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PROFILE OF STUDENT'S ACTUAL COMPETENCIES ON ATOMIC STRUCTURE TOPIC USING E-MODULE BASED ON RADEC MODEL

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ABSTRACT
Atomic structure material is one of the chemistry topics that is abstract and complex. Learning topics that contain abstract and complex material requires high-level reasoning and thinking. This research aims to describe students' actual abilities in atomic structure material using an e-module based on the RADEC model. This research method is development research that adapts the Borg & Gall design. The subjects of this research were 31 students in the experimental class and 37 students in the control class. This research was conducted at one of the high schools in the city of Bandung. Students' abilities are measured through pretest questions and assignment of pretest questions. The data analysis used in this research is descriptive analysis and n-gain. This research showed that the actual competence of students in the experimental class had an n-gain of 0.58 and was in the medium category. In contrast, the actual competence of students in the control class had an n-gain of 0.29 and was in the low category. Thus, learning using e-modules based on the RADEC model can improve students' competence. The results of the student perception survey show that RADEC-based e-modules are very helpful in independent learning and completing assignments.

Keywords: actual competencies, e-module, radec model.

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INTRODUCTION

Atomic structure is the basic material in understanding chemistry. Lack of understanding of the material can make it difficult for students to understand subsequent material. Research shows that most teachers teach atomic structure using the lecture method, which is usually teacher-centered (Capone, 2022). However, the learning process using this method does not support students to be ready to face the challenges of the 21st century.

According to the Zone of Proximal Development (ZPD) theory by Vygotsky (1978), the development of a person's abilities can be divided into two levels, namely the level of actual development (independent performance) and the level of potential development (assisted performance) (Fitriani & Maemonah, 2022). In learning, the actual level of development is also called the student's actual abilities. Actual abilities can describe the process of student acceptance of the material being taught (Hayati et al., 2023).

Actual development is the ability students gain through independent study, including reading relevant material (Hasan & Ahmad, 2018). Independent learning can be pursued through a student-centered learning approach (Student Center Learning) (Pan, 2023) ; (González-Pérez & Ramírez-Montoya, 2022) ; (Suhartini et al., 2019). In this approach, students are actively involved in learning, and the teacher acts as a facilitator (Byusa et al., 2022) ; (Capone, 2022). One form of teaching material that supports this approach is a module (Darwanto & Meilasari, 2022). The module contains

material that must be studied according to learning objectives and guides students in independent learning (Widiari, 2023). In the technological era, electronic modules (e-modules) are increasingly popular. E-modules can help students understand the material before, during, and after learning (Ananda & Usmeldi, 2023) ; (Enawaty, 2023) ; (Nugroho & Arianto, 2023) ; (Rusmansyah et al., 2023) ; (Osmi et al., 2023).

E-modules can also be integrated with learning models, such as RADEC (*Read, Answer, Discuss, Explain* and *Create*). The RADEC model is a learning model that emphasizes student activity and helps develop learning independence. This model can contribute to the Indonesian government's efforts to encourage creative and independent learning. Most students still tend to read textbooks when learning occurs or just before an exam. The RADEC learning model provides an innovation in overcoming this problem, namely by having Read and Answer steps carried out by students independently before face-to-face activities. These two learning steps have been proven to improve reading habits and students' reading abilities if carried out consistently (Sopandi, 2017). Each stage in the RADEC learning model is a student activity, so students must learn continuously, and learning independence will be formed.

In this research, the focus is on developing a RADEC-based e-module on atomic structure material. The ultimate goal is to form students who are active in lifelong learning by using effective and innovative teaching materials. Research results prove that the integration of several learning models in the development of module teaching materials has a positive impact on student learning outcomes (Khotim et al., 2015) ; (Mas-ud et al., 2021) ; (Pamularsih, 2020). Based on the background above, this research aims to describe students' actual abilities in atomic structure material using an e-module based on the RADEC model. The e-module is expected to improve students' learning abilities and independence.

METHOD

This research is quantitative and descriptive. The subjects of this research were class X students at a high school in Bandung, consisting of 31 people in the experimental class and 37 people in the control class. The experimental class was given e-module teaching materials based on the RADEC model developed through this research. In contrast, the control class was given e-module teaching materials prepared by the Ministry of Education and Culture. Students in both classes were given the same pretest questions and assignments before learning was carried out. Measurement of students' actual abilities is carried out through pretests and assignment of pretest questions. This pretest instrument contains 13 questions in essay form. The questions represent each learning indicator used in developing e-modules based on the RADEC model. Data on students' abilities is obtained through tests in answer activities in the RADEC model stages. The data obtained were analyzed using n-gain and descriptive statistics. The n-gain value obtained measures students' ability categories, which are grouped according to Table 1. Descriptive analysis is obtained from students' perceptions in the experimental class regarding the e-module based on the developed RADEC model; this is in the form of students' level of difficulty in understanding the material on atomic structure and length. The time students use to read the e-module is being developed.

Table 1. Category Grouping Based on N-gain Value

N-gain	Category
g < 0.3	Low
0.3 < g < 0.7	Currently
g ≥ 0.7	Tall

RESULTS AND DISCUSSION

The atomic structure material has six topics that students must master. These topics include the development of atomic theory (topic 1); atomic notation (topic 2); isotopes, isotones, and isobars (topic 3); electron configuration (topic 4); quantum numbers (topic 5) and orbital shapes (topic 6). Actual abilities can be described through understanding reading material and using this information for independent learning. Students can answer questions correctly and independently without the help of the teacher. Using e-modules based on the RADEC model can help students learn independence. Research results prove that the actual abilities of students in the experimental class are higher than those in the control class. This actual ability is demonstrated by the student's ability to answer questions about the six topics discussed in the e-module, such as explaining the development of atomic theory based on experiments carried out by experts, determining the atomic notation of an element, comparing isotopes, isotones, and isobars, writing down the electron configuration, determine quantum numbers and describe orbital shapes.

Before learning, students are given pretest questions. Students cannot answer the majority of these questions. The pretest questions will be assignments that students must complete before the topic is studied in class. During learning, students are asked to complete and discuss the pretest questions with friends in the group. The research results showed increased student learning outcomes in the experimental class, which was higher than in the control class. These results can be seen in Table 2. The experimental class has an n-gain value of 0.58. It is in the medium category, while the control class has an n-gain of 0.28 and is in the low category. This shows that the use of RADEC-based e-modules can increase student learning independence. Using this e-module, students can answer pretest questions given as assignments.

Table 2. Comparison of n-gain values for experimental and control classes

Class	N-gain	Category
Experiment	0.58	Currently
Control	0.28	Low

The highest average value of students' actual ability was the topic of atomic notation. The experimental class showed higher changes in student learning outcomes than the control class during the pretest and assignment. These results show that students who use RADEC-based e-modules can complete assignments correctly compared to the control class. Meanwhile, the result of students' lower abilities is the development of atomic theory. The comparison results of students' actual abilities in atomic structure material can be seen in Figure 1.

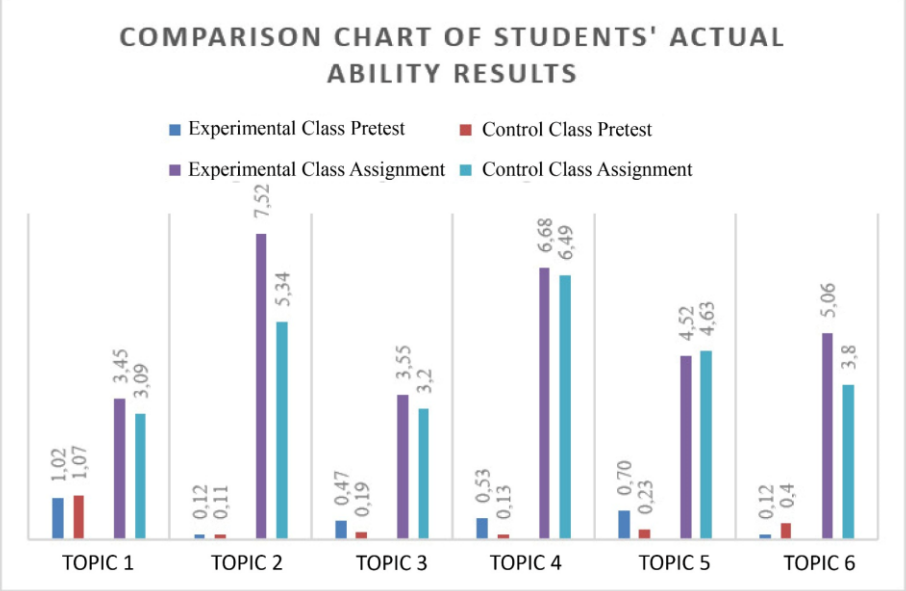

Figure 1. Comparison of the average actual abilities of students in the experimental and control classes

RADEC-based e-modules can improve students' ability to understand six topics in atomic structure material. Through this e-module, students can study and understand the material independently. This RADEC-based e-module-assisted learning is in line with ZPD learning. In ZPD theory, students are asked to complete assigned tasks independently (Agustyaningrum et al., 2022). This RADEC-based e-module can be used as a learning resource that supports students in completing the assigned tasks. So, both can help improve students' actual abilities. The RADEC model has five stages: *Read, Answer, Discuss, Explain* and *Create*. The *Read* stage can build students' knowledge and learning readiness. This stage allows students to understand concepts (Petscher et al., 2020). The *Read stage* also helps students continue *the Answer stage* with the knowledge gained at the *Read stage*. On average, students spend 1 hour reading RADEC-based e-modules. This reading activity is used to answer the assignments given at each meeting. The results of a survey on the length of reading time carried out by students can be seen in Figure 2. Based on Figure 3, students needing longer reading time are on topic 6. This topic is considered to be a more difficult topic than the other five topics.

Meanwhile, the topic that students considered to have a low difficulty level was topic 3. This illustrates that students spent at most 2 hours reading on topic 3. The results of students' perceptions regarding the difficulty level of the material for each topic can be seen in Figure 4.

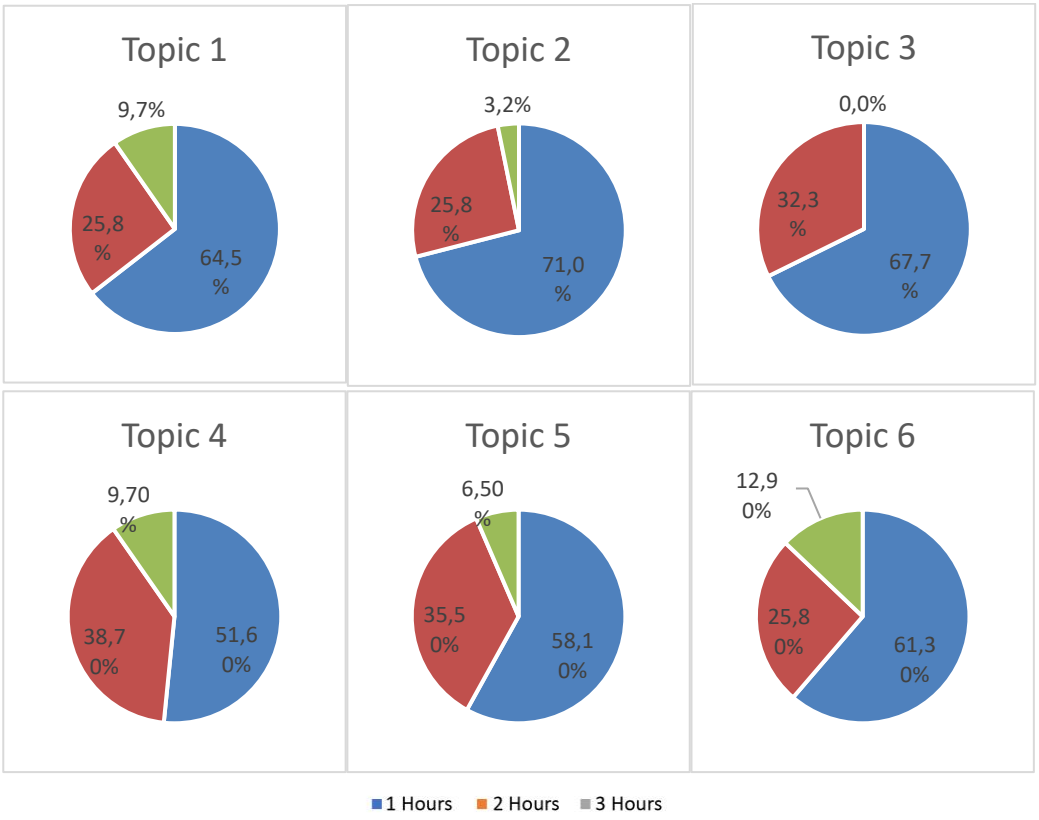

Figure 2. Percentage of time spent by students reading RADEC-based e-modules

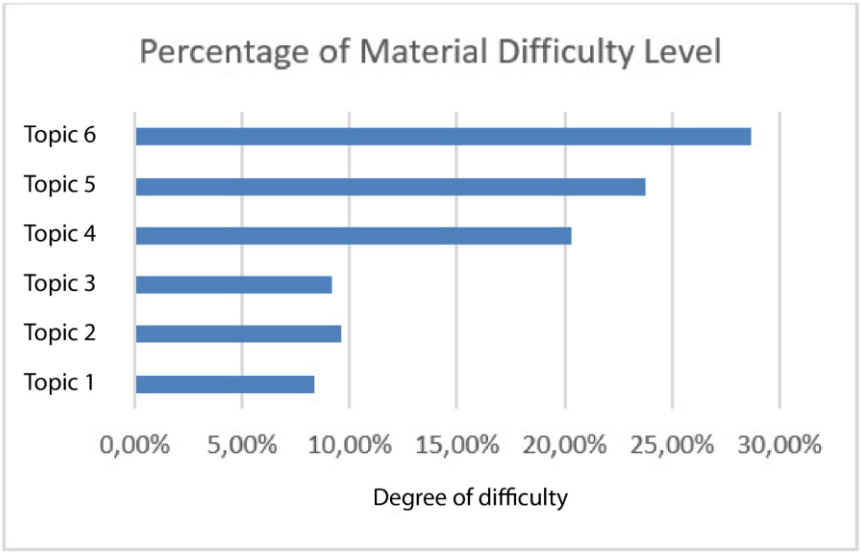

Figure 3. Survey results of student perceptions of the difficulty of the material on each topic

The RADEC e-module is designed so that students can use it for independent learning (Widiari, 2023). This is supported by the presentation of material and illustrations appropriate to the student's educational level. Based on the research results, student perceptions show positive value towards the e-module being developed. The results of student perceptions are contained in Table 2.

Table 2. Student perceptions of RADEC-based e-modules.

Indicator	Statement	Scale				
		1	2	3	4	5
Text clarity	The text or writing in this module is easy to read	0%	3%	34.3%	40.3%	22.4%
Image clarity	The size of the image presented is appropriate (not too big and not too small)	0%	0%	25.4%	38.8%	35.8%
	The colors and shapes of the images displayed are clear	0%	4.5%	22.4%	35.8%	37.3%
Suitability of image to material	The images presented correspond to the material	1.5%	4.5%	11.9%	37.3%	44.8%
Video clarity	The video link presented is appropriate (not too big and not too small)	3%	1.5%	35.8%	41.8%	17.9%
Image attractiveness	The images presented are interesting	0%	4.5%	31.3%	37.3%	26.9%
Presentation of material	The presentation of material starts from simple to complex	1.5%	9%	25.4%	38.8%	25.4%
	The presentation of material in modules is simple and easy to understand	3%	6%	34.3%	38.8%	17.9%
	The order of presentation of the material is clear	3%	7.5%	19.4%	40.3%	29.9%
Sentence clarity	The sentences used in the module are easy to understand	0%	9%	26.9%	35.8%	28.4%
	The language used is communicative and not boring	0%	6%	31.3%	41.8%	20.9%
Clarity of terms	Explanations accompany the terms used in this module and are easy to understand	0%	6%	29.9%	37.3%	26.9%
Suitability of examples to the material	This module explains the material using appropriate example questions and is accompanied by solutions.	1.5%	3%	23.9%	38.8%	32.8%
Ease of learning	The instructions for using the module are clear and can help in using this module	0%	1.5%	22.4%	49.3%	26.9%
	The learning steps in the module can help students understand the material	0%	4.5%	22.4%	46.3%	26.9%
Interest in using the module	This module is interesting to study	1.5%	7.5%	31.3%	37.3%	22.4%
Increased learning motivation	This module can increase motivation to learn chemistry	1.5%	9%	31.3%	26.9%	31.3%

Description: 1 (strongly disagree); 2(disagree); 3 (quite agree); 4(agree) and 5(strongly agree).

CONCLUSION

This research shows an increase in students' actual abilities through learning with the help of RADEC-based e-modules. The RADEC model can facilitate students' cognitive development in atomic structure material. The actual abilities of students in the experimental class were higher than those in the control class. Through reading and answering activities, students can prepare themselves to

study the material they will study. Therefore, reading and answering activities can encourage students before learning is carried out.

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