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Development of Science Literacy-Based Cognitive E-Assessments on Chemical Bonds

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Abstract: This study aims to develop scientific literacy-based cognitive e-assessments on chemical bonds and describe the validity, teacher responses, and student responses to the developed e-assessment. The research design used in this study was a research and development (R&D) design according to Gall, Borg, & Gall (1996). The instruments used in this study were expert validation questionnaires, teacher response questionnaires, and student response questionnaires. The data obtained from validators, teachers, and students were then analyzed by descriptive statistical analysis method. This scientific literacy-based cognitive e-assessment uses 4 aspects of scientific literacy, namely aspects about the knowledge needed for intelligent participation in science-based social problems, aspects about the ability to think critically about science and dealing with scientific expertise, aspects about understanding science and its applications, and aspects about understanding science and its applications. knowledge of the risks and benefits of science. This e-assessment was created to measure students' scientific literacy. The results of expert validation and teacher responses on aspects of content suitability, construction aspects, and readability aspects indicate a very feasible category. The results of student responses on the construction aspect and the readability aspect showed the criteria were very feasible. Thus, the scientific literacy-based cognitive E-assessment on the chemical bonding material developed can be said to be valid and feasible to use.

Keywords: cognitive e-assessment, chemical bonding, scientific literacy.

Abstrak: *Penelitian ini bertujuan untuk mengembangkan e-asesmen kognitif berbasis literasi sains pada materi ikatan kimia dan mendeskripsikan validitas, tanggapan guru, dan tanggapan siswa terhadap e-assesmen yang dikembangkan. Desain penelitian yang digunakan dalam penelitian ini adalah desain penelitian dan pengembangan (R&D) menurut Gall, Borg, & Gall (1996). Instrumen yang digunakan dalam penelitian ini yaitu angket validasi ahli, angket tanggapan guru, dan angket tanggapan siswa. Data yang diperoleh dari validator, guru, dan siswa yang kemudian dianalisis dengan metode analisis statistik deskriptif. E-asesmen kognitif berbasis literasi sains ini menggunakan 4 aspek literasi sains, yaitu aspek tentang pengetahuan yang dibutuhkan untuk partisipasi cerdas dalam masalah sosial berbasis sains, aspek tentang kemampuan berpikir kritis tentang sains dan menangani keahlian ilmiah, aspek tentang memahami sains dan aplikasinya, dan aspek pengetahuan tentang risiko dan manfaat sains. E-asesmen ini dibuat untuk mengukur literasi sains siswa. Hasil validasi ahli dan tanggapan guru pada aspek kesesuaian isi, aspek konstruksi, dan aspek keterbacaan menunjukkan kategori sangat layak. Hasil tanggapan siswa pada aspek konstruksi dan aspek keterbacaan menunjukkan kriteria sangat layak. Dengan demikian, E-asesmen kognitif berbasis literasi sains pada materi ikatan kimia yang dikembangkan dapat dikatakan valid dan layak digunakan.*

Kata kunci: *e-asesmen kognitif, ikatan kimia, literasi sains.*

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▪ INTRODUCTION

Assessment is carried out as an effort to measure the level of achievement of learning indicators and collect information on student learning development in various aspects. Mueller (2005) explains that various assessment methods must be able to measure all aspects that students know and do. An authentic assessment based on scientific literacy is a form of assessment that is real, meaningful for students, able to develop high-level thinking skills and contains dimensions of scientific literacy (concepts, processes, and contexts). The development of scientific literacy-based assessment instruments provides an understanding of scientific concepts and methods, the impact of technology and science on the environment (Chang & Chiu, 2005).

The development of science today requires humans to understand various phenomena that occur in everyday life that are science and technology oriented. The emergence of public awareness about the meaning and importance of science and technology in everyday life can increase the scientific literacy of the community itself. With the literacy of the community towards scientific literacy, it can be a good step to be able to improve the quality of education. The things that can reflect the quality of education can be seen from the evaluation of education carried out.

Scientific literacy is an important aspect that can be used as a provision for students to face increasingly sophisticated technological developments, especially in terms of accessing information. Scientific literacy is not only a requirement for scientists, but is also important for all people, including students. Scientific literacy must be fostered as early as possible in its application (Bybee, 1997). The scientific literacy applied to students may be influenced by the increasing importance of digital technology (Leu et al., 2004) and increasing students' engagement in interactive media (Beschorner & Hutchison, 2013). This has resulted in the development of students' literacy, namely reading and writing, which must be expanded through multimedia and ICT. Students must be able to face challenges in the global era. Therefore, a learning method is needed that can prepare students who are good and literate in science and technology, think logically, critically, creatively, and are able to argue correctly and be able to collaborate. There are several factors that influence the low scientific literacy of students. According to Anggraini (2014), the cause of low scientific literacy is the tendency that the learning process does not support students in developing scientific literacy skills. In addition, the assessment process that is usually carried out in schools is also the cause of Indonesia's low position in the PISA study.

The PISA results for the 2015 scientific literacy component put Indonesia in position 62 out of 70 countries with a score of 403. These results reveal that the average scientific ability of Indonesian students is only able to recognize basic facts, they have not been able to communicate and relate these abilities to various science topics, especially up to applying concepts (Toharudin et al, 2011). This shows that the scientific literacy of Indonesian children is at a low level. One of the reasons is that they are not trained in solving problems with characteristics such as those on PISA.

The benefit of the process of integrating scientific literacy for science subject teachers is that the content of science material presented by the teacher can bring up literacy aspects by developing questions with scientific characteristics that include content, processes, and applications. Based on the 2013 curriculum, chemical bonding material is a material in class X science learning in odd semesters. The basic competence of the knowledge dimension is to analyze ionic and covalent bonds while the basic competence of the skill dimension is to design, perform, conclude and present

experimental results to determine the types of covalent ionic bonds (Permendikbud No. 59 of 2014). To master these basic competencies, good students' scientific literacy skills are needed in the application of effective learning.

Chemical bonding is also one of the abstract topics in chemistry. Something that is far from the daily experience of high school students, where students cannot see atoms, atomic structures, and how these atoms form bonds, so that many students have difficulty understanding the concepts of chemical bonds (Özmen, 2004; Nahum, Mamlok-Naaman, Hofstein, & Taber, 2010; Bergqvist & Rundgren, 2017; Eymur & Geban, 2017; Tsaparlis, Pappa, & Byers, 2018). The development of scientific literacy-based assessment on this bonding material has been carried out by several researchers. However, there are weaknesses in the development of the assessment, namely that it is still carried out conventionally using paper as the medium and there are still few researchers who develop assessments on chemical bonding materials. Until now there has been no researcher who has developed an electronic form of cognitive assessment to measure the scientific literacy of students on chemical bonding material.

One program that can be used to create an E-assessment is iSpring Quizmaker. The iSpring Quiz maker is an authoring tool that can be used by teachers to support the learning process. By using this application, teachers can easily make various choices of questions in making interactive questions, ranging from true-false, multiple-choice, to essay questions. In terms of value processing, it can be displayed immediately when you have finished answering all the questions that have been given. In previous studies, many have used the iSpring program, development research on the iSpring program is widely used to make interactive multimedia development and in research on the development of evaluation or assessment tools, only a few have developed. Based on the problems above, it is necessary to develop a cognitive e-assessment based on scientific literacy on chemical bonding material.

▪ METHOD

This research uses research and development methods according to Gall, Gall, & Borg (2011) which says that Research and Development (R&D) is a process to develop a new product or improve an existing product that can be accounted for. There are ten steps in implementing the research and development strategy, namely 1) research and information, which includes measuring needs, studying literature, research on a small scale, and value considerations; 2) planning, by compiling a research plan which includes the capabilities needed in conducting research, formulation of objectives to be achieved, research design, and the possibility of testing in a limited scope; 3) develop preliminary form of product, includes the development of learning materials, learning processes, and evaluation instruments; 4) preliminary field testing, conducting field trials in 1 to 3 schools with 6 to 12 test subjects (teachers) and during the trial interviews and questionnaires were distributed; 5) main product revision, by improving the test results; 6) main field testing, by conducting wider trials in 5 to 15 schools 32 with 30 to 100 test subjects; 7) operational product revisions, by perfecting products resulting from field tests; 8) operational field testing, testing is carried out through filling out questionnaires, interviews, and observations of 10 to 30 schools involving 40 to 200 subjects; 9) final product revision, improvement based on input from field implementation tests; 10) dissemination and implementation, by reporting the results in professional meetings and in journals.

The data sources in this study were chemistry subject teachers and tenth grade of high school students who had already received the subject of chemical bonding. At the preliminary research stage, the data sources were 3 chemistry teachers and 72 science students at tenth class and from three public high schools in Bandarlampung, and the data was obtained from filling out questionnaires via google. teacher and student forms. At the development stage, the research data used is the result of validation from two validators. Meanwhile, for the initial field trial phase, it was carried out again by filling out questionnaires via google forms along with e-assessment products to 3 chemistry teachers and 30 students at tenth grade at one of public high school in Bandarlampung city.

▪ RESULT AND DISCUSSION

The results of research on the development of scientific literacy-based cognitive e-assessments on chemical bonding materials consist of the results of literature studies and the results of initial field studies. The needs analysis consists of a literature study and a preliminary field study. The literature study obtained information that cognitive e-assessments were in the form of questions and none were based on scientific literacy. The results of this literature study are the basis for compiling the developed e-assessment. Based on the results of distributing questionnaires to teachers and students via the google form, it is known that (1) the online assessment has been carried out; (2) have not used the *i-Spring* to make questions; (3) the source of the questions made from the internet and made by the teacher himself; (4) an assessment is needed that is able to measure students' scientific literacy. Based on the results of teacher and student questionnaires, it is necessary to develop a cognitive e-assessment based on scientific literacy on chemical bonding material.

Initial product development

Parts of the development of a scientific literacy-based cognitive e-assessment prototype on chemical bonding materials consist of an introductory section, a content section, and a closing section. The introduction section consists of the front cover, the Log in page, and work instructions. The content section contains discourse and questions to achieve the measured aspects of scientific literacy. There are four discourses, the first discourse is made to measure aspects of scientific literacy about the knowledge needed for intelligent participation in science-based social problems. The second discourse was created to measure aspects of scientific literacy about the ability to think critically about science and deal with scientific expertise. The third discourse was created to measure aspects of scientific literacy about understanding science and its applications. The fourth discourse was created to measure aspects of scientific literacy about knowledge about the risks and benefits of science. The questions section is designed with several types of questions, namely, *multiple choice*, *essay* and *select form lists*. For *multiple choice* and *multiple choice* questions, after students answer the questions, *feedback*. The question section is designed with the same theme but different colors so it doesn't look monotonous. Finally, the closing section contains a thank you note and developer bio, as shown in Figure 1.

Figure 1. (a) Opening, (b) Content, and (c) Closing Section

Expert validation results

The instruments that have been developed are tested for quality through expert validation. Expert validation was carried out by 3 expert lecturers of Chemistry Education, University of Lampung. This expert validation includes aspects of content suitability, construction aspects, and readability aspects. Aspects of conformity of content include conformity of material content with KI-KD and scientific literacy-based cognitive e-assessments, construction aspects include construction according to the ideal test instrument format and construction of cognitive e-assessment content, readability aspects include variety of letters, font size, and image quality. . The results of the validator's assessment show that the average value of the validation for the three aspects ranges from 77.4-79.8% which indicates that the developed instrument is very suitable to be used to measure students' scientific literacy.

Initial field trial

After conducting expert validation and making improvements according to suggestions and input from the validator, the next step is to conduct a limited trial. The limited trial was carried out at SMA Negeri 1 Bandarlampung, which consisted of 3 chemistry teachers and 16 class XI students. The results show that the content suitability aspect has a score of 81.85% (very good) while the construction and readability aspects have a score of 77.7% and 74.75%, respectively, with good criteria.

The results of student responses obtained by distributing scientific literacy-based cognitive e-assessments on chemical bonding material at SMA Negeri 1 Bandarlampung class XI MIPA 2 with 15 students during the limited test, the results of the limited data test are shown in Figure 2. Then students are asked to provide assumptions about e-assessment by filling out a questionnaire on the construction aspect and the readability aspect. The results of students' responses to the construction and readability aspects of the e-assessment developed on the construction and readability aspects were 94.25% and 91.86%, respectively, with very good criteria.

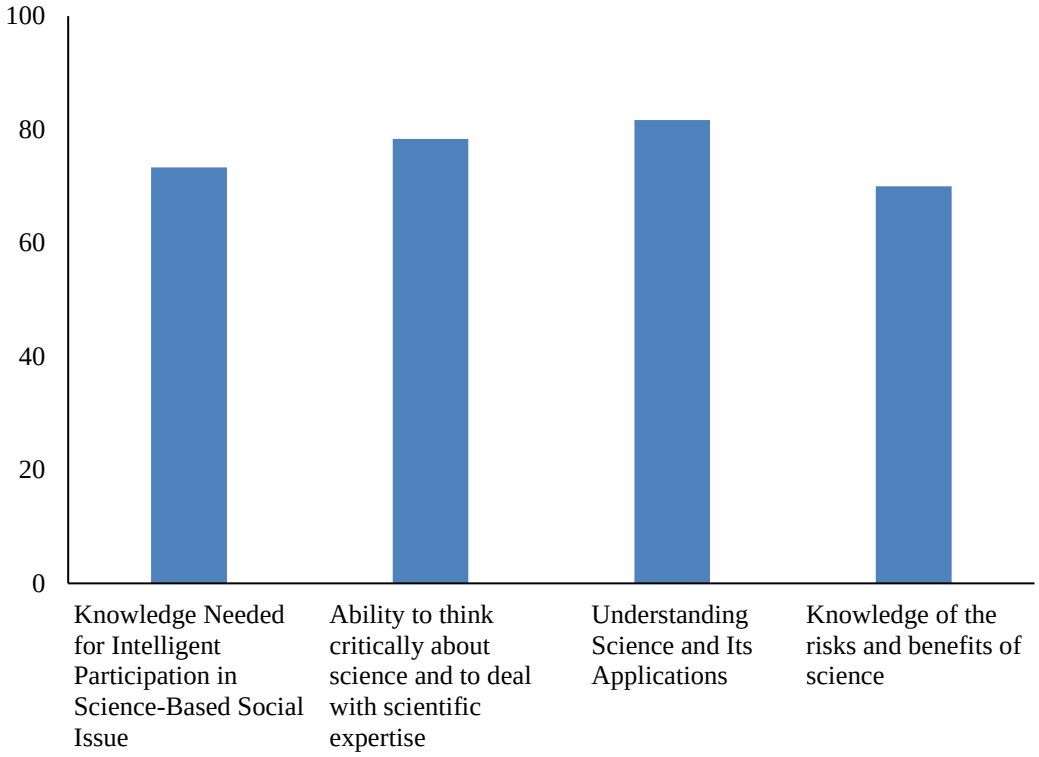

Figure 1. The average value for each indicator of scientific literacy

The first step is to carry out a needs analysis by conducting preliminary research in schools for . namely the absence of the use of e-assessment to measure students' scientific literacy and not using the iSpring Quizmaker media to evaluate students. The initial design of the development of this e-assessment is to look for scientific literacy questions for class X students on chemical bonding material, then analyze the questions based on learning indicators. Next, create a grid of cognitive literacy-based e-assessment questions that were developed, then create an assessment rubric for the e-assessment. After that, enter the questions that have been made into the iSpring Quizmaker to be designed to make them look attractive by making covers, creating login pages, making instructions for working on questions, making feedback on several questions, and closing pages. Then change the questions in iSpring into links that contain questions that have been made to be shared with students. The research data shows that the developed E-assessment is valid and practical.

The results of the validation cover three aspects of the assessment, namely the content suitability aspect, the construction aspect, and the readability aspect. In the expert validation process there are several comments and suggestions from each validator to be improved so that it is more suitable for use to students. The results of the assessment of the three experts for the content suitability aspect were categorized as very feasible. The results of the assessment of the three experts for the construction aspect are categorized as very feasible. The results of the assessment of the three experts on the readability aspect were categorized as very decent. From these three aspects, the average category is very feasible. Therefore, the scientific literacy-based cognitive E-assessment on chemical bonding material is appropriate for students to use.

The practicality of the developed E-assessment is stated based on the teacher's response and the student's response. The teacher's response regarding aspects of the suitability of the content of the material with KI-KD and aspects of the suitability of content to measure students' scientific literacy were categorized as very good. The teacher's response to the construction aspect is categorized as good. The teacher's response to the readability aspect is categorized as good. This shows that the practicality of cognitive e-assessment on chemical bonding material is feasible to use. The results of the limited trial, the researchers provided a link to the scientific literacy-based cognitive e-assessment on chemical bonding material, after students worked on the e-assessment that had been given. Furthermore, students were given a response questionnaire regarding aspects of construction and aspects of readability. The results of students' responses to the construction aspect and the readability aspect were categorized as very good. This shows that the practicality of cognitive e-assessment on chemical bonding material is feasible to use. Overall, from the results of expert validation, teacher responses, limited trials and student responses, satisfactory results were obtained and it was stated that the scientific literacy-based cognitive e-assessment on chemical bonding material developed was very feasible to be used in the student assessment process.

▪ CONCLUSION

Based on the results of the research and discussion, the following conclusions can be drawn: the scientific literacy-based cognitive e-assessment on the chemical bonding material developed has been valid. This is indicated by the results of the assessment of the validator on three aspects, namely the content suitability aspect, the construction aspect, and the readability aspect. e-assessment can be said to be practical, this is indicated by: the teacher's response to the product has a percentage of 78.67% which is categorized as very good. The results of students' responses to the developed cognitive e-assessment have a percentage of 93.05% which is categorized as very good.

▪ REFERENCES

Anggraini, G. (2014). Analisis Kemampuan Literasi Sains Siswa SMA Kelas X di Kota Solok. *Jurnal Prosiding Mathematics and Science Forum 2014*. Jurusan Biologi FPMIPA: Universitas Pendidikan Indonesia.

Bergqvist, A., & Rundgren, S. N. C. (2017). The influence of textbooks on teachers' knowledge of chemical bonding representations relative to students' difficulties understanding. *Research in Science & Technological Education*, *35*(2), 215-237.

Beschorner, B. & Hutchison, A. 2013. IPads as a literacy teaching tool in early childhood. International Journal of Education in Mathematics, Science and Technology, 1(1): 16-24. https://lib.dr.iastate.edu/edu_pubs/26/

Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices*. Heinemann, 88 Post Road West, PO Box 5007, Westport, CT 06881.

Chang, S.N & Chiu, M.H. (2005). The development of authentic assessment to investigate in ninth graders' scientific literacy: in the case of scientific cognitive concerning the concepts of chemistry and physics. *International Journal of Science and Mathematics Education*. *3*, 117-140.

Eymur, G., & Geban, Ö. (2017). The collaboration of cooperative learning and conceptual change: Enhancing the students' understanding of chemical bonding concepts. *International journal of science and mathematics education*, *15*(5), 853-871.

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction*. Longman Publishing.

Leu, D. J., Jr., Kinzer, C. K., Coiro, J., & Cammack, D. W. (2004). Toward a theory of new literacies emerging from the Internet and other information and communication technologies. In R. B. Ruddell & N. Unrau (Eds.), *Theoretical models and processes of reading* (5th ed., pp. 1570–1613). Newark: International Reading Association. Downloaded March 26, 2009 from www.readingonline.org/newliteracies/lit_index.asp?HREF=leu/.

Mueller.J. (2005). The Authentic Assessment Toolbox: Enhancing Student Learning through Online Faculty Development. *North Central College, 1(1)*. Hal 1-7.

Nahum, T. L., Mamlok-Naaman, R., Hofstein, A., & Taber, K. S. (2010). Teaching and learning the concept of chemical bonding. *Studies in Science Education*, *46*(2), 179-207.

Özmen, H. (2004). Some student misconceptions in chemistry: A literature review of chemical bonding. *Journal of Science Education and Technology*, *13*(2), 147-159.

Toharudin, U. (2011). *Membangun Literasi Sains Peserta Didik*. Bandung: Humaniora.

Tsaparlis, G., Pappa, E. T., & Byers, B. (2018). Teaching and learning chemical bonding: Research-based evidence for misconceptions and conceptual difficulties experienced by students in upper secondary schools and the effect of an enriched text. *Chemistry Education research and practice*, *19*(4), 1253-1269.