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RESEARCH ARTICLE

Atomic Structures – Advantages of E-Module Nanotechnology Development According to the Independent Curriculum for Phase E SMA/MA Students

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ABSTRACT

The independent curriculum was developed as a flexible framework, focusing on material, character development, and student competencies. One of the materials studied in this curriculum is atomic structure-advantages of nanotechnology. This material is difficult for students, especially in the sub-material for determining electron configurations, sorting, classifying, and differentiating the periodicity of elements in the periodic system. To overcome this problem, teaching materials are needed to help students understand this material. One of the recommended is an e-module based on problem-based learning. This study aimed to develop an e-module of the atomic structure advantages of nanotechnology for Phase E SMA/MA students and to analyze its level of validity and practicality. The type of research is Educational Design Research with the Plomp development model. The research subjects were UNP chemistry lecturers, teachers, and Phase E students at SMAN 7 Padang. Data validation results were analyzed using Aiken's V formula, which shows that the e-module is valid with a value of V=0.82. Practicality test results data were analyzed using the percentage formula. They obtained practicality tests on teachers by 92% and students by 85% in small groups indicating that the e-modules produced were very practical.

KEYWORDS

Chemical Equilibrium, Instagram, Learning media, Plomp

1. INTRODUCTION

The independent curriculum has various intra-curricular learning where the content will be optimal, giving students enough time to explore concepts and strengthen competence[1]. The independent curriculum was developed as a flexible framework, focusing on essential material, character development, and student competencies[2]. One of the essential materials in this curriculum is the atomic structure-the advantages of nanotechnology.

Atomic structure material-the advantages of nanotechnology is one of the materials studied in the independent curriculum for Phase E students (grade X) SMA/MA with the following sub-materials: atomic structure, electron configuration, periodic system of elements

and their periodic properties, as well as explaining the concept of nanotechnology and utilization. Nanotechnology is a technique of manipulating matter on an atomic and molecular scale to control an object so that it has specific desired properties[3].

Based on the results of the deployment data, the questionnaire stated that 68.3% of the participant's students consider the atomic structure material advantages of nanotechnology to be quite difficult to understand, this is because the sub-materials are interrelated and quite dense. The problem can be overcome by using materials-appropriate teaching and learning models. In this case, one of the recommended is an e-module based on problem-based learning.

To make this research more focused and centered then, the problem in this research is limited to developing and determining the validity and practicality of the e-module structure atomic-advantage nanotechnology accordingly independent curriculum for students phase E SMA/MA with learning based on problem-based learning on sub matter of the periodic system of elements.

Problem-based learning (PBL) is a learning model that encourages students to use logical thinking in solving given problems so that they can develop skills in thinking[4]. PBL empowers students to conduct research, integrate theory and practice, and apply knowledge and skills to create viable solutions to defined problems[5]. This PBL learning model can be combined with teaching materials so that students can investigate, analyze, and seek solutions to problems in finding and strengthening conceptual understanding[6]. One of the teaching materials that can be integrated with this model is an electronic module (e-module).

E-module is a learning media module based on Information Communication Technology (ICT) which has advantages compared to printed modules. E-modules contain material in the form of writing, graphics, videos, pictures, and animations, as well as evaluation questions that provide feedback for students[7]. E-modules can be studied and accessed anywhere and anytime and arranged in such a way that they are the minor learning units in a systematic, directed, and structured manner[8].

Based on the background above, this study aims to: develop e-modules of atomic structure excellence nanotechnology according to the independent curriculum for Phase E SMA/MA students and analyze the level of validity and practicality.

2. METHOD

The research was conducted on the FMIPA UNP and SMAN 7 Padang campuses, with three chemistry lecturers at UNP, three chemistry teachers, and stage E students as subjects. This type of research was educational design research with the Plomp development model. The stages of developing Plomp model consist of three stages, namely, (1) initial research (preliminary research), (2) the prototype stage (prototyping phase), and (3) the assessment stage (assessment phase)[9].

A preliminary research stage was conducted to determine the primary problem needed to develop the module[10]. At this stage, a needs and context analysis is carried out as a literature study and the establishment of a conceptual framework. Needs analysis is to identify problems in learning the atomic structure-the advantages of nanotechnology. Context analysis was carried out to examine the curriculum, learning outcomes, learning objectives, and material coverage of the atomic structure advantages of nanotechnology.

The prototyping stage consists of prototype I, II, III, and IV. The prototype I carried out the initial design of the e-module atomic structure-the advantages of nanotechnology. The design of the modules is adjusted to the module components in the independent curriculum. This component consists of general information (identity, initial competency, Pancasila profile of student, facilities & infrastructure, learning models), core components (learning objectives, meaningful understanding, triggering questions, learning activities, assessment, enrichment & remedial, and reflection), and attachments (student activity sheets, teacher and student reading materials, glossary and bibliography). The e-module design is evaluated formatively self- evaluation then revised. The result of the review is prototype II.

The complete e-module design on prototype II was then evaluated formatively by expert reviews by five validators and testers and one-to-one evaluation by three students. The validation results were revised to produce prototype III in the form of a valid e-module design.

The valid e-module design was then evaluated formatively using trials in small groups. This step resulted in prototype IV in the form of an e-module that was practical and effective for small groups. The research was limited to the prototyping stage which will produce a valid and practical e-module.

The data collection instruments used were validity and practicality questionnaires. Data validation results are processed and represented using Aiken's V formula. In proving the validity researcher can determine the number of rating categories that affect the content validity standard set by Aiken[11]. Practicality questionnaire data were processed and analyzed using the percentage formula[12].

3. RESULT AND DISCUSSION

The results of the research that has been done are explained as follows:

3.1. Preliminary Research

Stage preliminary research carried out through 4 stages, namely:

3.1.1. Needs Analysis

Needs analysis of some conclusions relating to the learning of atomic structure-the advantages of nanotechnology, namely: (1) students still have difficulty understanding the structure atom, determining the Bohr electron configuration, classifying, ordering elements, and distinguishing their periodicity in the periodic system of elements; (2) the source books used by students are not specific yet, causing limited learning reference sources; (3) Insufficient teaching materials designed by teachers as additional references to learning resources; (4) The understanding of application concept-based learning has not yet been implemented according to the demands of the independent curriculum.

3.1.2. Context Analysis

Context analysis produced learning outcomes: understanding atomic structure and its application in nanotechnology with learning objectives so that students are able; (1) Explain atomic theory; (2) Write down the atomic notation of an element; (3) Determine the number of protons, electrons and neutrons based on the mass number and atomic number; (4) Determine the electron configuration of an element based on the Bohr atomic model; (5) Describe the meaning and importance of nanotechnology, rare earth metals and examples of their application in everyday life; (6) Explain the development of the periodic system of elements; (7) Determining the periodic nature of elements by analyzing their trends in elements of a group and a period; (8) Find a solution to a given problem about sorting, classifying, and distinguishing periodic properties of elements using critical thinking skills, creative, collaborative, disciplined and capable of communicating the results of the discussion, solving the problem well.

3.1.3. Literature Study

The study of the literature produced research references as follows:

(1) Electronic or ordinary module called an electronic module (e-module) is a set of non-printed digital learning media that is arranged systematically and can be used independently by students to solve a problem[13]. The advantages of e-modules are that they are easy to carry anywhere and do not require paper and ink, so they are cheaper and easier to implement[14].

(2) Atomic structure is one of the chemistry subjects given to Phase E SMA/MA students. This material has the following characteristics: (1) is abstract (invisible), namely about electrons, protons, neutrons, isotopes, isobars, isotones, and atomic models, (2) conceptual understanding, namely the theory of atoms and the particles that make up atoms, (3) procedural understanding, namely the rules for the electron configuration of several atoms. Various characteristics, from simple concepts to more complex and abstract concepts, are one of the factors causing students' difficulties in understanding and linking understanding between concepts in advanced learning.

(3) The development of e-module of problem-based learning in the chemistry subject for class X SMA Negeri 8 Malang found that the e-module learning media was effectively used in learning activities as evidenced by the increased student learning outcomes after using the e-module[15]. The results of that study are relevant to other research, about developer module Problem-Based Learning (PBL) integrated scientific literacy on chemical reaction rate material, the research found that PBL-based modules integrated scientific literacy on chemical reaction rate material are valid and engage with an average validation percentage of material experts of 84.63%. The average percentage of the average media expert is 84.41% and declared attractive after obtaining an average percentage of teacher responses of 93.45% and an average percentage of student responses of 86.77% with an exciting category[16].

3.1.4. Conceptual Framework Development

Framework to all the ideas underlying the research, namely:

(1) The underlying problem research, in the form of students who still have difficulty in understanding the structure atom, determining electron configurations, sorting, classifying, and distinguishing the periodic properties of elements in the periodic system.

(2) Solutions offered in Overcoming this problem are by developing e-modules problem-based learning periodic system of elements with the Plomp expansion model.

The results of preliminary research were used as a reference in making the initial design of the structural module atom-the advantages of nanotechnology. The initial draft is an e-module that contains learning outcomes, learning objectives, Pancasila student profiles, trigger questions, meaningful understanding, the material provided as students' understanding of concepts as well as understanding test questions, formative tests, enrichment and problem-based learning on the periodic system of elements at the end of the meeting.

3.2. Prototyping Stage

The formation stage will produce a product that will be tested and revised through formative evaluation.

3.2.1. Prototype I

The initial design of the e-module (prototype I) was evaluated formatively through self-evaluation. This evaluation is carried out to identify the completeness of the e-module components, such as general e-module information, how to use the e-module, core components, attachments, and

problem-based learning on the periodic system of elements at the end of the meeting. Results from the reflection produce prototype II as a complete e-module of atomic structure-advantage of nanotechnology.

3.2.2. Prototype II

Prototype II was re-evaluated with formative evaluations, expert reviews, and one-to-one evaluations. Expert reviews were conducted to test the validity of the developed e-module. This test was carried out by filling out a questionnaire by three UNP chemistry lecturers and two chemistry teachers at SMAN 7 Padang. This test was carried out using a validity questionnaire instrument which contained content validity, constructs, and media experts.

Based on the validation that has been carried out, suggestions/comments for improvement from the validator are: (1) Include reference sources for materials and images in the e-module. (2) Images presented in the module must be clear (not broken/blurred). (3) The videos presented in the e-module must certainly be available/function properly. (4) Improve the instructions for working on the questions on the comprehension test questions that are unclear and difficult to understand. (5) There is no formative test to discuss the advantages of nanotechnology and its uses. (6) Add an electron configuration diagram and compare it in each shell. (7) Add other learning resources in the module besides videos, such as ppt. (8) Try to cover the module using attractive bright colors. (9) Links to e-modules for teachers and links to e-modules for students should be separated

Data from content validation results were analyzed and produced an index value of 0.84, representing that the developed e-module was valid. This is Aiken's opinion that a product can be valid if the considerable V value is equal to 0.8 with a percentage of error of 4%[17]. The results of this content validity show that the material in the e-module is scientifically appropriate.

Construct validity and media experts were tested to determine the consistency of the product and to provide information as well as evaluate and provide advice on the results of the media (three-dimensional chart) produced [18] . Each component of the research results must be constantly linked[19]. The results of construct validity can be seen in Figure 1.

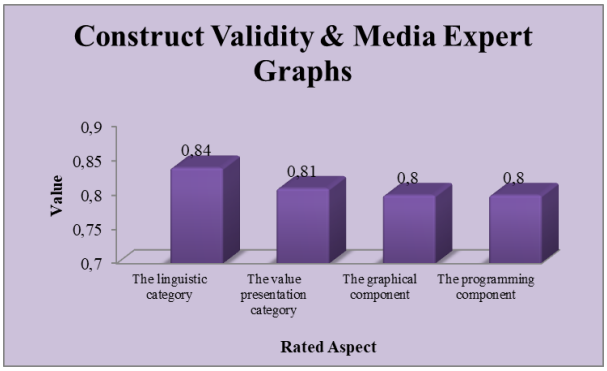

Figure 1. Construct Validity & Media Expert Graphs

Overall construct validity has a value of V = 0.81 with a valid category. The details of each aspect are as follows: (a) The linguistic category has a value of V=0.84, which means it is valid. This data shows that the e-module presented already has a language that is easy to understand so that the desired goals are achieved [20] . (b). The value presentation category obtained is V=0.81, representing that the developed e-module is presented systematically, clearly, and in an easily observable manner. (c) The graphical component gets a V value of 0.80, This shows that the design of the e-module is neat and attractive (d) The programming component gets a value of V=0.80, This value indicates that the resulting e-module is following the programming aspect.

The one-to-one evaluation was done by filling out a questionnaire by three Phase E students at SMAN 7 Padang with high, low, and medium ability levels. Students argue that the e-module structure of atoms The advantages of nanotechnology are good and interesting. However, it needs some improvements/revisions including, (1) Some of the images on the e-module are not clear (2) The videos listed should be in Indonesian. (3) The e-module sheet filled in by the teacher should not be displayed on the student's e-module sheet (4) It is better to add other learning resources such as ppt.

Results of reflection and suggestions from expert reviews and one-to-one evaluation analyzed and revised to produce a better e-module. These improvements resulted in a valid prototype III e-module atomic structure-the advantage of nanotechnology.

3.2.3. Prototype III

E-modules that are already valid are tested in practicality small groups. The evaluation was carried out by filling out a questionnaire by three chemistry teachers and 20 students at SMAN 7 Padang. The practical results obtained from the practicality questionnaire filling data by students received a P = 85% with very practical criteria, and practicality by the teacher got a P = 92% with very practical criteria. Practicality criteria can be determined using the provisions; that is, if the P value is in the range of 81% - 100%, it means that it is included in the very practical category[21].

The data shows that the developed e-module is easy to access and understand for both teachers and students. The results of the practicality of students and teachers can be seen in Figure 2 dan Figure 3. This formative evaluation method produces practical media to use in small groups.

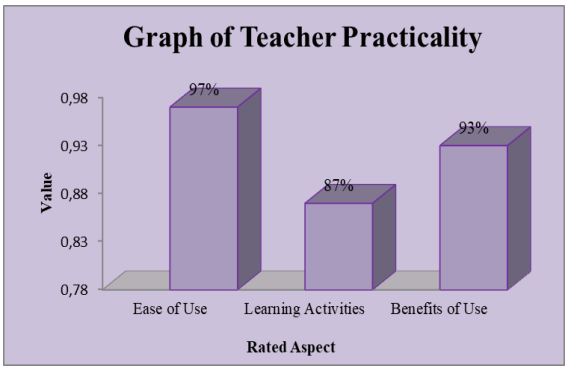

Figure 2. Graph of Teacher Practicality

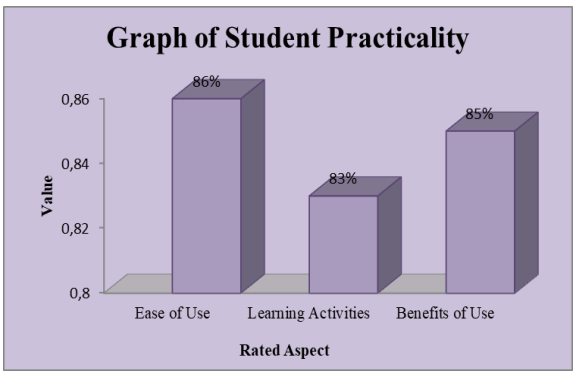

Figure 3. Graph of Student Practicality

4. CONCLUSION

Based on the research that has been done, it is concluded that an atomic structure-advantages nanotechnology e-module according to the independent curriculum for Phase E SMA/MA students has been produced, which is valid and practical in small groups. The validity test shows that the resulting e-module is valid in content and construct with a content V index value of 0.84 and a construct and media expert index value of 0.81. The practicality test on small groups shows that the e-module is very practical to use in small groups, with a percentage value of questionnaire 92% from the teachers and 85% from the students.

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