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The Development of an Instrument for Testing the Ability to Think Creatively on Ecosystem's Material

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ABSTRACT

The ability to think creatively is the main goal of science and education, because graduetes who are able to think creatively will contribute positively to themselves, the social worl, technology and economy, they will face life in the 21st century. The ability to think creatively has become a goal in the 2013 curriculum. This research is aimed to develop an instrument for testing the ability to think creatively on the ecosystem's material. The research used developmental research as the research design and formative evaluation as the method by Tessmer (1994). The instrument development is focused on three stages. There are preliminary, self-evaluation, prototyping (expert review, one to one, small group) and field test. The developed test instruments were essay on the ecosystem's material with the 24 questions and it arranged based on the indicators by William, which has fluency, flexibility, originality, and elaboration. Based on the research, there are 16 valid questions have represented 12 indicators of creative thinking. So that, the final steps of the test used 15 questions of creative thinking that have been valid with one question not used because of the obstacles during the process of filling the question. The finding has shown that the developed instrument meets the requirements of a good test that are valid and reliable. 15 questions that were tested in the field test showed the results of 15 valid questions with a percentage of 100%. The reliability test was used Cronbach Alpha so that the value of r11 was 0,753 (high). It can be concluded this research resulted in a suitable test instrument to be used with a total of 15 essay questions.

Keywords: Creative thinking, ecosystem's material, instrument development,

INTRODUCTION

The main objective of education is to improve and develop students' abilities [1]. Factors that influence this success are the ability of teachers to carry out and take advantage of assessments, process evaluation, and learning outcomes [2]. Tests are one of the easiest and cheapest ways that can be done to capture student learning progress in the cognitive realm [1]. One of the life skills that must be possessed in the 21st century is the ability to think creatively [3]. The ability to think creatively is the main goal of science and education, because graduates who are able to think creatively will positively contribute to themselves, the social world, technology and economy, they are the ones who will face life in the 21st century that will come as adults [3].

Creative thinking is the ability to create something new [4].. The 2013 curriculum is a curriculum that provides opportunities for students to ask questions and think oddly. "Asking and thinking oddly is closely related to creative thinking skills [5]. Students 'creative thinking abilities can be identified by giving tests that have been designed in such a way as to the characteristics contained in the classification of students' creative thinking abilities [6]. The ability to think creatively is not the ability to create something from nothing, but the ability to generate new ideas by combining, changing or applying existing ideas [7].

Biology is a group of Natural Sciences (IPA or Science) which aims to help students develop thinking skills to enable them to face the challenges of everyday life [8]. Biology learning is a part of science that must follow developments in the era of globalization without leaving the essence of science which includes: developing thinking skills and skills in a scientific manner [9]. One of the biology materials studied by students is ecosystem material. KI and KD on ecosystem material seem to target students to have creative thinking competencies, therefore a creative thinking ability test instrument is a necessity in the context of developing a creative thinking ability test. The findings in the field that tests of creative thinking skills in a biological context, especially on ecosystem material, are not yet available. Ecosystem material is material related to the home where living things (the universe) live and their problems. Emphasis on ecology has the potential to introduce the concept of human relations with the environment

[10]. The selection in this ecosystem material is expected to provide students with understanding in maintaining interactions between living things and their environment. So it is necessary to act of human consciousness in protecting the universe, therefore students are required to be able to produce ideas or ideas that vary so that they can improve and develop their thinking skills.

A preliminary study on three public and private high schools in Central Lampung district conducted by Habiby, Rudibyani, & Efkar (2015) shows that teachers in the three high schools (SMA) still have difficulties in making test instruments that demand students' cognitive abilities especially creative thinking. It proved that in making test instruments, the teachers did not understand the principles. In addition, these teachers have never made a test instrument to measure students' creative thinking abilities. In the research conducted by Nisa ul 2017, the instrument developed was intended for high school level with chemistry subjects, however, the instrument developed was only carried out until the stage of revising the results of the trial where the instrument could not be used. Thus, the availability of instruments for the ability to think creatively for SMA level in biology is still very minimal. This study was designed to develop a creative thinking ability test instrument on ecosystem material. This research is focused on developing a creative thinking ability test instrument.

RESEARCH METHOD

This study uses a developmental research method with a procedural development model. Procedural research is a descriptive model by showing the steps that must be followed to produce a product (Arifin, 2014). Floating research steps refer to Tessmer's formative evluation design flow [12]. This development research is focused on 3 stages, namely the preliminary stage, self-evaluation, the prototyping stage (exspert review, one to one, small group) and the field test.

The population in this study were students of class X and XI IPA. In the trial phase (one to one and small group) using respondents from class XI IPA SMAN 1 Tambun Selatan with cluster random sampling technique. The one to one trial used 3 students and the small group trial used 24 students. Meanwhile, the validation was carried out by 3 experts, namely 2 biology lecturers and 1 biology teacher. Meanwhile, the field test involved about 100 students of class X IPA who were taken randomly from various high school schools in West Java and DKI Jakarta.

Research procedure

1. Preliminary step, which is preparing references related to research and research trials.
2. The self-evaluation step, carried out the curriculum analysis stage, students and material which then carried out the design stage to produce the items
3. Prototype step
    a. Expert review, expert validation by 2 biology lecturers and 1 teacher at SMAN 1 Tambun Selatan to assess and provide suggestions on the creative thinking ability test instrument.
    b. One-to-one, tested into the one-to-one stage by 3 students of SMAN 1 Tambun Selatan who were not subject to a research trial and provided a questionnaire on educators' responses to questions about creative thinking skills. The results of the assessment of expert suggestions, the responses from students are used to revise prototype I which will produce prototype II.
    c. Small group, tested on 24 students who are not research subjects. After working on the questions, students were asked to complete a questionnaire on student responses to the revised creative thinking ability test instrument from the one-to-one stage by the researcher to determine the readability of the questions and responses. After revising the questions based on students' responses to the small group, the validity test, reliability test and item analysis were calculated to become prototype III.
    d. Field test, prototype III which has been revised from the small group stage is tested on 100 students. Based on the results of the test at the field test stage, the validity, reliability, difficulty level, and distinguishing power of the test instruments can be determined. At this stage the final product or final prototype will be produced.

Data analysis techniques consisted of tests and questionnaires. The test used is a test instrument that refers to indicators of creative thinking skills according to Williams (1999); (Saufi & Riandi, 2017) which have aspects, namely: Fluence, Flexibility, Originality, Elaboration. The questionnaire used in this study was the student response questionnaire to the readability of the instrument for creative thinking skills. The data analysis technique consisted of instrument validation, student response questionnaire

analysis, validity test of creative thinking skills, reliability tests of creative thinking skills, difficulty level analysis of creative thinking skills tests, differentiation analysis of creative thinking skills tests.

RESULTS AND DISCUSSION

In this research, the step that must be done is to determine the type of test, the test material, then the preparation of the items, the arrangement of the instrument grid, then validated by an expert (expert review) and then carried out by prototyping which consists of Phase I (one to one) trials. , Phase II trials (small group) and field tests (field tests).

Expert validation results (expert review)

The judgment process of the content validation of the test instruments to measure creative thinking skills was carried out by 3 experts (validators) including two lecturers of the biology education study program, and one biology subject teacher. The results of the validation analysis are as follows.

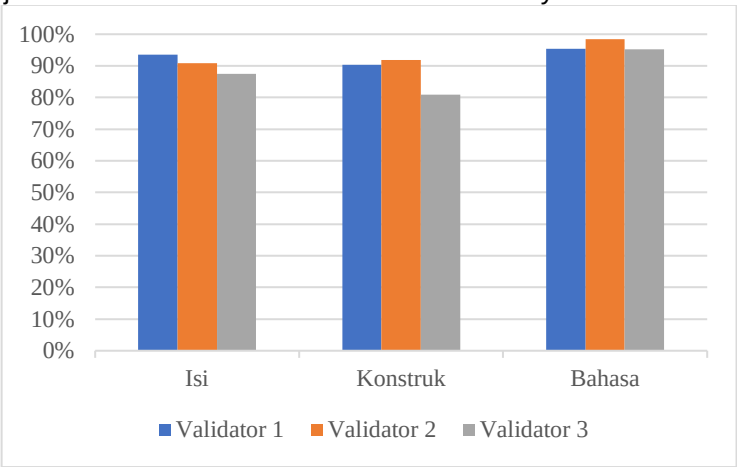

Figure 1. Expert Validation Results

Figure 1, shows that of the 24 items that have been assessed by the expert, it has shown that these items are declared valid with very good criteria. Apart from providing an assessment using a validation sheet, experts are also welcome to provide suggestions for producing better instruments.

Results of student response questionnaire analysis

The results of the student response questionnaire analysis in the one to one trial obtained an average of 84.52% of students' positive responses to the creative thinking test instrument. Whereas in the small group trial, an average of 88% of students responded positively to the creative thinking test instrument. It can be said that more than 50% of students gave a positive response, meaning that the readability of the questions was good and could be continued to the field test.

The results of the validity test of the creative thinking ability

Table 1. The results of the validity test of the creative thinking ability

Validitas Empiris	criteria	Item number	Amount
Small group	Valid	1, 2, 4, 5, 6, 8, 10, 11, 13, 16, 18, 19, 21, 22, 23, 24	16
	Invalid	3, 7, 9, 12, 14, 15, 17, 20	8
Field test	Valid	1, 2, 4, 5, 6, 8, 10, 11, 13, 16, 18, 19, 21, 22, 23	15
	Invalid	-	-

The results of the analysis of the validity test showed that in the second trial stage (small group) there were 16 valid items and 8 invalid items. Meanwhile, for the final stage test (field test) obtained 16 valid questions.

The reliability test results of the creative thinking ability test

The reliability test based on the calculation results with the Cronbch alpha formula shows the reliability value of the creative thinking ability test instrument is 0.753 with high interpretation. This shows that the test is said to be reliable.

The results of the analysis of the difficulty level of the creative thinking ability test

Table 2. Analysis of the difficulty level of the creative thinking ability test

Step	Category	Item number	Amount
Small group	Easy	1, 2, 4, 5, 6, 8, 11, 15, 23	9
	Medium	3, 7, 9, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22	14
	Hard	17	1
Field test	Easy	4, 6, 8, 11, 13, 16, 18, 21, 22	9
	Medium	1, 2, 5, 10, 19, 23	6

The results of the analysis of the difficulty level of the creative thinking ability test in the phase II (small group) trial obtained 9 items in the easy category, 14 items in the medium category and 1 item for the difficult category. In the final stage test (field test) obtained 9 items in the easy category and 6 items in the medium category.

The results of the distinguishing power analysis of the creative thinking ability test

Table 3. Differentiation analysis of creative thinking ability tests

Step	Category	Item number	Amount
Small group	Poor	2, 3, 4, 6, 7, 9, 12, 14, 15, 17	10
	Satistifactory	1, 5, 8, 10, 11, 13, 16, 18, 19, 20, 21, 22, 23, 24	14
Field test	Poor	2, 13, 18	3
	Satistifactory	1, 4, 5, 6, 8, 10, 11, 16, 19, 21, 22, 23	12

The results of the analysis of the distinguishing power of the creative thinking ability test in the second phase of the trial (small group) obtained 10 items in the bad category, 14 items in the sufficient category. In the final stage test (field test) obtained 3 items in the bad category and 12 items in the enough category.

Discussion

The development of a test instrument for the ability to think creatively on ecosystem material has gone through a series of stages with reference to the Tessmer model starting from the preliminary stage, self-evaluation, prototyping (exspert review, one to one, small group) and field tests so as to produce a product, namely a test instrument.

The prototype carried out included an expert review, one to one, small group and field test assessment. In the expert review stage and one to one carried out in parallel, the results of this stage then become prototype I. The results of the expert review assessment by the experts obtained an instrument with a very good category so that the instrument that had been prepared was declared valid with an average percentage of 91.57%, it can be said that the creative thinking ability test instrument is feasible to use with a slight revision based on expert advice. The assessment according to expert advice is focused on the construct, content and language aspects so that revisions are based on expert advice on the test instrument, which includes test questions, question indicators and question answer keys.

In the one to one stage, it is done by giving 24 questions to describe the ability to think creatively to 3 class XI students who are high-skilled, medium-skilled and low-skilled. From the results of the student questionnaire to determine the readability of the questions, it was obtained an average percentage of 84.52%. Thus, the students' responses to the test questions for the ability to think creatively were positive (high) on the level of readability of the questions. Based on the comments of students, it was found that according to the students, the items 10, 12, 16 and 17 had questions that were not clear. According to students, this question is difficult to understand so that the question is difficult to answer. The results of the questionnaire analysis of students' responses to the readability of the questions can be used to revise prototype I which then produces prototype II.
In the small group stage, the researcher used 24 revised items based on expert advice and the results of the analysis in the one to one stage were then tested on 24 students. The results of the analysis of

the readability questionnaire by students obtained an average percentage of 88%, thus the students' responses to the test questions for the ability to think creatively were positive (high) on the level of readability of the questions. The results of the validity test at the small group trial stage revealed that there were 8 invalid questions. The average value of the validity test at the small group stage was 0.443 with sufficient criteria. Invalid questions at the small group stage were items number 3, 7, 9, 12, 14, 15, 17 and 20. The reliability test results obtained were 0.825 with very high interpretation. The cause of invalid questions can be because students work together, the physical conditions of students are less favorable, besides the tendency of students to answer quickly, but not correctly [13].

Analysis of items at the level of difficulty found that there were 9 items categorized as easy, 14 items categorized as medium and 1 item categorized as difficult. In the analysis of the distinguishing power, it was found that 10 questions were categorized as bad, 14 questions were categorized as sufficient. The results of the small group are then used to revise prototype II which will produce prototype III, this stage will be used in the field test stage.

Problems that are not used at the field test stage are invalid questions because they have r count <r table. Based on expert advice, invalid questions are not used at a later stage. The small group stage produces 16 valid questions that represent 12 indicators of creative thinking with item numbers, namely 1, 2, 4, 5, 6, 8, 10, 11, 13, 16, 18, 19, 21, 22, 23, and 24, however, due to research limitations and on the advice of the supervisor, the questions tested at the field test stage amounted to 15 questions with item numbers, namely 1, 2, 4, 5, 6, 8, 10, 11, 13, 16, 18, 19, 21, 22, and 23.

In the field test stage, the validity of the questions obtained 15 valid questions with a percentage of 100% and the average value of validity was 0.471 which had sufficient interpretation. A test can be said to be good if it always gives the same results at different times and occasions [13]. The results of the reliability test at the field test stage were 0.753, based on the reliability test value, it could be seen that the creative thinking skills test questions developed had high test reliability. According to the Ministry of National Education (2008); [14],, the factors that influence the reliability score are the length of the test, the length of time working on the questions, homogeneity of the hemisphere and the level of difficulty of the questions.

The level of difficulty at the field test stage obtained 6 items (40%) in the medium category and 9 items (60%) in the easy category. The questions included in the medium category were item number 1, 2, 5, 10, 19 and 23 with the difficulty level value respectively 0.69; 0.70; 0.70; 0.70; 0.63 and 0.70. Meanwhile, questions number 4, 6, 8, 11, 13, 16, 18, 21, and 22 with the difficulty level are 0.75 respectively; 0.85; 0.78; 0.79; 0.77; 0.73; 0.72; 0.78; and 0.76 with easy category. Good questions are questions that are not too easy and not too difficult [15], meaning that the questions with a good level of difficulty are in the medium category. According to [16] it is better if a package of questions given to students should have a balance between difficult: medium: easy with a ratio of 3: 4: 3 or 2: 5: 3.This study shows that the comparison of the difficulty level of creative thinking skills is 6 ; 9 medium; easy, based on these comparisons, it can be concluded that the questions of creative thinking skills developed have an unbalanced proportion [17].

The distinguishing power at the field test stage was obtained that there were 3 items (20%) in the bad category and 13 items (80%) in the sufficient category. The questions in the bad category were questions number 1, 13 and 18 with the value of differentiation power, respectively, 0.13; 0.15 and 0.19. While the distinguishing power of questions with sufficient categories, namely questions number 1, 4, 5, 6, 8, 10, 11, 16, 19, 21, 22 and 23 with the value of distinguishing power respectively is 0.26; 0.21; 0.25; 0.21; 0.22; 0.24; 0.24; 0.36; 0.32; 0.27; 0.22 and 0.28. The distinguishing power of a question is said to be adequate if it is on the discrimination index between 0.20 to 1.00 which lies in the distinguishing power of sufficient and good questions [18]. It can be said that the number of questions that has been adequate is that there are 13 items (80%) while 3 items (20%) have insufficient distinguishing power. According to [15], the distinguishing power of a question is the ability of a question to distinguish between smart (high-skilled) students and low-ability students. So it can be said that a test kit with sufficient distinguishing power has been able to distinguish smart (high-skilled) students from dumb (low-skilled) students [17].

The results obtained at the prototyping and field test stages, namely validation by experts, trials and final stages of testing, it can be seen that the resulting test instrument reaches predetermined criteria, namely valid and reliable with sufficient and high category The validity is stated as good with the

coefficient category ranging from sufficient to very good, and the reliability of the questions is also in the high category (Guilford, 1954); [14]. In general, expert validation assessments with an average percentage of 91.57% were declared valid. Based on the data obtained, 15 items are categorized as valid because they have a value of r Table> r count. The reliability of the test instruments was generally declared reliable because based on the analysis of the test instruments, the reliability was obtained with a value of 0.753 with high interpretation.

According to [15], the terms of a good test have five requirements, namely: validity, reliability, objectivity, practicality and economics. Problems with the validity category are found in item number 1, 2, 4, 5, 6, 8, 10, 11, 13, 16, 18, 19, 21, 22 and 23 The revised questions are found in item number 3, 8, 12, 17, 20 and 22. For example item number 8 in the one to one stage is an invalid question with moderate difficulty level and poor differentiation, then the questions are revised according to expert advice to be tested at a later stage so that at the small group stage Field test questions get better with valid question categories, moderate difficulty level and sufficient distinguishing power. This the final prototype test questions produced in this study consisted of 15 essay items with a time allocation of 2x45 minutes.

CONCLUSIONS

This research can be concluded that in the final stage or field test, a valid and reliable test instrument is obtained, namely by looking at the expert validation assessment in general with an average percentage of 91.57% which is declared valid by validity analysis, it is obtained that 15 items are categorized as valid because they have r count> r table. In general, the test instrument was declared reliable because based on the analysis of the test instrument, reliability was obtained with a value of 0.753 at high interpretation. The level of instrument difficulty obtained was 6 items (40%) in the medium category and 9 items (60%) with the easy category. The distinguishing power of the instrument of the ability to think creatively has a different power with 13 items (86.6%) and 2 items (13.3%) in the poor category. Thus this research produces a test instrument that is suitable for use with a total of 15 test items in essay. The resulting test instrument is in the form of essay questions totaling 15 items and represents 12 indicators of creative thinking which include 4 aspects, namely the fluency aspect, there are 4 questions. (30%). On the flexibility aspect, there are 4 question points (40%). In the aspect of originality there are 3 items (20%) and in the aspect of elaboration there are 3 items (20%).

REFERENCES

[1] R. Herpiana and U. Rosidin, “Development of instrument for assessing students’ critical and creative thinking ability,” *J. Phys. Conf. Ser.*, vol. 948, no. 1, 2018.
[2] A. Budiman and Jailani, “Pengembangan Instrumen Asesmen Higher Order Thinking Skill (HOTS) ... (Agus Budiman, Jailani) - 139,” *Ris. Pendidik. Mat.*, vol. 1, no. November 2014, pp. 139–151, 2014.
[3] N. Maghfiroh, H. Susilo, and A. Gofur, “Kemampuan berpikir kreatif siswa kelas x sma negeri 4 sidoarjo pada mata pelajaran biologi,” *Semin. Nas. Pendidik. dan Saintek 2016*, vol. 2016, no. 2, pp. 635–639, 2016.
[4] G. Talajan, *Menumbuhkan kreativitas dan prestasi guru*. Yogyakarta: Laksbang Presindo, 2012.
[5] I. W. Redhana and S. Sya’ban, “Pengembangan tes keterampilan berpikir kreatif,” *Semin. Nas. Ris. Inov. II*, pp. 18–25, 2014.
[6] S. Marwiyah, K. Kamid, and R. Risnita, “Pengembangan Instrumen Penilaian Keterampilan Berpikir Kreatif Pada Mata Pelajaran IPA Terpadu Materi Atom, Ion, Dan Molekul SMP Islam Al Falah,” *Edu-Sains J. Pendidik. Mat. dan Ilmu Pengetah. Alam*, vol. 4, no. 1, 2015.
[7] L. P. W. Adnyani, I. Kurniawan, and E. A. R. Pinahayu, “Development of Creative-Thinking Instrument in Mathematics Problem Solving Based on Logical Mathematics Intelligence,” *JRAMathEdu (Journal Res. Adv. Math. Educ.*, vol. 3, no. 1, pp. 1–12, 2018.
[8] G. M. Saido, S. Siraj, and O. Saadallah, “MALAYSIAN ONLINE JOURNAL OF EDUCATIONAL MANAGEMENT (MOJEM) TEACHING STRATEGIES FOR PROMOTING HIGHER ORDER THINKING SKILLS : A MALAYSIAN ONLINE JOURNAL OF,” no. December 2017, 2015.
[9] D. Ramadhani, R. Susanti, and D. Zen, “Pengembangan Soal Keterampilan Proses Sains Pada Pembelajaran Biologi Sma,” *J. Pembelajaran Biol. Kaji. Biol. dan Pembelajarannya*, vol. 2, no. 2, pp. 185–198, 2015.
[10] R. Effendi, H. Salsabila, and A. Malik, “Pemahaman Tentang Lingkungan Berkelanjutan,” *Modul*, vol. 18, no. 2, p. 75, 2018.

[11] I. Habiby, ratu betta Rudibyani, and T. Efkar, "Habiby et al. Pengembangan Asesmen Kemampuan Berpikir Kreatif …. | 985," vol. 4, no. 3, pp. 985–996, 2015.
[12] M. Tessmer, "Formative Evalution Alternatives," vol. 7, no. 1, pp. 3–18, 1994.
[13] Z. Arifin, *Evaluasi Pembelajaran*. Bandung: PT. Remaja Rosdakarya, 2016.
[14] N. Novitasari, M. Ramli, and Maridi, "Mengukur problem solving skills siswa SMA pada mata pelajaran biologi," *J. Biol. Edukasi Ed. 14*, vol. 7, no. 1, pp. 1–6, 2015.
[15] S. Arikunto, *dasar-dasar Evaluasi Pendidikan*, 2nd ed. Jakarta: Bumi Aksara, 2018.
[16] N. Sudjana, *Penilaian Hasil Proses Belajar Mengajar*. Bandung: PT. Remaja Rosdakarya, 2004.
[17] M. Nuswowati, A. Binadja, K. Efti, and N. Ifada, "Pengaruh Validitas Dan Reliabilitas Butir Soal Ulangan Akhir Semester Bidang Studi Kimia Terhadap Pencapaian Kompetensi," *J. Inov. Pendidik. Kim.*, vol. 4, no. 1, pp. 566–573, 2010.
[18] A. Sudijono, *Pengantar Evaluasi Pendidikan*. Jakarta: PT. Rajagrafindo Persada, 2005.