, and navigation that makes the user more interactive with the program (Puspitasari, 2019).

Use experimentation to increase students' PCOI skills. This is very appropriate when applied in eye lesson chemistry because experiment is one of the methods necessary for learning in science education to reach knowledge and skills for psychomotor students. Besides that, it can also be done to help students accept lessons, make students more active, foster a sense of responsibility, and make learning more meaningful (Amalia et al., 2020). Therefore, the way it is done for low PCOI is to insert activity practice into learning so that the theory can be studied in real life (Maison et al., 2020); (Amalia et al., 2020). Therefore, an e-module can increase results in science and engineering practices on the PCOI indicator.

## 2. Research Method

### 2.1. Types Study

This study includes research and development or R&D i.e. method research used for producing a product and studying the effectiveness of the product (Sugiyono, 2013). This R&D research will produce new products through the 4D development process.

### 2.2. Procedure Development

#### 2.2.1. Define (Stage Definition)

The objective of this stage is to determine the condition of instruction. Stage beginning is the stage for analyzing and determining goals and obstacles for material intrinsics. Activities carried out at this stage are the following: analysis, beginning to end, is the initial work done by the researcher. The aim is to see efficiency and effectiveness. Learning chemistry covers technical problems that need development device learning. Student analysis is to analyze the characteristics of students. A task analysis that is used to determine content unit learning refers to PCOI. Analysis draft that is for analyzing concepts that will be taught. Finally, that is specification objective purposeful learning for writing objective learning and change expected behaviour after study.

#### 2.2.2. Design (Stage Planning)

This is a continuation of the defined stage. At this stage, we conduct research on instrument design, preparation of the outline of the e-module, and selection of the e-module format.

#### 2.2.3. Develop (Stage Expansion)

Develop stage is the stage for producing product development. At this stage, this consists of several steps, among them: validation expert, revision based on results validation expert, revision product, and testing products by educators and students.

#### 2.2.4. Dissemination (Stage Spread)

Stage spread: This is the expansion product that has been produced.

### 2.3. Types of Data

Types of data in research there are two, which are, quantitative and qualitative. Qualitative data was obtained through input from validators and practitioners. Meanwhile, quantitative data originates from the evaluation validity questionnaire, practicality questionnaire, and effectiveness question test using the Likert scale.

## 3. Result and Discussion

The research aims to produce an e-module in chemistry using the TTI learning model to increase MA (*Madrasah Aliyah*) students' PCOI abilities that are valid, practical, and effective. In this e-module, there is practical work carried out by students following group students. Data collection in this research uses the questions given to students and questionnaire responses from the educator as well as student class XI IPA MAN *Kota* Solok for students' PCOI abilities. The data constitutes quantitative and qualitative data.

Results of the study is in the form of an e-module on chemistry. The results of the 4D model stages are as follows:

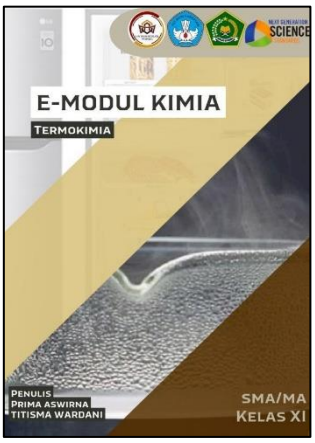
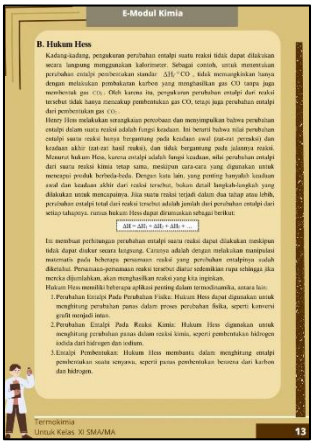
### 3.1. Define (Stage Definition)

Results of observations and interviews with a chemistry teacher in class XI MAN *Kota Solok* disclose that there is a constraint in the learning process. Challenges generally arise as a consequence of a lack of motivation. Study participants learn at school, which has an impact negatively on their performance. As well as in learning chemistry, teaching especially focuses on exposure material with formulas, which makes students feel less interested and less motivated to study chemistry. Based on the analysis carried out, educators and students need more interesting teaching materials again.

### 3.2. Design (Stage Planning)

This stage includes designing research instruments as well as preparing the product outline for prototype I. The designed instrument has sheet validation, practicality, and effectiveness. In preparing the outline will create e-modules, core competencies, a competency basis, goal learning, and materials. The display and information of the thermochemistry e-module can be seen in Table 1.

**Table 1. Display and Information of Thermochemistry E-module**

| Display | Information |
|---|---|
|  | The cover of the e-module created is entitled "E-module Chemistry, Thermochemistry " using pictures with exothermic reaction phenomena and includes the author's name and class identity. |
|  | With material about enthalpy in this e-module, students with high abilities will take the initiative to study it directly with their friends. Meanwhile, students with low skills will learn it with their friends and receive additional learning from the teacher. |
|  | In chemistry material about Hess's law students who have high abilities tend to learn about Hess's law directly with their group friends. Meanwhile, students with lower abilities will study with their group friends and receive additional guidance from the teacher. |
|  | As with chemistry material regarding bond energy, students who have high abilities tend to study bond energies directly with their group members, while students with lower abilities will study with their group members and receive additional guidance from the teacher. |

### 3.3. Develop (Stage Development)

Validation tests, practicality tests, and effectiveness tests will be carried out. Results prototype II will be evaluated formatively in an independent way.

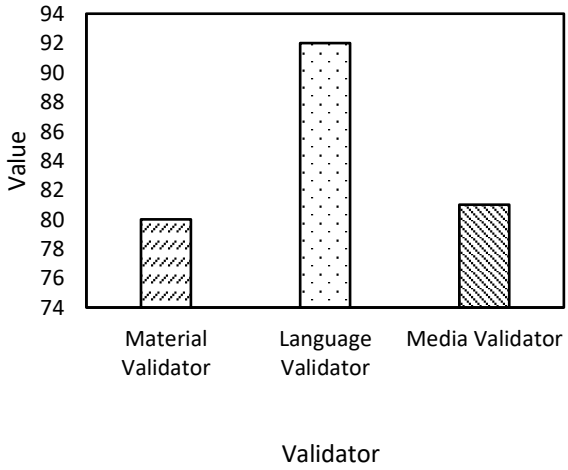



**Figure 1. Validity Results Product**

Validity test results were obtained from a questionnaire filled out by three validators, which are one expert in material, one media expert, and one expert in language. The result validity materials, media, and language can be seen in Figure 1.

Figure 1 illustrates that the results of material validity with the x-axis one is equal to 80% obtained from eight statements, language validity with the x-axis two is for 92% of five statements, and media validity with the x-axis three is for 81% of 81 statements. So, it can be obtained with an average validity of 84.3% in a very valid category.

The practicality test was carried out by distributing questionnaires to one educator and two class XI MAN students in *Kota* Solok. Practitioner test results can be seen in Figure 2 following.

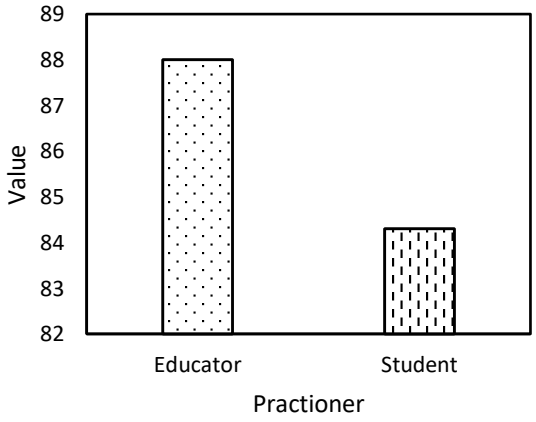



**Figure 2. Practicality Results Product**

Figure 2 depicts that the average practicality test by educators with the x-axis one is at 88% of the 12 statements on the instrument, and the average practicality of students with the x-axis is 84.3% from eight statements. So, the average product practicality is 86.2% in the very practical category.

Effectiveness test for students planning and carrying out investigation abilities, a spread-question test was given to student XI IPA 1 MAN Kota Solok.

Based on answer questions on the e-module obtained effectiveness test results. The effectiveness test results can be seen in Table 2 below.

**Table 2. Results of Effectiveness Product**

| Class | Average |
|---|---|
| XI IPA 1 | 82,3 |

Table 2 shows that the question scores of tests answered by students in class XI IPA 1 is 82.3% of the 25 questions in *KD (Kompetensi Dasar)* 3.10. So, the effectiveness of the product is in the very effective category.

### 3.4 Dissemination (Stage Spread)

This stage is an activity using existing e-modules developed in a wide range of ways.

Learning involves interaction between educators and students, with an objective main that is seen in the absorption and mastery of abilities and concepts taught to students. In this process, every student has their differences in how they accept and understand the material presented. There is interaction and influence between the ability of students and the environment; study ensures harmony in understanding the material. This emphasizes the importance of students developing skills and participating actively in the learning process alone (Logan et al., 2021).

Talented students need a different education than the normal (Galitskaya et al., 2022). They need to use a capable learning model to accommodate their potential because every talented student has different characteristics, so strategy learning must be customized to meet the needs of each (Nacaroğlu & Bektaş, 2023). That matters because every student has a different individual who caused it. Not all students are suitable for every condition studied. If it's a student with a different ability, then the teacher gives help or guidance, especially to underprivileged children who are smart or slow in studying (Firmansyah, 2021). The TTI model is a learning model that is carried out by educators who give different treatments to students. Therefore, a capable

learning model is needed to adapt to individual student differences and give students different treatment.

The TTI model is an effective learning model used by individuals following the abilities they possess (Aswirna & Harahap, 2020). TTI is the expected learning model that can accommodate and appreciate individual differences between students (Fahmi et al., 2020). Before applying the TTI model, participants are educated to do IQ tests first so they can group their abilities in groups high and low. After getting group ability high and low, the next step is to give different treatments in the learning process. Group students who have the ability are given treatment with studying independently (self-learning), and for the participants, students who have low ability are treated with learning normal as well as with learning additional (regular teaching plus tutorials). Studying in a way independent possible student to take not quite enough answers on the learning process himself, including determining, planning, and evaluating ability (Nacaroğlu & Bektaş, 2023). Temporarily, students with low ability tend to depend more on explanation material from educators and follow learning addition (regular teaching plus tutorial).

The connection between results-based learning and the TTI learning model is very tight. Learning with the TTI model can increase the results of study students. Research conducted by Aswirna (2018) shows that the TTI model can increase the academic knowledge of chemistry students. Research results (Aswirna, et al., (2022) show that interactive modules based on participant TTI education can help students study more independently, without or with guidance from educators. Research by Malik et al., (2023) shows there are enhancement results from the study of the use of e-modules in learning chemistry. Research conducted by Lee (2013) shows that in the development of STEM learning, adaptive support ability, adaptation material learning, and considering style study students become more effective. The TTI model will have quite an impact and present the process of communication and understanding behaviour (Lee, 2013). Based on relevant research, it can be concluded that the TTI model has a strong relationship with achievement among study students. TTI models can make the learning process more effective and improve understanding of the material, which ultimately has a positive impact on results.

Based on the study, Puspitasari (2019) shows that the electronic module is very effective in increasing motivation in study students. Study Mutmainnah et al., (2021) shows that learning with the use of modules can increase results for study students. Based on the study, it can be concluded that e-modules can increase motivation study and results study students.

NGSS is a framework for science or standard education that emphasizes students' abilities and engineering. NGSS aims as a guide or standard for carrying out learning and developing interest in students' knowledge and practice of science (Cahyanti et al., 2019). NGSS explains that the most effective way to convey learning is through investigation, collecting and analyzing data (collection and analysis of evidence), reasoning, and communicating information (communication of information) (Tuna & Kaçar, 2013).

PCOI demands students get used to activity practice. The PCOI aspect is very important because participant education in the 21$^{st}$ century is required for control of knowledge and possession skills (Amalia et al., 2020). PCOI is a suite of practice components that will be dismantled to help students struggle with the science involved in building knowledge about nature (Duschl & Bybee, 2014). Therefore, PCOI's ability can improve the ability to carry out activities based on conducting investigations first. This is related to the TTI learning model because, by using the TTI model, students will be motivated to be involved in learning activities, including planning activities and carrying out investigations (practice). This is because students receive support according to their characteristics.

This matter is in line with the results of the study by Bansu et al. (2023) stated that PCOI students are in the category currently. Therefore, PCOI-oriented learning is necessary to improve again for students to better understand science.

Based on the relevant research above, it can be concluded that the use of e-modules with the TTI model can also increase students' PCOI abilities. Because via the e-module with the TTI capability model, cognitive, reasoning, results-based learning, and creativity can happen, this influences students' PCOI abilities. The researcher combines the TTI model with an e-module because the e-module as a learning medium can support students in study-independent (self-learning), especially for students who have high ability. Temporary students with low ability can utilize learning normally together with tutorials (reteaching plus tutorial). Besides that, researchers link e-modules with students' PCOI abilities. The above can be seen from the results of the answers made by students. Students' answers to questions related to planning indicators were 84% and for carrying out investigation indicators it was 83%.

Research results obtained show that teaching materials in the form of e-modules in chemistry using the TTI learning model in the material thermochemistry can be used as should be by students.

## 4. Conclusion

The development process started with an analysis that needed educators and students to teach the materials that would be developed. Next, do the planning involving product preparation instruments and outline the product. Products that have been designed then developed, and stages final spread the product to the general audience. Quality products are assessed based on facet validity, practicality, and effectiveness. E-module shows a high level of validity; the average score was 84.3% in aspect materials, language, and media. Practicality test products also gained an average score of 86.2%. Temporary, that is, effectiveness product categorized as very effective with an average score of results test student reached 82.3%.

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