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# Development of a Guided Inquiry-Based E-Module Integrated with KingDraw on Isomerism to Improve Motivation and Learning Outcomes

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**Abstract:** This research aims to develop an e-module, test the feasibility of the e-module, and test the effectiveness of the guided inquiry-based e-module integrated with KingDraw on isomerism to improve motivation and learning outcomes. This research and development which refers to the Borg & Gall development model which consists of 10 steps and was conducted in three senior high schools in Surakarta. Data collection techniques were carried out by observation, interviews and test questionnaires. The effectiveness test used a pretest-posttest design group. Data on motivation and learning were analyzed using normalized gain and SPSS, including normality, homogeneity, and independent sample t-tests. The results show that the guided inquiry-based chemistry e-module integrated with KingDraw was successfully developed through ten Borg and Gall stages and declared feasible as supporting teaching material. Feasibility was demonstrated through expert validation using the Aiken index on media (V = 0.87), material (V = 0.85), and language (V = 0.88) aspects. Guided inquiry-based e-modules with the help of KingDraw have been proven to be more effective than conventional methods in improving students' motivation and learning outcomes, as shown by the higher N-gain value of the experimental class compared to the control class, both in learning outcomes (0.553 > 0.246) and learning motivation (0.673 > 0.216). In addition, the results of the independent t-test with a sig. value of 0.00 indicate that the use of e-modules provides a significant difference to students' motivation and learning outcomes.

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## INTRODUCTION

The 21st century learning is an educational approach that is technology-based and oriented towards developing skills that are relevant to the demands of the times. The 21st century demands education prepare students who are able to face global competition (Pratiwi et al., 2019). In the 21st century, everyone must have 21st-century skills. 21st century skills are known as "the 4C skills," which include critical thinking skills, creativity, collaboration, and communication (Mahmudah et al., 2022). 4C skills are fundamental skills recommended by a team of experts in the New World of Work in the 21st century. 4C's abilities as a solution to global challenges through critical thinking in contributing new ideas as creative individuals capable of solving real-world problems and working together and collaborating in teams (Pratama et al., 2019).

Chemistry lessons serve as a means to practice thinking skills, not just memorizing concepts. Chemistry learning includes three aspects of study, namely macroscopic, microscopic, and symbolic aspects (Ihsan et al., 2019). Chemistry is the study of the structure, properties, and uses of matter. Chemistry plays important roles in everyday life. Despite its importance, many factors make chemistry difficult to learn. Among the factors affecting the students' learning of chemistry are teacher-centered method of teaching and the abstract concepts of chemistry. Most Chemistry concepts have proved to be difficult for students (Berhanu & Sheferaw, 2022). Most chemical matter is abstract, according to the characteristics of chemistry that: (1) are abstract, (2) are simplifications of actual conditions, and (3) are sequential. These three characteristics cause chemistry to be one of the subjects that are considered difficult by students (Adawiyah et al., 2021).

Difficulties in understanding the concept of chemistry make it difficult for students to solve problems scientifically and critically. Based on interviews with three chemistry teachers, so abstract chemistry concepts are difficult for students to understand. Furthermore, based on the pre-research conducted 191 students from three schools, 84% of the students identified isomerism as a topic that was difficult to learn. These difficulties are primarily caused by teacher-centered learning practices, which limit the development of students' active participation. On the other hand, the presentation of material that is not contextual makes abstract chemical concepts increasingly difficult for students to understand.

In addition to conceptual understanding, low learning motivation also contributes significantly to students' learning difficulties and poor learning outcomes. This finding is consistent with the study by Sookoo-Singh and Boisselle (2018), which reported that many students are not motivated to learn chemistry because the subject is perceived as highly challenging. Based on the results of the student needs questionnaire, low learning outcomes were influenced by negative perceptions of chemistry learning. This is reflected in students' statements indicating low motivation during chemistry lessons. Low learning motivation is associated with weak understanding of fundamental concepts and is considered an internal factor contributing to learning difficulties (Camelia, 2022). Learning motivation also has a significant influence on students' learning outcomes (Rahman, 2021). Students with high learning motivation tend to study diligently on a regular basis, whereas those with low motivation often experience boredom during learning activities (Emda, 2017). When students lack learning motivation, they are less interested in the learning process, which ultimately results in meaningless learning experiences (Halim & Wahyuni, 2023).

In chemistry learning, one of the most abstract and challenging concepts is isomerism. Isomerism is a fundamental phenomenon in which two or more compounds share the same molecular formula but differ in their structural or spatial arrangements of atoms, resulting in distinct chemical and physical properties (Clarke & Tew, 2023). It is categorized into structural isomerism (where the connectivity of atoms differs) and stereoisomerism (where the spatial orientation varies). The compounds exhibiting this phenomenon are called isomers. Understanding isomerism requires students to visualize molecular structures, identify spatial arrangements, and recognize how different structural forms of the same molecular formula give rise to different properties (Umanah & Atabang, 2025). Based on research that has been conducted by Malajai et al. (2025), isomerism is a material that is considered difficult by most students. These difficulties arise because students experience obstacles in identifying and determining various types of isomers in hydrocarbon compounds. Fitriana et al. (2014) also reported that students' that students' scores on isomeric materials tend to be low because they still have difficulty in understanding the concept of isomers and predicting the isomers of a compound.

Conceptual understanding of isomerism often requires numerous examples, visual representations, and structured exercises in drawing molecular structures to help students connect theoretical concepts with the actual forms of chemical compounds (Rahmawati & Prasetyo, 2022; Muliawati et al., 2024). The electronic module is one of the teaching materials that can be used with electronic media and has several devices that make this teaching material interesting. The application of e-module which utilizes technology and information that is developing rapidly and is believed to be able to improve the learning abilities of students and allow two-way interactions which are expected to be able to improve the quality and effectiveness of learning (Maghfirotika et al., 2024). The electronic module can present material interactively through several multimedia such as video, animation, simulation, and questions accompanied by feedback directly (Irwansyah et al., 2017). The electronic module is presented systematically so that readers can learn with or without a teacher or facilitator. The use of electronic modules is very effective in increasing student motivation. Students are not bored with studying due to the students can explore each material using their cell phones only when travels, students are still able to open the electronic module for learning. Because students are motivated to learn, student learning outcomes will also increase (Hairishah & Nurjayadi, 2024). The use of e-modules will be more meaningful when combined with a learning approach that can increase student activity and involvement. Guided inquiry-based e-modules are electronic modules of independent learning resources that are systematically and interactively arranged using a guided inquiry approach (Yunus et al., 2022).

Guided inquiry module used in the learning process contains learning activities which are carried out in accordance with the stages in the guided inquiry learning model. The parts contained in the module include the presentation of the problem, formulation of hypotheses, presentation of data source, drawing conclusions, tasks application, and measurement of the level of understanding through the exercise (Wardani et al., 2016). The use of guided inquiry learning models on teaching process, students can be invited to observe phenomena in daily life will gain experience of the discovery of concepts through teacher guidance (Said et al., 2021). The guided inquiry learning model trains students to build answers and think intelligently in determining various alternative solutions to problems asked by teachers, develop concept understanding skills, build a sense of individual responsibility, and train the process of delivering the analyzed concepts (Maknum, 2020). The guided inquiry approach has been proven to increase motivation, curiosity, and understanding of concepts because students are directly involved in the process of building knowledge. This guided inquiry-based e-module is arranged in a structured learning unit that contains videos, audio, and images so that it can make it easier for students to understand the concept of isomers and increase motivation for independent learning and teachers are no longer the only source of learning (Yunus et al., 2022).

The traditional method of teaching chemistry, which relies heavily on text-based explanations and chalkboard illustrations, is inadequate in enhancing students' active engagement and conceptual understanding (Umanah & Babayemi, 2024). This approach often fails to address the abstract nature of concepts like isomerism, which requires visualization and interactive learning. Consequently, there is a growing need to integrate innovative and technology-driven instructional materials that can simplify complex concepts, promote student engagement, and enhance conceptual visualization, understanding, and retention of knowledge, particularly for abstract topics that require deeper cognitive processing (Itighise, 2016). Visualization through molecular models or chemical simulation software can help students develop a more comprehensive understanding of isomerism. To facilitate students' comprehension of three-dimensional isomer structures, guided inquiry-based e-modules can be integrated with the KingDraw application. KingDraw is a molecular drawing application that supports instruction through visualization and simulation and is suitable for teaching subjects involving abstract concepts (Zulfah & Yodi, 2021). In the research by Rosa and Roehrs (2020), it is highlighted that the structural drawing application KingDraw: Chemistry Station presents an extensive variety of tools, making it the most comprehensive mobile application among others with the same function.The visualization features of KingDraw help students more concretely distinguish structural and stereochemical differences, thereby reducing misconceptions that frequently occur in conventional chemistry instruction.

Based on the problems described above, this study focuses on the development of an e-module. The e-module was developed using a guided inquiry approach integrated with KingDraw to enhance upper secondary school students' motivation and learning outcomes in isomerism. This study has several limitations, including the involvement of only three public senior high schools in the city of Surakarta and the focus on cognitive learning outcomes. Therefore, the objectives of this study are to develop the e-module, to analyze its feasibility, and to evaluate the effectiveness of the guided inquiry-based e-module integrated with KingDraw in improving students' motivation and learning outcomes on isomerism.

## METHOD

This research and development which refers to the Borg & Gall development model which consists of 10 steps. According to Sugiyono (2019), R&D research is a research and development method used to obtain a product, and test the effectiveness of the product. This development research adapts the development model according to Borg and Gall which consists of 10 stages including: 1) research and information collecting, 2) planning, 3) develop preliminary form of product, 4) preliminary field testing, 5) main product revision, 6) main field testing, 7) operational product revision, 8) operational field testing, 9) final product revision, 10) dissemination and implementation. The research procedures as shown in Figure 1.

This research was carried out on isomerism in grade XII in three high schools in Surakarta. The research sample totaled 198 students from three schools, with each school consisting of one control class and one experimental class. The entire series of research will be carried out in the 2024–2025 school year.

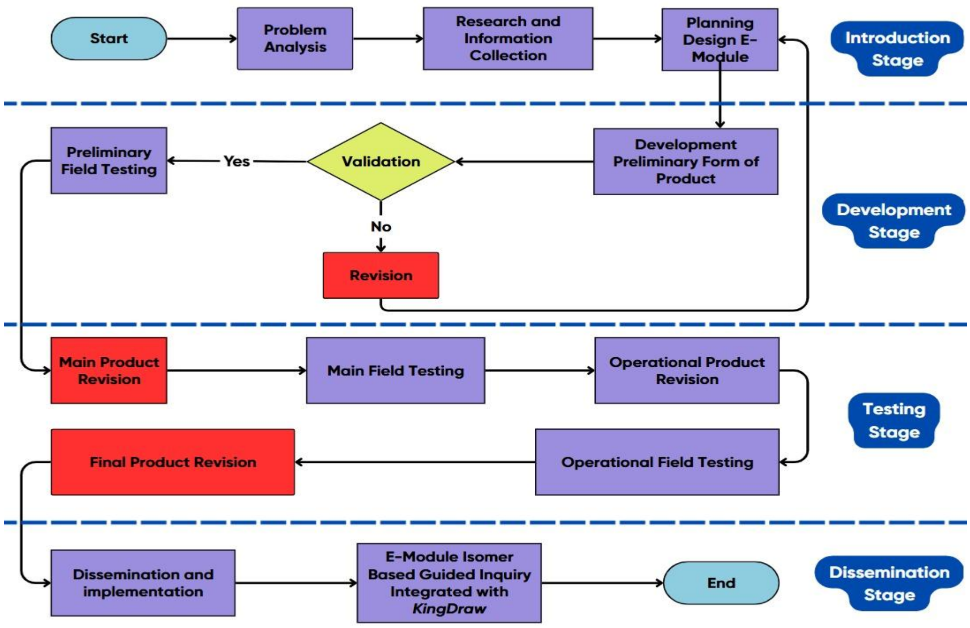



**Figure 1**. Research Procedure

The research and information gathering stage is carried out by providing a questionnaire of students' needs and conducting interviews with teachers. The purpose of conducting this preliminary analysis is to find out the learning process that has been carried out by the teacher, find out the problems experienced, the requirements for the e-module content needed, and find out the difficulties of students and teachers in chemistry learning. Then continued the planning stage of the e-module to be developed. At this stage, the design of the e-module is prepared in accordance with the learning objectives, materials, and needs of students. In addition, the preparation of a design for an e-module assessment instrument and a learning motivation instrument was carried out.

The development stage aims to develop an initial product in the form of a guided inquiry-based e-module integrated with KingDraw. At this stage, the product design will be validated by expert validation consisting of media experts, material experts and media experts, and chemistry teachers. Once everything is valid, trials are carried out in small, medium, and large groups on all aspects developed including media, material and learning aspects. To test the effectiveness of the e-module, testing is used in the form of a quasi-experimental design. The design model used is Pretest-Posttest Group Design as shown in Table 1. Pretest and posttest questions and questionnaires are used to measure learning outcomes and learning motivation of students.

**Table 1.** Pretest-Posttest Group Design

| Classes | Pretest | Treatment | Posttest |
|---|---|---|---|
| Eksperimen | P1 | X | P2 |
| Controls | P1 | | P2 |

Description:
P1 : Pretest Students' abilities before using the e-module based on guided inquiry
P2 : Posttest Students' abilities after using the e-module based on guided inquiry
X : Be given treatment of students, namely the use of e-module based on guided inquiry

The pretest and posttest data were first analyzed using normality and homogeneity tests as prerequisites for testing the effectiveness of the e-module. The normality test was conducted using the Shapiro–Wilk test in SPSS 25, with the data being normally distributed if the significance value is ≥ 0.05. The homogeneity test was conducted using the Levene Test in SPSS 25, with the data being considered homogeneous if the significance value is ≥ 0.05. Once the data met the normality and homogeneity requirements, the analysis continued with a t-test to determine differences in learning outcomes before and after using the Guided Inquiry-based e-module.

Furthermore, n-gain analysis was carried out to determine the level of increased motivation and learning outcomes before and after using the guided inquiry-based chemistry e-module. Dewi et al. (2021) explained that the value of N-gain can be obtained through calculation with the formula shown in equation 1.

$$\text{N-gain} = \frac{(\text{Score Posttest-Score Pretest})}{(\text{Max Score-Score Pretest})} \quad (1)$$

After that, a comparison was made between the results of the gallin calculation and the n-gain standard shown in Table 2.

**Table 2**. N-gain value category

| Average gain | Category |
|---|---|
| $0.00 < g \leq 0.30$ | Low |
| $0.30 < g \leq 0.70$ | Medium |
| $0.70 < g \leq 1.00$ | High |

## RESULT

Based on the results of the research and the explanation of the research results and the e-module development process that has been carried out, the following results were obtained:

**Introductory Stage**

1. Research and information collection

**Table 3.** Result of Student Questionnaire Needs Analysis

| No | Statement | Answer Option | |
|---|---|---|---|
| | | Yes (%) | No (%) |
| 1 | In chemistry learning, teachers often use lecture methods rather than exploration or inquiry activities. | 90 | 10 |
| 2 | I write more theoretical notes than do practical or analytical activities during chemistry lessons. | 72 | 28 |
| 3 | I feel less motivated when studying chemistry, especially in abstract materials like isomers. | 86 | 14 |
| 4 | I had a hard time understanding the concept of isomers because I couldn't imagine the shape of the molecular structure. | 84 | 16 |
| 5 | In addition to chemistry printed books, teachers also have teaching materials or other textbooks that are used in the teaching and learning process. | 70 | 30 |
| 6 | Teachers rarely use visual aids (such as animations, molecular models, or digital applications) to explain chemical materials. | 63 | 37 |
| 7 | With interesting and innovative learning modules, it can increase my motivation in learning. | 92 | 8 |
| 8 | I needed learning mediums such as guided inquiry-based e-modules that guided me to observe, ask questions, and discover isomer concepts on my own. | 84 | 6 |
| 9 | I have a smartphone and can access it for study purposes at school or at | 97 | 3 |

| No | Statement | Answer Option | |
|---|---|---|---|
| | | Yes (%) | No (%) |
| | home. | | |
| 10 | I support the development of innovative chemistry e-modules that combine guided inquiry approaches and molecular visualization (e.g. with KingDraw). | 98 | 2 |

Based on the results of the questionnaire of students' needs in Table 3, it can be concluded that chemistry learning is still dominated by teacher methods and theoretical recording activities, thus limiting the active involvement of students in the learning process. This condition has an impact on low learning motivation and high difficulty for students in understanding isomer concepts which are abstract and require the ability to visualize molecular structures. Even though teachers already have teaching materials other than printed books, the use of visual media and digital technology in learning is still relatively low. In fact, students show a very high need for alternative learning media that are more interactive and innovative. This is shown by the high percentage of students who need and support the development of chemistry e-modules based on guided inquiry with the help of molecular visualization. In addition, the readiness of students in terms of technological facilities is very adequate, characterized by almost all students having smartphones that can be used for learning. Thus, the development of a guided inquiry-based chemistry e-module integrated with KingDraw is a relevant solution and has the potential to improve students' motivation and learning outcomes.

2. Planning

The results of the initial design of the e-module based on guided inquiry integrated with KingDraw are in the form of an e-module storyline.The storyline in this e-module consists of cover/home/home/starting page, introduction, learning activities, learning materials, practice questions, and self-reflection. The results of the initial design or storyline of the e-module are shown in Table 4.

**Table 4.** Storyline e-modules

| No | E-modules section | Remarks |
|---|---|---|
| 1 | Home page | The front page contains: The title of the e-module and the e-module builder, syntax shortcut keys, concept map and KingDraw, animated videos and a little explanation, as well as the author's foreword. |
| 2 | Introduction | The introductory menu contains the identity of the material, concept map, learning outcomes, learning objectives, brief description of the material, instructions for using the module, learning syntax, references and glossary. |
| 3 | Activities | Learning activities use a guided inquiry syntax that contains orientation steps, formulating problems, making hypotheses, collecting data, testing hypotheses, and formulating conclusions. |
| 4 | Material | Contains isomer learning materials ranging from the definition to the types of isomers. |
| 5 | Practice Questions | There are practice multiple-choice questions and answers. |
| 6 | Self Reflection | Contains a reflection link, a learning motivation questionnaire, and student responses. |

**Development Stage**

1. Develop Preliminary form of Product

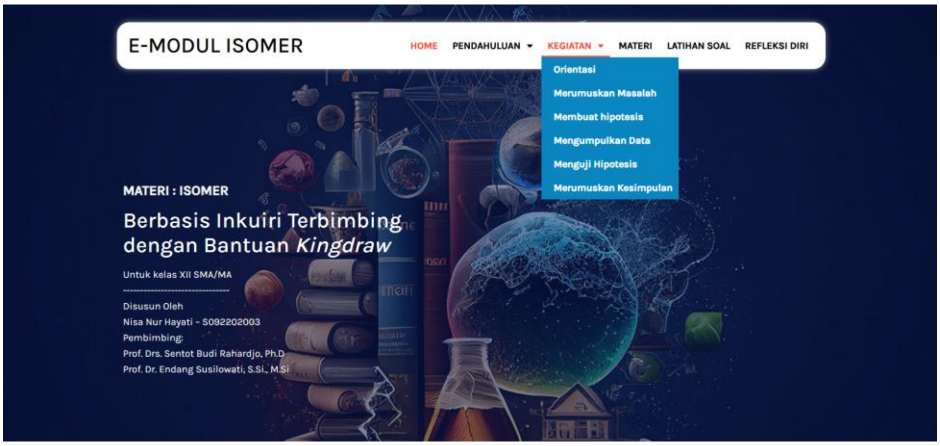
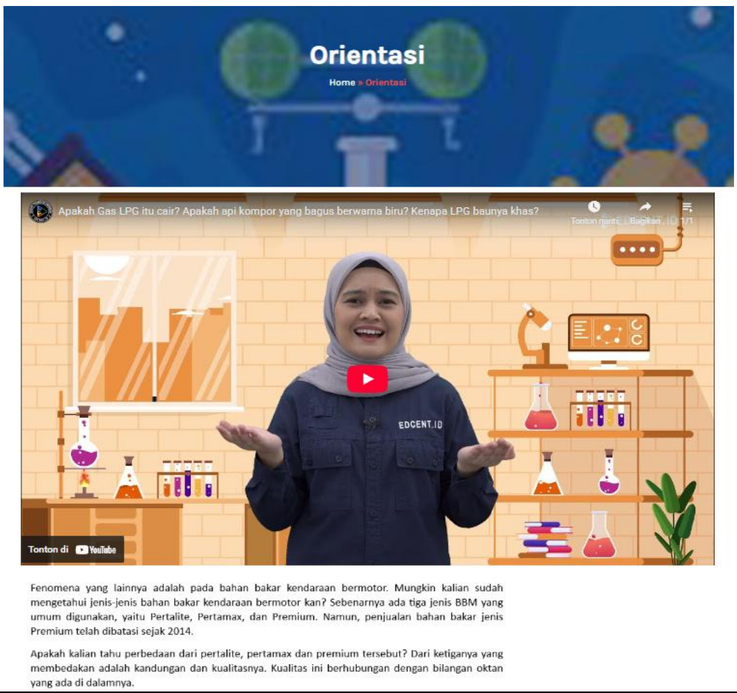
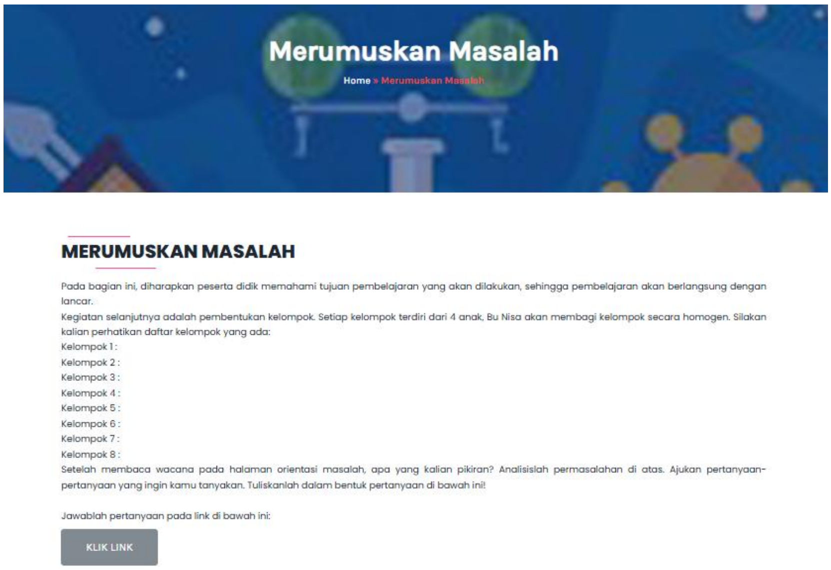
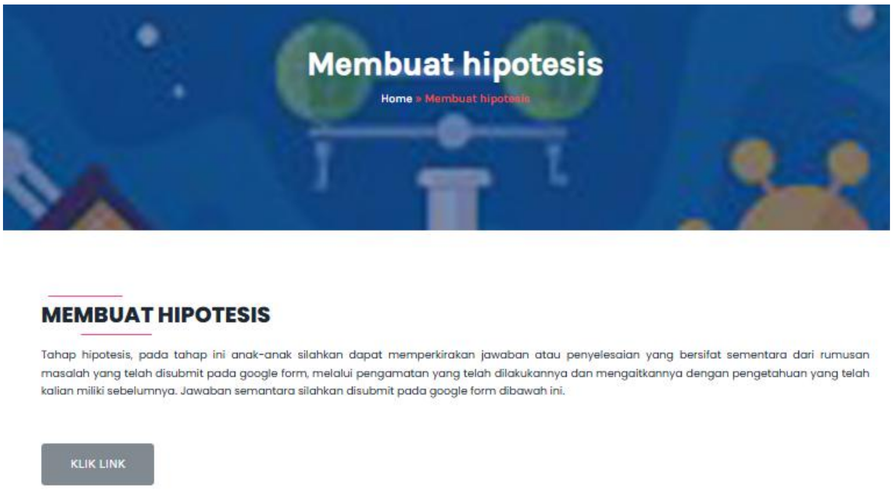



**Figure 2**. Main menu display e-module

**Table 5.** The Result of e-module development

| No | Syntax | E-module section screenshoot and activities of teachers and students |
|---|---|---|
| 1 | Orientation | • The teacher brought up an interesting phenomenon, for example two substances with the same formula but different shapes and properties. Then explain the purpose and benefits of learning in a contextual manner (e.g. in relation to fuel)<br>• Students pay attention, observe, and respond to the phenomena presented and then put forward initial conjectures and ask questions that are not yet understood.<br> |
| 2 | Summarizing the problem | • The teacher guides students to formulate problems by understanding the learning objectives by forming groups, each group consists of 4 children.<br>• Students formulate a question, for example: "What is an isomer?", "Why can compounds have different structures?", "What types of isomers are there?" |

<table>
<tr><th>No</th><th>Syntax</th><th>E-module section screenshoot and activities of teachers and students</th></tr>
<tr><td></td><td></td><td>
</td></tr>
<tr><td>3</td><td>Hypothesis submission</td><td>• The teacher guides students to formulate hypotheses based on the formulation of the problem that has been made.<br>• Students discuss hypotheses in groups and write hypotheses on the LKPD.<br>
</td></tr>
<tr><td>4</td><td>Collect data</td><td>• The teacher provides a tool (molecular model with the KingDraw app) and provides a step-by-step guide to use. As well as providing practice questions describing the structure of molecules with the KingDraw application.<br>• Students draw 3D structures using the KingDraw app.</td></tr>
</table>

| No | Syntax | E-module section screenshoot and activities of teachers and students |
|---|---|---|
| | |  |



| No | Syntax | E-module section screenshoot and activities of teachers and students |
|---|---|---|
| 5 | Hypothesis testing | • The teacher asks each group to present the results of the discussion in front of the class and provide feedback and clarification if there are any misconceptions.<br>• Students present the results of the analysis in the form of a table or a short presentation.<br> |



| No | Syntax | E-module section screenshoot and activities of teachers and students |
|---|---|---|
| 6 | Conclusion | • The teacher leads the students to conclude the results of the investigation.<br>• Students submit the results of the conclusion in the LKPD.<br> |

At this stage, the product design was validated by expert validators consisting of media experts, material experts, language experts, and practitioners, namely chemistry teachers. The media expert validators consisted of six people, consisting of two lecturers and four chemistry teachers. Validation was carried out to obtain assessments, criticisms, and suggestions for the developed e-module to meet the valid criteria. The validator assessment was given in the form of a score based on a Likert scale. The results of the analysis using the Aiken index showed that the guided inquiry-based e-module with the help of KingDraw on material isomers was declared feasible, with validity values of media (V = 0.87), material (V = 0.85), and language (V = 0.88). These values indicate that the e-module was declared valid from the media, material, and language aspects.

2. Preliminary Field Testing

The Preliminary Field Testing stage, or initial field trials, was conducted after the product was validated by expert validators and practitioners. This trial was conducted in three schools, involving 15 randomly selected 12th-grade students, each consisting of five students. This limited trial aimed to identify any remaining errors in the e-module. Students were asked to complete a response questionnaire and provide qualitative feedback and suggestions for improving the guided inquiry-based e-module using the KingDraw application for the isomer topic.

According to the graph in Figure 3, student assessments of the media, materials, and learning aspects were predominantly in the good category. Overall, these results indicate that students positively assessed the e-module in terms of media, materials, and the learning process.

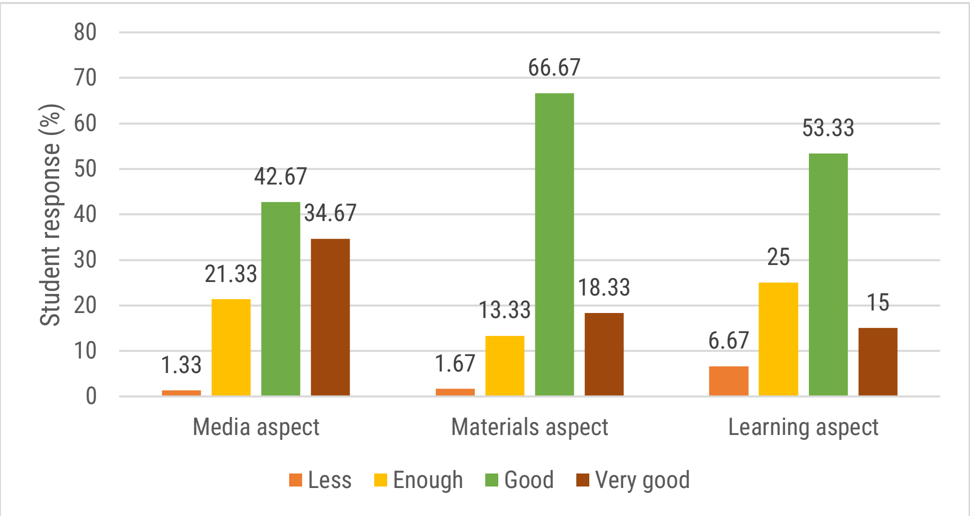



**Figure 3**. Student response percentage graph preliminary field testing

3. Main Field Testing

The main field testing phase was conducted by implementing learning using a guided inquiry-based e-module. This phase was conducted to test the e-module's feasibility and measure the validity of the research instrument. Thirty-three students from three schools participated in this activity. The results of the main field test are obtained valid and reliable learning motivation measurement instruments. Student responses were collected through questionnaires. The questionnaire of students' responses to the e-module was reviewed from three aspects, namely the media aspect, the material aspect and the learning aspect. This questionnaire uses a likert scale of 1-4. The percentage data of student responses to the e-module is presented in graphic form in Figure 4.

Based on the results of the main field trial, the chemistry e-module based on Guided Inquiry integrated with KingDraw received a very good response from 97.05% students. Media, materials, and learning aspects are considered interesting, easy to use, and help understand abstract isomer concepts. Thus, the e-module developed is declared suitable for use as teaching materials to support chemistry learning and has the potential to increase students' motivation and learning outcomes.

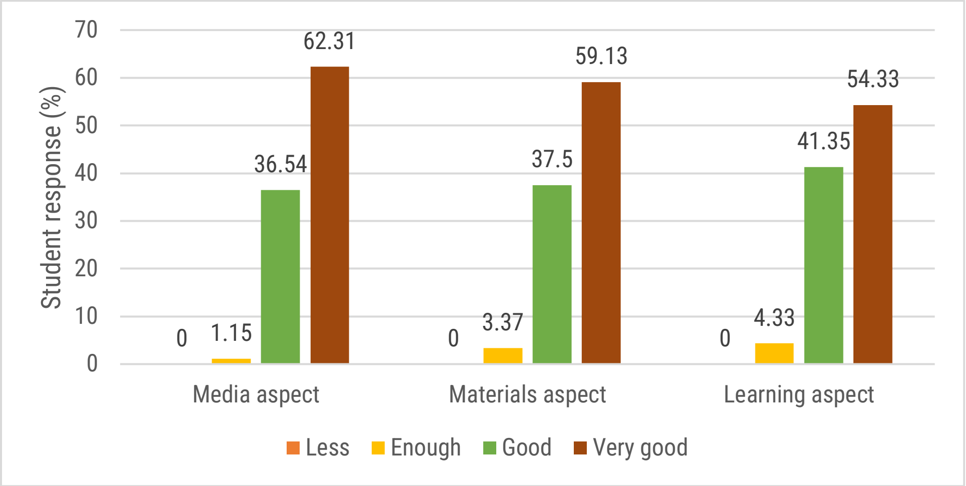



**Figure 4**. Student response percentage graph main field testing

**Testing stage**

1. Operational field testing

This stage aims to find out the extent to which the e-modules developed are able to increase students' motivation and learning outcomes. The research subjects consisted of students from three schools, namely SMAN 1, SMAN 5, and SMAN 7. In each school there are two classes, namely the control class and the experimental class, with a total of 33 students in each class. Students in the experimental class were given learning using guided inquiry-based e-modules, while the control class followed learning without using e-modules.

The effectiveness of the guided inquiry-based e-module integrated with KingDraw was measured through pretest and posttest to determine the improvement of learning outcomes. A total of 20 multiple-choice questions were given to students to solve. From this large-scale trial, it was used to conduct a prerequisite test consisting of normality and homogeneity tests. The results of the normality test for three schools are shown in Table 6.

**Table 6.** Normality test results

| School | Classes | | *Shapiro-Wilk* (sig.) | Remarks |
|---|---|---|---|---|
| SMAN 1 | Eksperimen | Pretest | 0,056 | Normal |
| | | Posttest | 0,091 | Normal |
| | Control | Pretest | 0,060 | Normal |
| | | Posttest | 0,843 | Normal |
| SMAN 5 | Eksperimen | Pretest | 0,101 | Normal |
| | | Posttest | 0,446 | Normal |
| | Control | Pretest | 0,362 | Normal |
| | | Posttest | 0,291 | Normal |
| SMAN 7 | Eksperimen | Pretest | 0,118 | Normal |
| | | Posttest | 0,740 | Normal |
| | Control | Pretest | 0,078 | Normal |
| | | Posttest | 0,317 | Normal |

Table 6 shows the results of the normality test in SMAN 1, SMAN 5 and SMAN 7, both experimental and control classes, with a significance value of more than 0.05, meaning that the learning outcomes from the three schools are distributed normally. Furthermore, a homogeneity test was carried out which was obtained in Table 7.

**Table 7**. Homogeneity test results

| School | | Test of Homogemity of Variances | |
|---|---|---|---|
| | | Levene statistic | Say. |
| SMAN 1 | Pretest | 0,090 | 0,766 |
| | Posttest | 0,208 | 0,650 |
| SMAN 5 | Pretest | 0,755 | 0,388 |
| | Posttest | 0,655 | 0,421 |
| SMAN 7 | Pretest | 0,08 | 0,931 |
| | Posttest | 0,628 | 0,431 |

Table 7 shows that the results of the homogeneity test of learning outcomes of SMAN 1, SMAN 5 and SMAN 7 students in both the pretest and posttest were obtained with a significance value greater than 0.05. This means that the learning outcomes of the three schools, both the control class and the experimental class, are homogeneous or come from the same population. After the data shows that it is normal and homogeneous, the independent t-test is continued to determine the significance after using the e-module. This test was carried out with the aim of finding out whether there was a difference in learning outcomes in the group that used e-modules and did not use e-modules. The results of the independent t-test are shown in Table 8.

**Table 8.** Independent t-test

| | | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | | F | Sig. | t | df | One-Sided p | Two Sided p | Mean Difference | Std. Error Difference | Lower | Upper |
| SMAN 1 | Pretest | Equal variance assumed | .090 | .766 | .760 | 64 | .225 | .450 | 2.57576 | 3.39052 | -4.19759 | 9.34910 |
| | | Equal Variances not assumed | | | .760 | 63,408 | .225 | .450 | 2.57576 | 3.39052 | -4.19881 | 9.35032 |
| | Posttest | Equal variance assumed | .280 | .650 | 7.871 | 64 | <.001 | <.001 | 16.06061 | 2.04054 | 11.98416 | 20.13705 |
| | | Equal Variances not assumed | | | 7.871 | 63,408 | <.001 | <.001 | 16.06061 | 2.04054 | 11.98334 | 20.13787 |
| SMAN 5 | Pretest | Equal variance assumed | .1693 | .198 | .548 | 64 | .293 | .586 | 1.96970 | 3.59549 | -5.21313 | 9.15252 |
| | | Equal Variances not assumed | | | .548 | 62,270 | .293 | .586 | 1.96970 | 3.59549 | -5.21697 | 9.15637 |
| | Posttest | Equal variance assumed | .655 | .421 | 5.906 | 64 | <.001 | <.001 | 16.66667 | 2.82216 | 11.02875 | 22.30458 |
| | | Equal Variances not assumed | | | 5.906 | 63,137 | <.001 | <.001 | 16. 66667 | 2.82216 | 11.02727 | 22.30606 |
| SMAN 7 | Pretest | Equal variance assumed | .008 | .931 | .054 | 64 | .479 | .957 | .15152 | 2.80763 | -5.45738 | 5.76041 |
| | | Equal Variances not assumed | | | .054 | 63,882 | 479 | .957 | .15152 | 2.80763 | -5.45738 | 5.76061 |
| | Posttest | Equal variance assumed | .628 | .431 | 3.699 | 64 | <.001 | <.001 | 11.96970 | 3.23637 | 5.50431 | 18.43508 |
| | | Equal Variances not assumed | | | 3.699 | 63,195 | <.001 | <.001 | 11.96970 | 3.23637 | 5.50273 | 18.43667 |

The results of the independent t-test of learning outcomes in the three schools shown by Table 8 obtained a significance value of <0.001 which means that the significance $(p) < 0.05$. This causes differences in learning outcomes in the experimental class and the control class. Based on these results, it can be concluded that the learning outcomes of students who are given learning with guided inquiry-based e-modules integrated with KingDraw have different learning outcomes from the classroom using the conventional model.

After the prerequisite test was carried out, the results of the three schools were obtained, both in the control class and the experimental class, having normally distributed data with a homogeneous data distribution. Therefore, an effectiveness test was carried out using the N-gain formula. The results of each school's N-gain test are shown by Table 9.

**Table 9**. N-gain pretest and posttest results of learning outcomes

| School | Classes | N-gain | Category |
|---|---|---|---|
| SMAN 1 | Eksperimen | 0,65 | Medium |
| | Controls | 0,30 | Low |
| SMAN 5 | Eksperimen | 0,51 | Medium |
| | Controls | 0,17 | Low |
| SMAN 7 | Eksperimen | 0,50 | Medium |
| | Controls | 0,27 | Low |

The average N-gain is a measure of students' understanding improvement that considers pretest and posttest scores. Based on the data in Table 9, the experimental classes in the three schools showed higher N-gain values than the control classes. The N-gain value of the experimental class in SMAN 1 was 0.65; in SMAN 5 it was 0.51; and in SMAN 7 was 0.50; all of which were included in the medium category. Meanwhile, the control class at the three schools obtained lower N-gain scores, namely 0.30 in SMAN 1, 0.17 in SMAN 5, and 0.27 in SMAN 7, which were included in the low category. The difference in the N-gain value shows that the use of guided inquiry-based e-modules is more effective in improving student learning outcomes than learning without using e-modules.

A guided inquiry-based chemistry e-module integrated with KingDraw to improve motivation and learning outcomes in class XII isomerism in three high schools in Surakarta. The effectiveness of e-modules is measured by a learning motivation questionnaire. A total of 30 questions were given to students to complete. From this large-scale trial, it was used to do N-gain. This N-gain value is used to see an increase in the learning motivation of students from three high schools are shown in Table 10..

**Table 10**. N-gain results of learning motivation

| School | Classes | N-gain | Category |
|---|---|---|---|
| SMAN 1 | Eksperimen | 0,72 | Height |
| | Controls | 0,25 | Low |
| SMAN 5 | Eksperimen | 0,63 | Medium |
| | Controls | 0,19 | Low |
| SMAN 7 | Eksperimen | 0,67 | Medium |
| | Controls | 0,21 | Low |

Based on the data in Table 10, the experimental classes in the three schools showed higher N-gain values than the control classes. The N-gain value of the experimental class in SMAN 1 was 0.72, in SMAN 5 it was 0.63, and in SMAN 7 it was 067, all of which were included in the high and medium categories. Meanwhile, the control classes in the three schools obtained lower N-gain scores, namely 0.35 in SMAN 1, 0.19 in SMAN 5, and 0.21 in SMAN 7, which were included in the low category. The difference in N-gain values shows that the use of guided inquiry-based e-modules is more effective in increasing students' learning motivation than learning without using e-modules. Thus, the inquiry-based e-module guided integrated with KingDraw on the developed isomerism is effective in increasing the learning motivation of high school students.

### Dissemination Stage

The final stage of the research, dissemination and implementation, aims to socialize and disseminate the Guided Inquiry-based chemistry e-module, supported by KingDraw, to chemistry teachers in the Surakarta region. Dissemination will be carried out through the use of the e-module in learning and the preparation of scientific articles that can be used more widely and sustainably.

## DISCUSSION

### Develop an E-module

The initial testing phase of the guided inquiry-based e-module using KingDraw was conducted through validation by experts and practitioners to assess the material, media, and language aspects. The validation results indicated that the e-module met its development objectives and was deemed suitable for use, although revisions were still needed based on the validator's suggestions and input. The material was presented systematically using communicative language and supplemented with images, videos, and the KingDraw application to enhance student independence and learning interest.

Preliminary field testing aimed to identify deficiencies, particularly in the readability and usability of the e-module. Several technical challenges were encountered, such as access via QR code and difficulty understanding the steps for using the e-module, which were then used as the basis for product improvements. Student feedback was used to refine the e-module to enhance motivation and learning outcomes.

Main field testing, the e-module received positive feedback from students in terms of appearance, material, and learning, with the e-module categorized as "very good," making it suitable for further operational trials. The operational field testing demonstrated that the e-module was more effective than conventional methods in improving student motivation and learning outcomes, based on pretest-posttest results and N-gain analysis.

**Eligibility**

A chemistry e-module based on Guided Inquiry using KingDraw on isomers was declared suitable for use as an alternative teaching material in chemistry learning. The e-module's suitability was determined based on validation results from experts including material experts, media experts, linguists, and chemistry practitioners using the Aiken index.

The validation results showed that the e-module met the e-module's eligibility criteria for media, with an Aiken score of 0.87, indicating an attractive, interactive, and easy-to-use e-module display. For material, the Aiken score was 0.85, indicating the isomer material's suitability for learning outcomes, conceptual completeness, and support for the implementation of guided inquiry learning. Meanwhile, for language, the Aiken score was 0.88, indicating communicative language use, appropriate to the students' developmental level, and adherence to applicable linguistic rules.

Based on the validation results and supported by the results of previous research, the chemistry e-module based on Guided Inquiry integrated with KingDraw has met the eligibility standards and can be continued to the trial stage and used as supporting teaching materials in chemistry learning on isomerism.

**Effectiveness**

The use of a Guided Inquiry-based chemistry e-module integrated with KingDraw has been proven to increase student motivation in learning isomers. N-gain results showed that the experimental classes in three schools (SMAN 1, 5, and 7 Surakarta) had higher N-gain scores, ranging from 0.63–0.72 (medium–high category), compared to the control classes, which ranged from 0.19–0.26 (low category). This indicates that the e-module can make learning more engaging, interactive, and motivate students to learn actively.

Meanwhile, analysis of learning outcomes through pretests and posttests showed normal and homogeneous data, allowing for an independent t-test. The results showed that the experimental class had a higher average score than the control class, with a significance level of $p < 0.05$, indicating a significant difference. Furthermore, the N-gain value for the experimental class (0.50–0.65, in the moderate category) was higher than that of the control class (0.17–0.30, in the low category), confirming that the e-module effectively improved understanding of the isomer concept.

The results of the study show that guided inquiry-based chemistry e-modules integrated with KingDraw are effective in improving students' motivation and learning outcomes on isomeric materials. This is shown by the N-gain values of learning motivation and learning outcomes in the experimental classes in the three schools which were higher than the control classes. The increase in learning motivation in the experimental class occurred because the e-module presented learning that actively involved students through the stages of guided inquiry, supported by the visualization of isomer structures using KingDraw. Learning becomes more interesting and not monotonous, thus encouraging students' interest and involvement in the learning process.

Thus, the e-modules developed not only increase learning motivation, but also support the understanding of concepts and the achievement of student learning outcomes more optimally. Meriyenti et al. (2025) revealed that the use of e-modules has been proven to increase students' attention, enthusiasm, and active interaction so that it can increase student involvement and motivation to learn. This is proven through N-gain and independent t-test tests in experimental classes where the use of e-modules has a fairly effective effect on improving learning outcomes. Learning is said to go well if it contains all aspects that are interactive, fun, challenging, motivating and provide space for students to develop creativity and independence according to their interests and talents. From the effectiveness test of learning outcomes, it can be concluded that learning using guided inquiry-based e-modules integrated with of KingDraw is effective in improving learning outcomes.

## CONCLUSION

A chemistry e-module based on Guided Inquiry integrated with KingDraw on isomerism was successfully developed through ten stages of Borg and Gall and was declared suitable for use as supporting teaching materials. The e-module's suitability was proven through expert validation with the Aiken index on media (V = 0.87), material (V = 0.85), and language (V = 0.88) aspects. Guided inquiry-based e-modules with the help of KingDraw on isomer material have proven to be more effective in improving motivation and learning outcomes compared to conventional methods. This is shown from the learning outcomes, an average N-gain of 0.553 in the experimental class and 0.246 in the control class. While learning motivation obtained an average N-gain of 0.673 in the experimental class and 0.216 in the control class. This shows that the use of e-modules is more effective in improving student motivation and learning outcomes. The results of the independent t-test obtained a sig. 0.00 value on student motivation and learning outcomes, which shows that the use of e-modules provides a significant difference in achieving learning outcomes. These e-modules can be used as alternative teaching materials to support the learning process. Therefore, teachers are advised to continue developing learning innovations, particularly e-modules that are in line with technological developments, to enhance student learning motivation.

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