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Development of Student Competencies in Integrated Science Subjects Class VIII based on Cognitive Technology in the Era of Society 5.0

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***Abstract*---**This research was conducted to 1) produce integrated science learning based on cognitive technology to improve the skills of the 5.0 era student community; 2) know the potential of developing technology-based cognitive learning in integrated science learning; and 3) know the potency of developing in the era of society 5.0. The research method was Research and Development (R & D), pointing to ADDIE models. There were 5 main phases (Analyze, Design, Develop. Implement, Evaluate) and additional phases (preliminary field testing, main product revision, main field testing, and operational product revision). The instruments used included a product validation questionnaire, problem-solving test, observation sheet of problem-solving, and technology-based cognitive integrated science learning questionnaire. The results showed that: 1) integrated science learning based on technology-based cognitive developed was assessed very good by expert teaching lecturer and teacher, and before suitable for use in the learning process; 2) integrated science learning material technology-based cognitive could improve students' skills in the era of society 5.0; and 3) integrated science learning technology-based cognitive could improve students' science attitude.

***Keywords*---**cognitive technology, era society 5.0, integrated science, learning material, students skills.

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Introduction

Indonesia has to be ready to face a global challenge in this 21st century in the era of society 5.0. the demands include students that need character education, literacy, 4C skills (critical thinking, creative, collaborative, and communicative), and HOTS to compete and grow well in the future. However, the education environment does not facilitate teaching those skills to students. Students are less at socializing in real life, strange with learning context to the real-life and strange towards the conceptualization process, so they claim science as pure theory. Besides, character education, literacy, and HOTS context if change little they face difficulty even failure.

Organization for Economic Cooperation and Development (OECD) as an international Research organization showed that education in Indonesia placed the second-lowest after Tunisia in problem-solving competence and third lowest after Brazil for science competence. From the research, Indonesia should be developed through education, especially in science. Mastery of science and technology is considered as one of the keys to the progress of the nation. Learning Natural Sciences means studying data from experiments because learning integrated science is inseparable from analyzing real phenomena and experimenting with the surrounding environment. (AAS, 1993), (Gallagher et al., 1995; Herried, 1998; Stanley & Brickhouse, 2001; Walker, 2001; Aluko & Aluko, 2008; Atmojo, 2012; Masrukhi, 2012; Rosyidah et al., 2013; Acedo & Hughes, 2014; Subekti & Ariswan, 2016; Febu et al., 2017; Novitasari et al., 2017). Technological developments change students' cognitive abilities, especially in science learning (Dinsmore & PMP, 2014).

Permendikbud No 58/2014 states that the content of science lessons in SMP/MTs is developed based on an integrated concept from various branches of knowledge, which in the 2013 curriculum the integration is shown in core competencies (KI) and basic competencies (KD). Integrated science learning can build science knowledge, technology knowledge and can improve students' cognitive abilities (Sund & Trowbridge, 1967; Puskur, 2007; Arfinawati et al., 2016; Rahmiwati, 2018; Soeharto et al., 2019). Unfortunately, science learning does not yet fully possess 21st Century skills in the 5.0 society era, students should be guided so that they have strengthened character education, literacy and apply 4C skills (Critical Thinking, Collaborative and Communicative) and HOTS skills in learning (Utami, 2020; Pratiwi et al., 2019; Alam, 2019). This all aims so that all students can master skills related to learning science and technology (Osman & Marimuthu, 2010; Sliško, 2017; Rosana, 2012).

Meanwhile, various efforts have been made by the government to implement integrated science learning and Cognitive Technology. One of them is the government issued an integrated learning policy through ministerial regulations, make a guide to the development of science learning both at the elementary and junior high/MTs levels, and compile the basic competencies of subjects in an integrated form. This problem occurs because teachers who teach science are teachers who master one field of study, while science is a combination of physics, biology, and chemistry and teachers do not master technology, so students' cognitive abilities are low. lessons, As a result, the teacher is not able to connect

the favorite science material in one theme. Observing the importance of integrated science learning and the need for improvement science skills as a provision for students in facing the era of society 5.0, then In this study, an integrated science learning model was developed based on Cognitive Technology (Jackman, 2020; Mukaddas & Nilufar, 2021; Otakhonova, 2021).

Research questions in this study are: 1) how is the quality of integrated science learning material based on students' society 5.0 era skills; according to experts if it is seen from the material, graphic, presentment, and language aspects?; 2) can science integrated learning material based on cognitive technology improve the skills of the 21st-century era of society 5.0?; The purposes of this study are to know: 1) the quality of integrated science learning material based on cognitive technology seen from the material, graphic, presentment, and language aspects; and 2) the potency in improving skills of the 21st-century era of society 5.0 by using science learning.

Method

Research methods used in this study referred to ADDIE models and Borg & Gall. Development procedures consisted of 5 main phases (Analyze, Design, Develop. Implement, Evaluate) and additional phases (preliminary field testing, main product revision, main field testing, and operational product revision) that were taken from Borg and Gall procedure. Analyze phase was a phase of collecting the first data by literature review and field survey. In this phase, the writer analyzed local potency around the school, curriculum, learning condition, and students characteristics (Vitchenko et al., 2021; Widana et al., 2020). The design phase was a phase of developing the first product by preliminary field testing, main product revision, main field testing, and operational Revision.

Subjects in this study were students JHS grade VIII in some schools in Pariaman. The instruments included: 1) Questionnaire of learning material validation used to get data about product review from experts and science teachers of JHS towards the developed learning material. This questionnaire included: material, language, presentment, graphic, and inclusiveness of integrated science learning aspect, and skill era of society 5.0; and 2) The test was used to know the improvement of students' skill era of society 5.0. after doing learning process by using material based on integrated science learning (Elfeky et al., 2020; Piesche et al., 2016; Astra & Artanayasa, 2017). Test instrument was arranged based on the indicators available in standard basic competence in materials adapted to students' cognitive technology. An observation sheet was used to support improved data of students' skills of the 21st-century era of society 5.0 got from the test. After obtaining the data through the instruments that have been described previously, it is then analyzed using Data analysis of validity and practicality of Cohen's Kappa coefficient. To calculate Cohen's Kappa coefficient the following formula is used:

$$momen\ kappa\ (k) = \frac{\rho 0 - \rho e}{1 - \rho e}$$

Description:
K = Moment coefficient kappa
Po = Is the amount of data that is realized and calculated by the number of values given by the validator divided by the largest number of values
Pe = The proportion that has not been realized is then calculated by the number of maximum values minus the total value given by the validator divided by the maximum number of values.

The decision criteria were taken according to the Cohen's Kappa coefficient value which can be seen in Table 1 below.

Table 1
Decision category based on kappa moment coefficient (Boslaugh & Watters, 2008)

Interval	Category
0.81-1.00	Very High
0.61-0.80	High
0.41-0.60	Medium
0.21-0.40	Low
0.01-0.20	Very Low
≤ 0.00	Invalid

In observing the competence used by percentages of agreements at each meeting, the level of consistency and stability between the two observers is determined. The percentages of agreements between the two observers at each meeting used the formula proposed by Grinnell as follows:

$$Percentages\ of\ agreements = \frac{Agreements\ (A)}{Disagreements(\mathrm{D}) + Agreements\ (A)} \times 10$$

Description:

- Frequency match of data between two observers (Agreements (A))
- Frequency discrepancy between data from two observers (Disagreements (D))
- Instrument reliability coefficient (R)

The determination of the percentage of agreements is carried out through calculations based on the following provisions:

Tabel 2
Percentage of agreements

Persentase%	Conclusion	Category
81 – 100	Very Effective	Very high
61 – 80	Effective	High
41 – 60	Fairly Effective	Enough
21 – 40	Less Effective	Less
0 – 20	Ineffective	Low

The results of the normalized gain (N-gain) calculation are then interpreted in the classification as in the following Table 3 below.

$$\text{N-gain} = \frac{\%\ \text{skor posttest} - \%\ \text{skor pretest}}{100 - \%skor\ pretest}$$

Tabel 3
Normalized gain classifications

Gain (g)	Classification
g ≥ 0,70	High
0,30 ≤ g < 0,70	Medium
g < 0,30	Low

Results and Discussions

Validators' assessment toward the product of integrated science learning material based on cognitive technology

The validation of science learning materials with an integrated science learning approach was carried out by six expert lecturers. The results of the study are in Table 4. Table 4 shows that the development of integrated science learning competencies based on cognitive technology that was developed was considered valid in most aspects (Layout, Graphics, Language, Aspects of the Integrated Science Model Based on cognitive technology).

Table 4
Scope of material rolls ahead straddle

No	Rated aspect	K	Category
1	Layout	0,90	Very Valid
2	Graphics	0,90	Very Valid
3	Language	0,93	Very Valid
4	Aspects of an integrated IPA Model based on cognitive technology	0,80	Valid

The suggestions and criticisms of the validators on integrated science teaching materials based on cognitive technology are:

Table 5
Criticism and suggestions

No	Validator	Suggestions and Feedback
1	Dr. Skunda Diliarosta, M.Pd	a. Pictures on science teaching materials must be clear (Can be continued with minor revisions) b. The cover of teaching materials does not describe the process of teaching materials developed c. Add questions that train students' HOTS skills and cognitive technology
2	Dr. Ramli.M.Si	a. Numbering is adjusted to the rules of scientific

No	Validator	Suggestions and Feedback
		writing b. For the rational model, it is necessary to clarify aspects of the curriculum, characteristics of junior high school students, materials, social conditions, etc c. Must be consistent in the font size and type of writing used
3	Dr. Fatni Mufit, M.Si	a. Consistent in using typeface, size, color, font b. Philosophical foundation in the form of learning theories
4	Dr.Darmansyah, M.Pd	a. Show model components in one chart b. Correct the writing of punctuation Can be continued with minor revisions
5	Prof. Dr. Usmeldi, M.Si	a. The size of the letters on the components should be enlarged because they are not legible b. The syntax of the model is displayed in the form of a table or chart or cycle that describes the sequence of learning stages and adjusts it to the existing syntax in the learning process
6	Dr. Abdurrahman, M.P	a. LKPD on each material needs to be added b. Explain the learning objectives according to the material discussed

Developing students' era of society 5.0 skills by using integrated science learning based on cognitive technology

The test was done limited to students grade VIII of JHS based on the materials given. The materials given are the Movement of objects and living things in the surrounding environment KD 3.1. Students' skills of the 21st-century era of society 5.0 observation were done during the learning process, cognitive technology test was given before (pretest) and after learning (post-test) or only post-test. The result is as in Table 6 below.

Table 6
Result pretest and post test

Class	N	median Pre test	median Post test	median Gain (Δ)
Experiment	30	43	86	0,70
Control	30	40	65	0,60

To see whether there is an interaction between the application of integrated science learning competencies based on cognitive technology and student learning outcomes in the knowledge aspect, after testing the hypothesis, a two-way ANOVA test is carried out (Ali, 2012;; Fukuda, 2020; Nagy & Hajrizi, 2019). The results of the analysis show that there is an interaction between competence and student activities. The results of the two-way ANOVA test are reinforced by images showing the interactions that can be seen in Figure 1.

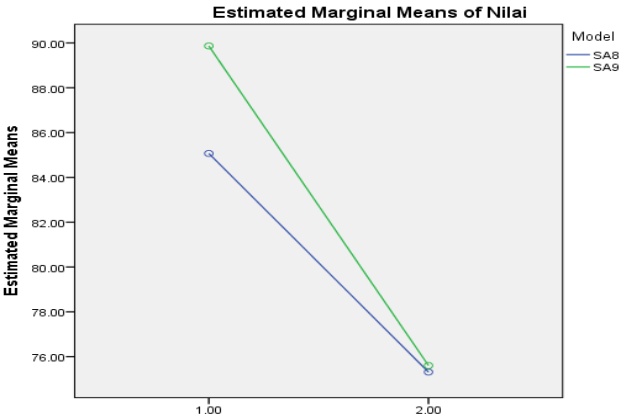

Figure 1. Interaction test results (two way ANOVA) student knowledge competence

From Fig 1 it can be seen that there is a line of intersection between the two lines. These data indicate an interaction between the application of competence with learning outcomes aspects of student knowledge. This means that the development of cognitive technology-based science competencies can be applied in all schools, up to the lower middle level. From Figure 1 above, it can be concluded that the development of technology-based science competence can improve 21st-century skills in the era of society 5.0 This is by the opinion (Fukuyama, 2018; Hussein, 2018; Wibawa, 2019; Hafil, 2019), that the development of technology-based science competencies applied in the 21st century in the era of society 5.0 can improve various characteristics such as critical thinking, creative and innovative, sense of curiosity, respecting the opinions of others, polite, honest, and responsible which can improve students' science competence which can be applied in all schools.

Discussions

The results of preliminary research obtained some information that is used as the basis for developing cognitive technology-based science competencies along with supporting systems/products, namely teaching materials. Regarding activities in the learning process, students who tend to be more passive, inactive, waiting for an explanation of answers from the teacher, students are still less independent and students are less interested in understanding, describing problems, and solving problems. Meanwhile, the strategy applied in the learning process is still dominated by the teacher (Bartoloni et al., 2021; Wolfengagen et al., 2022).

The teacher is still a learning center with the meaning of the word teacher activity being more than students, so most of the students are still not used to describing, not used to practicing honesty, thoroughness, and responsibility, not used to learning cognitive technology, not used to solving problems independently, not appearing interactions among students, activities, critical thinking skills that have not developed properly and students prefer to wait for an answer from the teacher or a solution from the teacher.

Follow-up of the suggestions and criticisms contained in Table 5 and the product of teaching materials was improved. Cognitive technology-based science competency development is developed and improved based on relevant suggestions. All lecturers have assessed that the development of cognitive technology-based science competencies that have been developed has used a learning approach. The revised teaching material produced by the validator's suggestions and criticisms was tested on subjects, namely class VIII SMP Negeri students (Shahali & Halim, 2010; Allen et al., 2013).

Based on Table 6 above, it can be seen that the development of cognitive technology-based science competencies is higher than the learning model commonly used by teachers. The criteria set to declare an integrated science learning model based on cognitive technology for effective science learning are 1) student activities in the moderate to the very active category; 2) improving learning outcomes in the high knowledge aspect of students in the control class; and 3) the increase in 21st-century skills learning outcomes in the 5.0 era of society was higher than students in the control class. Based on this, cognitive technology-based science competency development is effective when applied in learning. Where the increase in learning outcomes for both knowledge competence and problem-solving skills is higher when compared to the control class, and student activities are in the very active category (Dansereau & Dees, 2002; Gorayska & Marsh, 1996).

Conclusion

The development of competence in science subjects for class VIII based on cognitive technology is considered very good, seen from the material, presentation, graphic, and linguistic aspects by the lecturers, and is suitable for use in the learning process. Cognitive technology-based science learning can improve various characteristics such as; critical thinking, creativity and innovation, curiosity, respect for the opinions of others, politeness, honesty, and responsible by the 21st century in the current era of society 5.0.

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