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Developing an Atomic Structure E-Module Using Kvisoft Flipbook Maker in Senior High School

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Abstract

Based on the results of interviews with several chemistry teachers, it was found that technology-based teaching materials still needed to be improved, especially regarding atomic structure material. Therefore, it is necessary to create technology-based learning materials. This study aims to develop an e-module of atomic structure material using Kvisoft Flipbook Maker software and determine the level of validity, practicality, and students' responses. This article was a type of Research and Development (R&D) using the Borg & Gall model. The research subjects were material, media, and educational practitioner experts as validators and students as the subjects of the feasibility tests. Data collection techniques included validity test questionnaires, practicality tests, students' responses to the test, interviews, and documentation. Data analysis used qualitative and quantitative analysis techniques. The research results show that the e-module validity level is 88.88% with a valid category for material and 93.16% with a valid category for media. The level of practicality obtained was 89.33% in the practical category. Apart from that, student responses obtained a score of 86.55% in the good category. Thus, the atomic structure e-module developed is valid, practical, and has received a good response.

Keywords: Atomic Structure, E-Modul, Kvisoft Flipbook Maker, Learning Media

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1. Introduction

Science and technology consistently develop rapidly, which causes change and reform in various aspects of life, especially in education. The growth of science and technology is also hoped to achieve educational goals. Besides, teachers are expected to facilitate students with various technological innovations, such as computers, electronic whiteboards, electronic modules, and others (Larson & Miller, 2012).

In the current era, the transformation of educational media has become essential, especially during the COVID-19 pandemic, which has accelerated the adoption of digital learning tools (Atsani, 2020). The shift to online learning platforms has highlighted the need for effective and engaging digital learning materials, such as e-modules, to support remote education (Kharisma et al., 2020). E-modules have become an invaluable resource for facilitating independent and flexible learning, allowing students to access materials anytime and anywhere, thereby overcoming the limitations posed by traditional classroom settings (Sadikin & Hamidah, 2020). Additionally, the integration of e-modules in the learning process has been shown to enhance students' understanding and retention of complex scientific concepts, making learning more interactive and meaningful (Aji, 2020).

Electronic modules, commonly known as e-modules, are electronic versions of a module that can be read on a computer or smartphone using specific software (Priyanthi et al., 2017). E-modules are organized systematically and in the form of the minost learning units, with specific learning objectives in each unit. E-modules are presented in an electronic format containing videos, animations, images, and navigation that can make learning interactive (Perdana et al., 2017). E-module is an ICT-based module, which is more interactive in nature, makes it easier to navigate, allows presenting images, audio, video and animation and is equipped with formative tests or quizzes that allow immediate automatic feedback (Prasetya, 2021). E-modules are educational resources that include content, delivery methods, constraints, and assessment strategies that are arranged in an orderly and visually appealing manner to help learners attain the required skills in line with the electronically complex level (Wijayanti et al., 2024). E-modules are selected as teaching materials that can be used offline or online in the learning process because e-modules have many advantages.

The advantage of e-modules is that they allow students to learn everywhere and every time. E-modules could guide pupils to learn by themselves or groups. Through the e-module, students can study at home or school to solve learning problems considered tedious and challenging to understand (One, 2018). Moreover, the materials presented in the e-module are easy for students to understand. E-modules provide opportunities to practice questions and learning activities, which can increase students' participation during the learning process. Besides, e-modules can increase the creativity of teachers and students, familiarize them with how to think more productively, actively, effectively, and innovatively, and create fun learning conditions (Hikmah & Haqiqi, 2021). E-modules can also help students develop their learning independence, ensuring that learning is student-centered (Maniq et al., 2021). According to (Telussa & Tamaela, 2023), The presence of e-modules in the learning process will have a positive impact. Some effects of the presence of e-modules in the learning process include the successful improvement of numeracy literacy and character education, making learning more contextual and meaningful.

Furthermore, the development of e-modules has shown significant promise in enhancing student understanding and engagement across various scientific topics. Afifah et al. (2018) demonstrated that Android-based e-modules on the topic of the Plantae kingdom effectively improved student learning outcomes by providing interactive and accessible content. Similarly, Fauzi et al. (2019) highlighted the effectiveness of e-modules based on inquiry approaches in teaching chemical bonding, noting improvements in students' representational abilities. The integration of e-modules in polymer synthetic learning, as explored by Astuti et al. (2021), has also been beneficial in fostering high-level thinking skills through the principles of green chemistry. Additionally, Puspitasari (2019) found that the use of electronic modules in teaching physics not only made the content more engaging but also significantly enhanced students' comprehension and retention. These studies underscore the potential of e-modules to transform traditional learning environments by making learning materials more accessible, engaging, and effective.

E-modules can be made with various software, including Kvisoft Flipbook Maker. This software can convert PDF (Portable Document Format) files into electronic book form. The pages can be inserted with effects, backgrounds, images, videos, audio, and hyperlinks and flipped back and forth like an actual book (Oktaviara & Pahlevi, 2019). Also, this software provides some advantages: papers can be flipped, making it easier to make an e-module, inserting audio and video forms into the e-module to present the materials, and the resulting product can be published in SWF (Shock Wave Flash) or HTML (Hyper Text Markup Language) format if the creator wants to publish it via a website (Femalia & Ahmad, 2021). Moreover, this e-module created with Kvisoft Flipbook Maker

software can be opened simply on a computer using a video player application such as Gom Player, KM Player, and so forth. According to (Rini et al., 2023), The use of Kvisoft flipbook maker-based media in learning can actually help students understand concepts and thinking skills because by using the Kvisoft flipbook maker application, students become more enthusiastic in the learning process. According to (Simanjuntak & Hutabarat, 2022), E-books based on Kvisoft Flipbook Maker can be presented with all its advantages for both readers and writers. For readers, the attractive appearance and videos that make it possible to include them in the book also because of the ease of accessing this book, are very helpful in understanding the content and purpose of the book. Meanwhile, for writers, the output that can be produced from applications in the form of HTML, EXE, ZIP, and APP can help writers produce more than 1 output in one work and give writers freedom to express themselves.

Meanwhile, based on the results of interviews with chemistry teachers in several senior high schools in Pekanbaru, the biggest obstacle was the incomplete technology-based teaching materials that teachers owned for each subject in chemistry. This issue is further compounded by the lack of professional competence among teachers in effectively utilizing and integrating technology into their teaching practices (Dudung, 2018).

Chemistry, as part of natural science, directly relates to its everyday application. By learning chemistry, students are expected to learn about themselves and the environment to apply knowledge in everyday life and solve problems as a further prospect in studying it (Irwansyah et al., 2017). However, many concepts in chemistry are abstract; hence, it is necessary to connect those abstract concepts to life, which makes it easier for students to understand the chemical materials.

On the other hand, atomic structure material, as one of the chemistry abstract learning materials, is a material that becomes an apperception for many subsequent materials. This material discusses the constituent particles of the atom, the development of an atomic model, the classification of elements based on isotopes, isobars, and isotones, Bohr's atomic theory, quantum logic, the Aurbau principle, the Hund's rule, and Pauli's prohibition principle to create electron configurations and orbital diagrams. Therefore, unique approaches and teaching materials are required to teach this material to students.

Based on the above background, it is necessary to create an e-module on atomic structure material as electronic teaching material. Hence, this study aims to develop an e-module on the atomic structure using Kvisoft Flipbook Maker software and determine the level of validity, practicality, and students' responses to the developed e-module.

2. Research Method

This research was conducted at the undergraduate program of chemistry education at Riau University, SMAN 3 Pekanbaru, SMAN 5 Pekanbaru, SMAN 8 Pekanbaru, and SMA IT Al-Fityah Pekanbaru in the odd semester of the 2020/2021 academic year. The research subjects were validators, educational practicioner and students as subject of feasibility test. Validators consisted of three material expert lecturers and three media expert lecturers from three different universities in Pekanbaru, and educational practicioner expert from four chemistry teachers. Meanwhile, the respondents consisted of 12 students who had studied atomic structure material from four different schools.

Furthermore, this research method was a research and development (R&D) and development method, with the development method using the Borg and Gall model. This model consisted of 10 steps: research and information collection, planning, developing the preliminary form of a product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, dissemination, and implementation

(Sugiyono, 2019). However, in this research the researchers only carried out the main product revision stage.

The research and information-collection stage included empirical reviews in the form of field studies and literature studies. At this stage, data sources were obtained from four chemistry teachers and various other references.

The planning stage included formulating objectives and determining the sequence of research. During this stage, validators, teachers, and students also prepared e-module assessment questionnaire sheets.

The develop preliminary form of a Product stage involved developing an initial e-module product using Kvisoft Flipbook Maker software for three learning activities. After being developed, the resulting e-module was validated by three material experts and three media experts.

The preliminary field-testing stage included initial field testing to see the responses of 12 students from four different schools. In addition, the practicality of the produced e-module was also determined. The percentage of practicality was obtained from a questionnaire sheet filled out by four chemistry teachers. Data sources were obtained from questionnaires and documentation.

The last stage was the main product revision. This stage was to make improvements to the e-module based on the assessment, suggestions, and comments from teachers and students. Thus, it was expected that the e-module produced could be useful in the learning process because it had gone through many improvements and assessments.

The data obtained were analyzed using descriptive qualitative and descriptive quantitative data analysis techniques. Qualitative descriptive analysis was used to analyze comments and suggestions from validators and respondents. Also, quantitative descriptive analysis was used to analyze numerical data, such as the results of the assessment of validation and practicality questionnaire sheets from expert lecturers, teachers, and students (Trianto, 2010 & Rusdi, 2018).

The assessment components contained in the material expert validation sheet are self-instructional, self-contained, stand-alone, adaptive, and user-friendly, as adopted and modified by Daryanto (2013) The assessment components contained in the media expert validation sheet include graphic and programming aspects adopted and modified from *Badan Sertifikasi Nasional (BSNP)* 2014. The assessment components contained in the teacher response questionnaire are material aspects, media aspects, and e-module learning aspects. The learner response questionnaire's assessment components are language, display, and interest. The teacher and learner response questionnaires were adopted and modified by (Faisal, 2015). Determining the percentage of validity and user response to e-modules can be done using the Equation 1.

$$\text{Percentage} = \frac{Total\ Scores\ Obtained}{Maximum\ Score} \times 100\% \quad (1)$$

(Akbar, 2013)

The decision criteria guidelines for the validation sheet as shown in Table 1.

Table 1. Criteria for Data Assessment Percentage of E-Module Validation Data Assessment Criteria Percentage of E-Module Validation (Riduwan, 2010)

Percentage	Category
75.00 - 100%	Valid
50.00 - 74.99%	Valid Enough
25.00 – 49.99%	Less Valid
0 – 24.99 %	Not Valid

The results of the percentage of practicality and students' response are categorized based on the following criteria in Table 2.

Table 2. Criteria for Data Pracicality Assesment and Students' Response (Riduwan, 2010)

Percentage	Category
75.00 - 100%	Practical/Good
50.00 - 74.99%	Practical Enough/ Good Enough
25.00 – 49.99%	Less Practical/Less Good
0 – 24.99 %	Impractical/Not Good

3. Result and Discussion

Teacher This research was a study to produce and test the products' feasibility. This research was conducted based on data in the field, which showed that electronic teaching materials were needed for each subject in chemistry learning. The resulting product was an e-module designed using Kvisoft Flipbook Maker software. The selection of this e-module as teaching material was caused by some advantages, such as being arranged according to the learning objectives to be achieved, packaged in the form of small activity units, making it easier to learn thoroughly (Daryanto, 2013), and containing images, videos, or animations that increase students' interest in learning.

Developing an e-module using Kvisoft Flipbook Maker software was expected to produce valid and practical teaching materials that received positive responses from teachers and students. It was also intended to make the learning process more enjoyable and meaningful for students. It was also intended to make the learning process more enjoyable and meaningful for students. Meanwhile, an e-module was systematically organized and presented in electronic format, equipped with images and videos, so it was expected to make the learning process more exciting and positively affect students. Besides, research conducted by (Febrina et al., 2020) found that using e-modules could expand students' learning experiences because pupils could interact with the e-modules and be encouraged to think critically and get concepts independently. Also, (Herawati & Muhtadi, 2020) found that using e-modules as a learning resource effectively improved students' concept understanding when mastering the chemistry materials.

The development model used was the Borg & Gall model, which was simplified according to the needs of researchers. This model was chosen because it was systematic, the procedures were clear, and there were repeated revisions to improve the resulting product.

3.1. Research and Information Collecting

This stage consisted of field and literature studies. The field study was conducted by interviewing four chemistry teachers from different schools in Pekanbaru to find the problem to be solved. At this stage, information was obtained that teachers still lack electronic teaching materials in chemistry subjects, including atomic structure material. This material was quite complicated, but it was essential because it would have a lot to do with the material afterwards. Hence, teachers required complete, easy-to-use teaching materials, including videos or simulations, to help students learn atomic structure.

After conducting a literature review of various teaching materials, an e-module was chosen for development due to its numerous advantages. These advantages include being organized in small units according to learning objectives, being systemic and practical, and containing images, videos, and simulations. Additionally, e-modules are easy to access via smartphones. Laili et al. (2019) noted that e-modules foster student motivation, provide evaluations to identify completed parts, and distribute learning materials evenly across a semester. They are also more interactive and dynamic than printed modules, as they can include multimedia elements such as videos, audio, and animations. Wulandari et al. (2021) stated that e-modules increase students' learning motivation due to their well-packaged content, making the subject matter easier to understand. Nisa et al. (2020) supported the advantages of e-modules, highlighting their economical production, efficient portability, durability, and ability to incorporate multimedia elements.

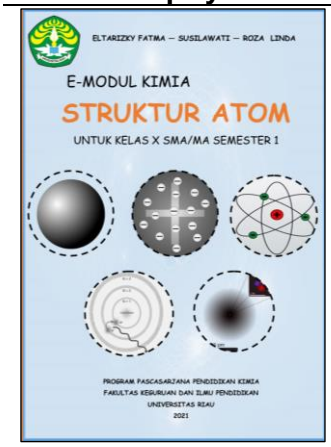
3.2. Planning

At this stage, several plans were carried out, including planning the basic framework of the e-module. This involved analyzing the Senior High School chemistry syllabus and essential competencies. From this analysis, learning objectives were formulated. The e-module was created using Microsoft Publisher, saved in PDF form, and then converted into an e-module format using Kvisoft Flipbook Maker software. The material covered atomic structure for class X of Senior High School's odd semester over three meetings. After development, experts validated the e-module, and an assessment sheet was prepared for validators from both material and media aspects.

3.3. Develop Preliminary Form a Product

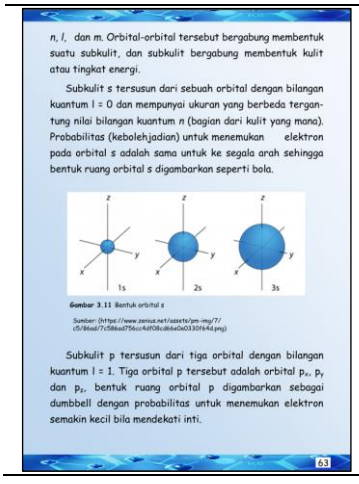
At this stage, an e-module was developed, which had been planned previously. The developed e-module consisted of a cover, preface, table of contents, ore competencies, basic competencies, concept map, instructions for using e-modules, learning objectives, an apperception and motivation, a description of learning materials, summary, evaluation, glossary, and bibliography. The cover of the developed e-module as shown in Table 3.

Table 3. Display of The E-Module Cover

Display	Information
	The cover of the e-module displays the title "The Concept of Atomic Structure," accompanied by images of various atomic models, including those proposed by Dalton, Thomson, Rutherford, Bohr, and quantum mechanics.

This e-module contains three learning activities. The first focused on atomic constituent particles and atomic theory. The second concerned atomic numbers, mass numbers, isotopes, isotones, isobars, and isoelectrons. The third focused on the atomic models of wave mechanics and quantum mechanics. Each activity included a video that could increase students' knowledge about the topic. Images of each learning activity are presented in Table 4.

Table 4. Three Learning Activities on E-module Developed

Display	Information
	This image explains atomic models from various scientists. Before this, there is a simple experiment where students test electrical phenomena by rubbing a ruler on dry hair to attract small paper pieces.
	This image illustrates the particles in an atom, where a neutral state is achieved when the number of protons equals the number of electrons, ensuring the atom remains electrically balanced.
	This images explain the shapes of the s, p, and d orbitals, helping students visualize electron arrangements and understand atomic structure, electron distribution, and chemical bonding.

The developed e-modules were then validated by three lecturers who were material experts and three media experts. Validation was conducted in two to three rounds, with each round incorporating feedback to refine the modules. The final validation percentage discussed reflects only the last assessment, after all revisions were made and every aspect was confirmed as valid. This process ensured that the e-modules met the required standards for both content and presentation.

3.3.1 Validation by Material Experts

This material expert validation aimed to assess the suitability of the e-module developed with the theoretical e-module characteristics, specifically fulfilling the aspects of self-instructional, self-contained, stand-alone, adaptive, and user-friendly (Daryanto, 2013). The percentage of material expert validation results after making improvements according to the validator's suggestions can be seen in Table 5.

Table 5. Validation Results by Material Experts

Aspect	Material Expert			Average (%)	Category
	1 (%)	2 (%)	3 (%)		
Self Instructional	92.31	86.15	82.69	87.05	Valid
Self Contained	100	80	93.75	91.25	Valid
Stand Alone	87.5	80	87.5	85	Valid
Adaptive	91.67	93.33	83.33	89.44	Valid
User Friendly	100	100	75	91.67	Valid
Total Average				**88.88**	**Valid**

Based on the validation results by three material expert validators, the e-module developed is valid in each aspect assessed, with a value of 88.88% valid in the self-instructional aspect, 91.25% valid in the self-contained aspect, 85% valid in the stand-alone aspect, 89.44% valid in the adaptive aspect, and 91.67% valid in the user-friendly aspect. Thus, the average value for material validation is 88.88% valid.

3.3.2. Validation by Media Experts

Media expert validation aimed to assess the feasibility of the graphical and programming aspects of the e-modules that had been developed. Three expert lecturers from different universities conducted the validation. Hence, Table 6 shows the results of media experts' validation of e-modules developed using Kvisoft Flipbook Maker software.

Table 6. Validation Results by Media Experts

Aspect	Media Expert			Average (%)	Category
	1 (%)	2 (%)	3 (%)		
Graphics	93.52	90.74	97.22	93.83	Valid
Programming	95	82.5	100	92.5	Valid
Total Average				**93.16**	**Valid**

Based on Table 6, graphics received 93.82% and programming 92.5%, with an average media validation score of 93.16%, categorized as valid.

3.4. Preliminary Field Testing

In this stage, four chemistry teachers assessed the practicality of the developed and validated e-modules, as well as the students' responses to the e-module.

3.4.1. Practicality Test by Teachers

This trial evaluated the practicality of the e-module developed to ensure that the resulting product was practical for use in the field. The results obtained were a quantitative assessment of the questionnaire's results. The product's practicality can be seen in Table 7.

Table 7. Practicality Test Results by Chemistry Teachers

Aspect	Chemistry Teacher				Average (%)	Category
	1 (%)	2 (%)	3 (%)	4 (%)		
Material	85.42	85.42	83.33	89.58	85.94	Practical
Display/Design	93	88	80	99	90	Practical
Learning Process	95.45	93.18	86.36	93.18	92.05	Practical
Total Average					**89.33**	**Practical**

Table 7 shows that the developed e-module is practical regarding the material aspect, with a score of 85.94%, the display aspect of 90%, and the learning aspect of 92.05%. Then, the average practicality value is obtained at 89.33% in the practical category.

3.4.2. Students' Response to the E-Module

This assessment was conducted by 12 students from four different schools. The results of students' assessment of the developed e-module can be seen in Figure 5.

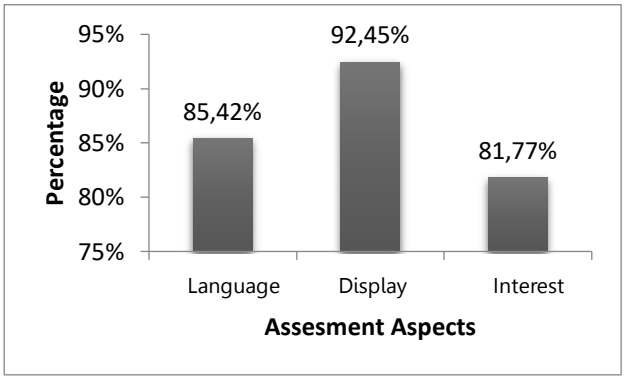


Figure 1. Diagram of Student Assessment Results on the E-Module

Based on Figure 1, it can be concluded that the students' response to the developed e-module is 85.42% in the language aspect, 92.45% in the display aspect, and 81.77% in the aspect of interest in the e-module. Thus, the average of all aspects is 86.55%, with a good response category.

3.5. Main Product Revision

Revisions to the e-module were based on comments and suggestions from chemistry teachers and students. The suggestions given by teachers and students can be seen as follows.

3.5.1. Suggestions and Comments from Chemistry Teachers regarding the E-Module

Suggestions and comments from chemistry teachers are required as a reference in improving the e-module so that it becomes better at assessing a teacher who understands the character of the material and the character of the students. Teacher Suggestions and Comments can be seen in Table 8.

Table 8. Teacher Suggestions and Comments

Chemistry Teacher	Suggestion and Comment
1	Add questions that are more challenging and varied.
2	The e-module developed can be used without revision.
3	Add motivation that can engage students' interest be more enthusiastic about starting the learning process.
4	The e-module that has been developed is good, but it will be better if there are more examples of questions and more varied.

Based on the teacher's suggestions and comments, the e-module was revised again to match what the teacher expected. The revisions made were adjusted to the characteristics of a good e-module according to Daryanto in (Fatikhah & Izzati, 2015) and (Septora, 2017), including: self-instructional (can be studied alone), self-contained (all learning material from one unit of competency studied is contained in one whole module), stand-alone, adaptive (adapts to technological developments), and user-friendly (easy to use).

3.5.2. Students Suggestions and Comments

Learner suggestions and comments were needed as a reference for improving the e-

module so that it became better in terms of user assessment. Students Suggestions and Comments can be seen in Table 9.

Table 9. Students Suggestions and Comments

No.	Aspect	Suggestion and Comment
1.	Language	The delivery of the material is clear, but it would be better if more motivational words were added.
2.	Display	E-modules are packaged quite well because there are many variations of images, illustrations, and videos. Suggestions to be able to provide color variations in writing so that it is not just black.
3.	Interest	I am interested in using this e-module for learning. The e-module is very helpful in understanding atomic structure materials. It is very useful for self-study.

The developed e-module was revised based on students' suggestions and comments. After the revision process was complete, the final product was obtained as an e-module that had gone through various improvement processes, was declared valid and practical, and got a good response from students.

After going through the stages described above, the final product is obtained as an e-module of atomic structure material. The atomic structure material was chosen because it is an essential material in chemistry and is difficult to explain because it is abstract (Rizawayani et al., 2017). According to research conducted by Mampate (2020), in assessing students' understanding of atomic structure material, 34% of students understand the concept, 54% of students experience misconceptions, and 10% do not understand the concept.

The e-module is developed using Kvisoft Flipbook Maker due to its user-friendly interface, offline accessibility, and cost-effectiveness (Wibowo & Pratiwi, 2018). This software enhances learning by allowing the integration of images, videos, and animations, making it more engaging. According to Adhhan & Tanjung (2022), e-modules created with this tool promote interactivity through motion animations and audio, enriching the learning experience. Additionally, they are available as soft files, eliminating extra costs for users. Research by Zulhelmi (2021) shows that these e-modules can improve student learning outcomes, while Yogiswara (2019) found that they also increase student interest and cognitive results.

Based on the validation results from lecturers of material experts and media experts, the developed e-module is declared valid with an average value of 88.88% from material experts and 93.16% from media experts. After being declared valid by expert lecturers, the e-module is assessed for its practicality by senior high school chemistry teachers with obtained a score of 89.33% in the practical category. In addition, how students responded to the developed e-module is also seen. A value of 86.55% is obtained with a good response category. Thus, the e-module developed can be tested and used in a larger group.

4. Conclusion

Based on the research results, it can be concluded that the resulting product is an e-module of atomic structure material. The resulting e-module meets valid criteria, with an average value of 88.88% from material experts and 93.16% from media experts. Besides, according to the teacher's assessment, the e-module is included in the practical category with a value of 89.33% and gets a good category response from students with a value of 86.55%.

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