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Characteristics of Instruments and Profile of Creative Thinking Ability of Students on Work and Energy Material

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Abstract

Physics learning in secondary schools requires students to achieve learning objectives in developing conceptual skills and creative thinking by studying every problem that occurs in life using the concept of physics. However, the fact is that the physics material taught rarely relates the content of the lesson to everyday life, the lesson is mostly filled with convergent so that creative thinking skills cannot be measured. This study aims to apply the developed instrument and obtain empirical data on the validity of the instrument as well as a profile picture of students' creative thinking abilities. This study uses the ADDIE model with 5 stages, namely analysis, design, develop, implement, and evaluate. The test subjects in this study were 34 students of class X UMIPA 2 at MAN 1 Bojonegoro. The results of the development obtained 10 items of instruments that have been validated by 3 lecturers of physicists. Empirical validity was analyzed using Microsoft Excel software. Based on the data from the validity test results that have been analyzed, it shows that the instrument that has been developed is theoretically valid with an average V Aiken value in the material, construction and language domains, respectively 0.91; 0.91; and 0.87. The results of instrument validation are also declared empirically valid by having values: (a) Empirical validation of items with an r_{xy} value range of 0.34 to 0.64; (b) The reliability of the instrument obtained an r_{11} value of 0.564 with a sufficient category, (c) The difficulty level of the instrument questions was 30% of the questions in the medium category and 70% of the questions in the easy category, (d) The discriminatory power of the instrument had 10% good questions, 40% enough questions, and 50% of the questions are not good. Creative thinking skills in students have a medium to very high category.

Keywords: Creative thinking ability, Instruments, Validation

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INTRODUCTION

It was recorded that since the end of 2021, Indonesia has human resources (HR) of 273 million people (Kemendagri, 2022). Indonesia is also one of the countries that has abundant natural wealth. This is believed to be the main support for the Indonesian nation to become a developed country in the future. To be able to process Indonesia's natural resources, intelligent, character, and creative thinking people are needed. Juan Hauarte, a Spanish philosopher, stated that the highest level of intelligence possessed by a human being is True Creativity (in Aziz, 2014). Therefore, every student who takes education is required to play an active role and think creatively in improving the quality of education in Indonesia. As educators who are expected to be able to build ideas/creativity in students, they should be aware that life's problems are increasingly complex, especially in this modern era which is always changing and developing rapidly. Various products of scientific and technological innovation are very close to human life. To face the challenges of modern life which is dynamic and full of uncertainty, it is necessary to develop creative thinking skills in learning

(Seyihoglu and Kartal, 2010). Like a tit for tat, the Government of the Republic of Indonesia has also issued policies to regulate and manage the education system of its citizens. Through Government Regulation No. 57 of 2021 concerning National Education Standards (SNP) it is emphasized that the implementation of learning is carried out in an interactive, inspiring learning atmosphere, playing an active, creative, and independent role (Kemdikbud, 2022). Thus, the creative thinking ability of students becomes One of the learning outcomes that all education actors need to pay attention to.

Creative thinking (CT) is a skill to generate new ideas (Amelia, 2021). In detail Arnyana (2019) defines creative thinking skills as the ability to create new ideas or ideas that are different from those that existed before. While creative thinking is divergent, productive, creative ways of thinking laterally and heuristic thinking that can be taught explicitly in learning (Zubaidah, 2017). Basically, CT is a skill that emerges because it often solves problems using different methods (Kiryak and Calik, 2017). CT according to Batlolona JR (2019) is the ability to produce new works in the form of products that combine data, information, and elements that can form new jobs or ideas. Based on the opinions of these experts, it can be drawn an understanding of creative thinking skills, namely the ability to develop and produce new ideas that are different from a problem and have several ways of solving that are divergent. According to psychologist JP Guildford, divergent can be trained so that creative thinking can be improved (in Wulandari 2021).

According to Mundar (2012), to see the creative thinking ability of students, it can be measured directly using several indicators which include: (1)fluency, namely the ability to provide several solutions, (2)originality, namely the individual's ability to seek specific answers, and create new ideas, (3) detailed thinking (elaborate), which describes the ability to allow deep reasoning behind answers, and (4) flexibility of thinking (flexibility), namely the ability to change the flow of thought when facing a dead end.

Basically every human being created, has his own mind and creativity in each. Every creative individual will be able to easily come up with ideas/creativity from existing problems. As for individuals who are less/not creative, it is clear that it will be difficult to pursue scientific and technological innovation. This is very crucial because it can become a permanent obstacle and threaten their survival. Yulius (2021) reveals that a person's creative potential can show the results of actions, performances/works, both in the form of goods and ideas in a meaningful and quality manner. For this reason, it is very necessary to monitor and measure the creative abilities of students on a regular basis, so that the level of creative abilities is recognized and assisted in developing or improving these abilities. Thus, instruments to measure creative thinking skills need to be prepared immediately in order to meet learning outcomes.

Based on the results of the preliminary study of science learning, it was revealed that Indonesian students have very low creative thinking skills. Fuad, et al. (2015) reported the results of the creative thinking test with a score range of 0–100, that the average achievement score for each creative thinking indicator was only 18.03. Each indicator of creative thinking has a very low achievement value, namely: *fluency* 15.90; *elaborate* 16.28; *originality* 12.05; and *flexibility* 18.7. In line with that, the *Trend International Mathematics and Science Study* (TIMMS) shows that the results of measuring the level of creative thinking skills of students in Indonesia are still relatively low, only 2% of Indonesian students are able to solve problems that require creative thinking skills in solving them (Muliss in Ismara, 2017). Nasution's research (2018) also strengthens existing findings, that the creativity and creative thinking of high school students are still low, because there are several causes that hinder the creative thinking process of students, including the limited understanding of students on concepts and explanations of the material listed in textbooks. . So that most students have not been trained to do the stages of creative thinking.

In learning physics in secondary schools, students are expected to work hard to achieve their learning objectives, namely developing conceptual skills and creative thinking skills as

much as possible. The effort in question is to study every problem that occurs in life using and applying physics concepts consistently (Collins, 2014). Creative thinking can be used as a learning innovation by educators, so educators must be able to carry out the mandate to constantly develop students' creative thinking skills. Wheeler, Bromfield, and Waite (2002) state that the task of educators is to provide the best conditions for students to acquire relevant thinking skills. However, Lestari (2021) provides an affirmation related to physics learning that has occurred so far, that the material taught rarely relates the content of lessons to everyday life, and lessons are mostly filled with tasks or practice questions that are *convergent*.

Based on the *Google Scolar* and a search on Google, several researches on the development of creative thinking instruments in the field of physics studies were recorded, including the research of Irmaya, FP and Sunarti, T. (2020) has developed a creative thinking instrument on dynamic fluid materials, Awalis Sholekhah (2020) developing instruments for materials of magnitude and measurement. Edi Istiyono, et al. (2018) developed 2 packages of creative thinking instruments for materials of elasticity and Hooke's law, static fluids, temperature and heat, as well as optical instruments. Marwiyah (2015) developed instruments on atomic, ion, and molecular materials. Nasution, IRY (2021) developing a creative thinking instrument on direct current electricity.

With the various considerations above, a creative thinking instrument was developed on the Business and Energy material in a format in the form of essay questions, in order to facilitate and give students freedom in giving *divergent.* This article will report on the preparation of instruments and describe the characteristics of creative thinking instruments that have been successfully developed by researchers.

To develop the intended instrument, the first step is to find information on the use of creative thinking skills in schools. Field observations were carried out at Madrasah Aliyah Negeri (MAN) 1 Bojonegoro. The results of interviews with students and school teachers obtained the fact that class X students had never taken measurements of creative thinking abilities, especially in the physics subject, while learning the material for work and energy, students only got knowledge of the concept of s as well as the principles of the material, have not yet reached activities that involve students directly such as conveying responses to phenomena, identifying and formulating problems to solving a problem. This is in stark contrast to the learning objectives where students must be able to master thinking skills and problem-solving skills they face (Apriani, 2019). Work and energy materials are closely related to everyday life, so this material needs in-depth understanding so that students' creative thinking abilities can be developed. This condition triggers researchers to apply the developed instrument and obtain empirical data on the validity of the instrument as well as a profile picture of students' creative thinking abilities. This activity also provides real experiences for the school and students to achieve learning goals and improve the quality of their education.

METHOD

This study uses the ADDIE model which consists of 5 stages, namely *analysis*, *design*, *develop*, *implement*, and *evaluate* (Branch, 2015). The creative thinking ability instrument was developed and tested on 34 students who had studied the business and energy materials. At the analysis stage, observations are made to meet development needs, determine goals, determine basic competencies that are adapted to the latest curriculum, and determine the material to be tested. Curriculum analysis is carried out by examining the KD physics 3.9 and 4.9 on the work and energy materials. Material analysis is carried out by reviewing various literature on work and energy materials from *textbook* (Serway, 2014; Mikrajuddin, 2017) as well as previous research studies discussing work and energy materials (Lestari, 2021).

After making observations, the next step is to design a grid of instrument questions. The preparation of the grid is done by reviewing some of the literature on work and energy

materials in order to obtain *a draft* of a creative thinking instrument in the form of essay test questions. In the third stage, the researcher develops the content *draft* instrument consultation discussions with the supervisor regarding the suitability of the content of the questions with the indicators, the fulfillment of the questions in terms of language and logic of thinking, as well as the depth and correctness of the concepts applied in the questions. The final draft of the instrument obtained 10 items which were then gradually carried out by the process of theoretical validation and empirical validation. The theoretical validation process involved 3 lecturers from the Department of Physics at Unesa who studied and assessed the content of physics material, the construction of the questions made, and the linguistic aspects of the questions. After going through the theoretical validation process, the instrument was improved according to the suggestions and input of the validator. The revised instrument draft was then tested on the students of MAN 1 Bojonegoro to obtain data on the empirical validity of an instrument. In addition to the validity of the instrument data, the test results are also equipped with checking the differentiating power and the level of difficulty of the items in order to obtain the characteristics of the instrument as a whole.

Subject

This study involved 34 students of class X UMIPA 2 MAN 1 Bojonegoro in the even semester of the 2021/2022 academic year. The participants were on average 16 years old and consisted of 27 women and 7 men. Data collection was carried out on the 4th week of April 2022..

Instrument, Procedure and Analysis

Data analysis techniques to obtain the theoretical validity of the instrument from the assessment of all validators, using Aiken's V test statistics by applying equation 1.

$$V = \frac{\Sigma S}{n(c-1)} \qquad \ldots(1)$$

Keterangan :
V = Aiken V Index
l_0 = Lowest Validation Value
c = Highest Validation Value
r = Value given by validator
n = Number of Validation
$s = r - l_0$

Items can be declared valid if they have a V-Aiken index in the range 0, 37 to 1.0 (Kowsalya, 2012: 702). According to the classification in Table 1.

Table 1. Index V Aiken

V Aiken	Criteria
0,00 < V ≤ 0,20	Very Low
0,20 < V ≤ 0,40	Low
0,40 < V ≤ 0,60	Enough
0,60 < V ≤ 0,80	High
0,80 < V ≤ 1,00	Very High

To obtain the empirical validity of the instrument, data analysis was carried out from the results of the instrument test, by applying the *product moment* as stated in equation 2.

$$r_{xy} = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{(n(\sum x^2) - (x)^2(n(\sum y^2) - (y_i)^2)}} \qquad \ldots(2)$$

Description :
r_{xy} = Correlation coefficient
xy = The product of the variables X and Y
$\sum x^2$ = Total squared value X
$\sum y^2$ = Total squared value Y
$(x)^2$ = Total X value squared
$(y)^2$ = Total Y value squared

To determine the validity of the instrument, the calculated correlation coefficient value was juxtaposed with the correlation coefficient value in the statistical data table. . Instruments can be declared empirically valid if the value of r_{xy} is greater than r_{table}. The criteria for the validity of the instrument can be determined according to the grouping of the correlation coefficient values calculated in Table 2.

Tabel 1. Criteria of empirical validity

Value V	Criteria
0,00 - 0,20	Very Low
0,20 - 0,40	Low
0,40 - 0,60	Medium
0,60 - 0,80	High
0,80 - 1,00	Very High

(Source: Sugiyono, 2012)

To obtain the reliability of the questions on the instrument, *Cronbach's Alpha* as stated in equation 3. Meanwhile, to determine the reliability criteria of the instrument, the correlation value of *Cronbach's Alpha* can be matched with the grouping of values from the criteria in Table 3.

$$r_{11} = \frac{k}{(k-1)}\left\{1 - \frac{\sum s_i^2}{s_t^2}\right\} \quad \ldots(3)$$

Description :
k = total of all items
$\sum s_i^2$ = total variance of scores
s_t^2 = varians question
r_{11} = *alfa cronbanch coefficient*

Tabel 3. Criteria Reliability

R Value	Criteria
$>$ 0,8	Very Reliabel
0,6 – 0,8	Reliabel
0,4 – 0,6	Fairly Reliabel
0,2 – 0,4	Less Reliabel
< 0,2	Not Reliabel

(Source: Sugiyono, 2012)

The determination of the distinguishing power and level of difficulty of each item is calculated by using equation 4 and equation 5

$$D = P_A - P_B \quad \ldots.(4)$$

Descriptions :

D = Discrimination index
P_A = Difficulty level for the upper group
P_B = Difficulty level for the lower group

$$P = \frac{N_P}{N} \quad \ldots.(5)$$

Descriptions :
P = Difficulty index (*proportion*)
N_P = Number of participants who answered the question correctly
N = Total participant answered the question wrong

The criteria for distinguishing power and the level of difficulty are determined according to Table 4 and Table 5.

Table 4. Criteria of Discrimination

D Value	Criteria
D ≤ 0	Very Low
0 < D ≤ 0,2	Low
0,2 < D ≤ 0,4	Medium
0,4 < D ≤ 0,7	High
0,7 < D ≤ 1	Very High

(Source: Bagiyono, 2017)

Table 5. Criteria of Difficuilty

P Value	Criteria
0	Very Difficult
0 < P ≤ 0,3	Difficult
0,3 < P ≤ 0,7	Medium
0,7 < P < 1 1	Easy
1	Very Easy

(Sumber: Bagiyono, 2017)

RESULTS AND DISCUSSION

The creative thinking assessment instrument was developed based on the CT indicators according to Munandar (2012) which consists of *fluency*,*originality*, *elaborate* ,and *flexibility*. The results of the recapitulation of the instrument are in Table 6.

Table 6. Representation of the number test questions

No	CT Indicators	Number of question	Total
1	*Fluency*	1 and 2	2
2	*Originality*	3, 4, and 5	3
3	*Elaborate*	6 and 7	2
4	*Flexibility*	8, 9, and 10	3
		Total Question	**10**

Based on the results of the recapitulation of the instruments that have been carried out at the *develop*, it has been obtained that 10 items of the description test were tested on students in order to determine the empirical validity of the questions and also their reliability. One example of an instrument and assessment attribute that was successfully developed by researchers on one aspect of the CT indicator, namely *flexibility* in Table 7

.

Table 7. Examples of Instruments Creative Thinking

CT Indicator	Question	Answer	Students Response	Score
Flexibility	Hasyim conducted a physics experiment as follows. In the first experiment, he pulled an object with a force F on a smooth flat surface, thereby accelerating the object from rest to a speed of v. In the second experiment, he accelerated with the same force so that he concluded that the ratio of the work in the first and second experiments was 1:3. What speed must Hashim accelerate from speed v in the second experiment? Explain!	**Method I:** Known : Gaya tarik = F $W_1 : W_2 = 1 : 3$ Asked : v_2 Answer : $W = \Delta EK$ $F_S = \frac{1}{2}m(v1^2 - v2^2)$ First Experiment : $W_1 = \frac{1}{2}m(v1^2 - 0^2)$ $W_1 = \frac{1}{2}mv1^2$ Second experiment : $W_2 = \frac{1}{2}m(v1^2 - v2^2)$ It can be conclude that : $\frac{W_1}{W_2} = \frac{1}{3}$ $\frac{\frac{1}{2}mv1^2}{\frac{1}{2}m(v2^2 - v1^2)} = \frac{1}{3}$ $\frac{v1^2}{v2^2 - v1^2} = \frac{1}{3}$ $3v1^2 = v2^2 - v1^2$ $4v1^2 = v2^2$ $2\ v1 = v2$ **Method II :** Known : $W_1 : W_2 = F_2 \times S_1 / F_2 \times S_1$ $1 : 3 = F \cdot S_1 / F \cdot S_2$ $1 : 3 = S_1 = S_2$ V1 = v V2 = 2v Answer : First experiment $vt^2 = v0^2 + 2as$ $v^2 = 2as$ $s = v^2/2a$ .. (eq 1) Second experiment $vt^2 = v0^2 + 2as$ $vt^2 = v0^2 + 2.a.3s$ $vt^2 = v0^2 + 6as$ $vt^2 = vo^2 + 3v^2$ .. (eq 2) Subtitution eq 2 $vt^{\mathbf{2}} = v0^2 + 3v^2$ $(2v)^2 = v^2 + 3v^2$ $4v^2 = 4v^2$	No Answer Solve questions or problems with one wrong answer. Solve questions or problems with two wrong answers. Solve questions or problems with one correct answer. Solve questions or problems with two correct answers.	0 3 5 7 10

CT Indicator	Question	Answer	Students Response	Score
		$v = 2$ So, in the second experiment Hasyim did it by accelerating the object's speed to 2 times the initial speed		

It can be seen in Table 7 that the problem contains 2 different ways to solve the requested problem with a single answer. Students are expected to be able to answer more than one way to get the right results. From these questions, students can be trained to think creatively to find or change the flow of thought when facing a dead end in the process of working on the problem. So that the ability of students in *flexibility* can be measured.

Result of Theoretical Validity

Instruments that have been developed at the develop stage are validated by three validators to obtain theoretical validity covering the realm of material, construction, and language. The preparation of the assessment rubric is carried out based on the suitability of each domain with the curriculum, research objectives, cognitive level of students, delivery of information both in terms of language and representation and communication techniques used. The assessment is given using a scoring system in the range of 1 to 4 which refers to the poor to very good category.

a. Theoretical validation of the material

The assessment of the realm of the instrument material is designed based on the content of the learning material asked in the instrument questions. The assessment aspect is viewed from the degree of conformity between the content of the questions developed and the material being taught, with the CT indicators, and with the cognitive level of students. The theoretical validity of the material domain includes lesson content that is in accordance with the curriculum to measure certain goals (Putra, 2013). The results of the theoretical validity of the material domain are presented in Figure 2

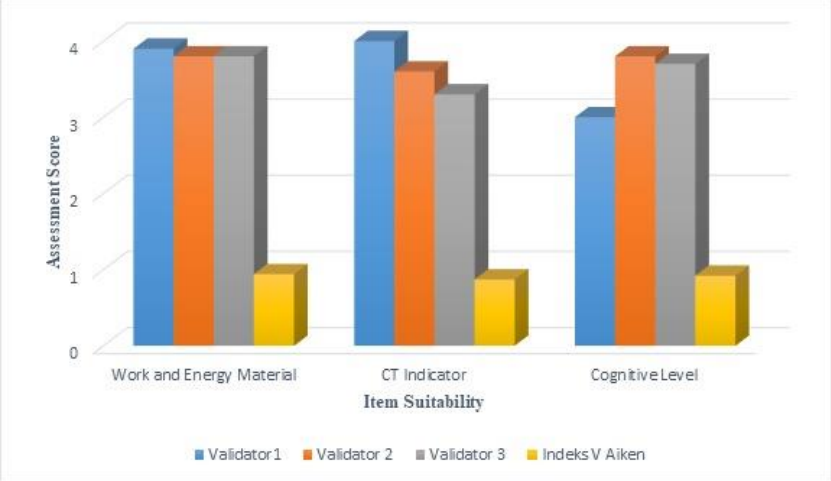


Figure 1. Achievement of Theoretical Validity of the Material

Based on the data in Figure 2, it can be seen that the instrument developed can be declared valid in the material realm because it has an average V Aiken value of 0.91 (Kowsalya, 2012: 702). All questions have met the business and energy material indicators, met the KBK indicators, and met the cognitive abilities of students who will receive the instrument, with an average achievement of above 3 (good). Only the third aspect, namely conformity to the cognitive level of students who get an average score

below 3, is given by the first validator. However, this aspect still meets the valid criteria in the good category.

b. Theoretical validity of the construction

The assessment of the theoretical validity of the construction realm is designed based on the structure/composition of information in the question sentence, the question framework and the question writing technique. Farida (2017) states that an assessment instrument that meets construction validity describes the instrument's ability to build research by measuring aspects of thinking. The results of the theoretical validity of the construction domain are shown in Figure 3.

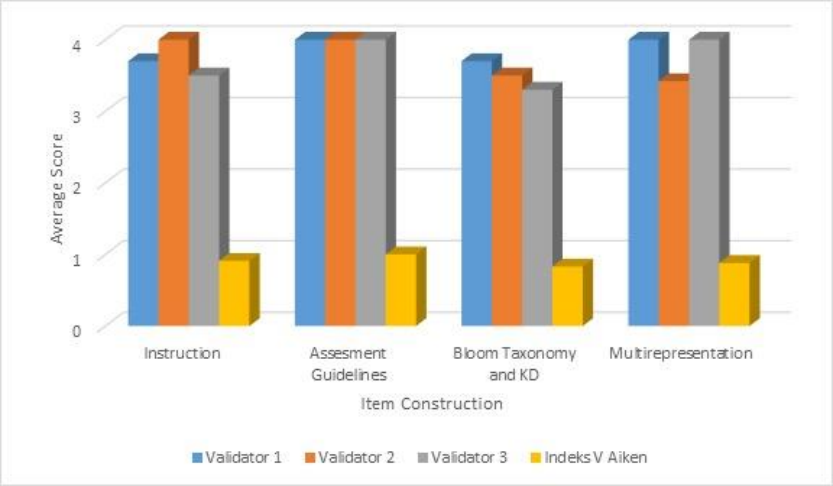


Figure 2. Achievement of Theoretical Validity of the Realm Construction

Based on the data in Figure 3, it can be seen that all of the instrument questions have met all four aspects of the construction domain assessment with assessment achievements in the score range above 3, in the good to very good category. The V Aiken index value for all aspects of the assessment reached an average value of 0.91. It can be concluded that the developed instrument can be declared valid in the construction domain because the average V-Aiken index value has exceeded 0.37 (Kowsalya, 2012: 702).

c. Theoretical validity of the language

The assessment of the theoretical validity of the language domain is designed based on the provisions of the Big Indonesian Language Dictionary (KBBI) both in terms of word meaning, sentence writing and the use of punctuation properly and correctly. The results of the theoretical validity of the language domain can be seen in Figure 4:

Figure 3. Achievement of Theoretical Validity of the Language

Based on the graph in Figure 4 above, it can be seen that all of the instrument questions developed have met the four aspects of the language domain assessment with the average score of each aspect being above 3, in the good category. Meanwhile, the achievement of the V-Aiken index scored 0.87. Thus the instrument can be declared valid in the language domain because it has a V-Aiken index of more than 0.37 (Kowsalya, 2012: 702).

Based on the analysis of the results of each theoretical validation domain above, the creative thinking instrument developed has met the assessment requirements of all validators. The creative thinking instrument was declared valid in the material realm, valid in the construction realm, and valid in the language realm. So it can be concluded that theoretically the creative thinking instrument is valid. In line with Irmaya's research (2020) which states that the instrument can be said to be theoretically valid if the three aspects of the material, construction, and language domains have good category validity results from all validators.

Result of Empirical Validity

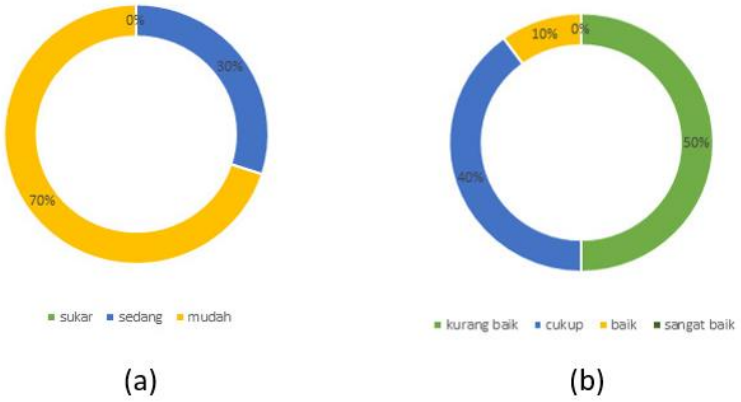
After the instrument is declared valid by the validator, improvements are made according to the validator's suggestions. Then the instrument was tested on students at MAN 1 Bojonegoro in order to obtain data on empirical validity, reliability, discriminating power and the level of difficulty of the instrument items. The results of item analysis to determine empirical validity, reliability, item difficulty, and discriminatory power are presented in Table 8, Figure 4, and Figure 5, respectively:

Table 8. Representation of empirical validation and reliability instruments

Number of Questions	r_{xy}	r table	Validity	r_{11}	Reliability
1	0,434	0.339	Valid	0,564	Reliabel (Enough)
2	0,359		Valid		
3	0,519		Valid		
4	0,393		Valid		
5	0,377		Valid		
6	0,470		Valid		
7	0,646		Valid		
8	0,549		Valid		
9	0,339		Valid		
10	0,386		Valid		

The results of the overall empirical validity of the questions (Table 8) have a value of r_{xy} an average of 0.44, the calculation of empirical validity using *Microsoft Excel software*. After calculating the whole question is declared valid with a value of r_{xy} is greater than the *r* table. value *r* Table determined from the number of students as many as 34 people so that it is worth 0.339 with a significant level of 5%. All questions that are asked are valid in the low to high category, this can mean that the instrument questions can be used to measure students' creative thinking abilities (Harni, 2021). As for the reliability of the instrument has a value of r_{11} of 0.564. So that the entire instrument that has been developed can be declared reliable with a fairly reliable category. A reliable value that has a sufficient category is caused by a small number of samples. This is in line with Irmaya's research (2020) which states that the reliability of an instrument is influenced by 4 factors, namely: 1) the length of the question (the longer the question, the higher the reliability value and vice versa, 2) the quality of the item (clear questions, directives). the desired answer must be good, 3) the number of trial samples (the more samples will determine the size of the reliability of an instrument), and 4) test administration (such as supervision, test sites, and a supportive environment). The

instrument with a reliability value of 0.564 indicates that the question of creative thinking skills can be trusted because it tends to give consistent results when given to different subjects (Son, 2019).



(a) (b)

Figure 4. (a) Level of Difficulty, and (b) Discrimination

The level of difficulty of the items is obtained from the ability of students to complete the items, not from the point of view of teaching in conducting analysis during the preparation of the questions (bagiyono, 2017). The level of difficulty of the instrument that has been developed by the researcher can be seen in Figure 4a, which is as many as 30% of the questions have a moderate level of difficulty and as many as 70% of the questions have an easy level of difficulty. The questions that have a low level of difficulty are caused because more than half of the students in class X UMIPA 2 MAN 1 Bojonegoro can answer the questions correctly. This is reinforced by Suharsimi's statement which states that questions with easy criteria can be done perfectly by almost all students (in Irmaya, 2020).

The instrument that has been developed by researchers with a moderate level of difficulty can then be used by educators to measure students' creative thinking skills and can be stored in a collection of questions. This is in line with Susanto's research (2015) which states that questions that fall into the medium criteria should be immediately recorded in a question bank book, while instruments that have easy categories need to be followed up to be better than before. However, under certain conditions, instrument questions with easy criteria can provide benefits for students to pass the selection test.

The discriminatory power of an item is the ability of an item to distinguish groups in terms of aspects that are measured according to the differences that exist in that group (bagiyono, 2017). It can be seen in Figure 4b that the discriminatory power of the instrument in this study, as many as 10% of the instrument questions had good discriminating power, 40% of the questions had sufficient discriminating power, and 50% of the questions had poor discriminating power. The overall discriminatory index of the questions has a value of 0.11 to 0.50. On questions that have a low index value, because upper and lower class students have the ability to answer questions that are almost the same. Questions that have low discriminatory power are 50%, because the number of subjects used in this study is only 34 students, so it is difficult to know the distinguishing power of each question.

Profile Creative Thinking Ability

Table 9. Persentage of CT Test

Grade Interval	Category	Frequency	Persentage
0-20	Very Low	0	0
21-40	Low	0	0
41-60	Medium	4	11,7 %
61-80	High	20	58,8%
81-100	Very High	10	29,5%

The results of the percentage of creative thinking ability tests owned by students of class X UMIPA 2 at MAN 1 Bojonegoro can be seen in Table 9, that students who have creative thinking skills in the medium category are 4 people with a percentage of 11.7%. Then students who have the ability to think creatively in the high category are 11 people with a percentage of 58.8%. While students who have creative thinking skills in the very high category are 10 people with a percentage of 29.5%. Of the 34 students who had the highest score of 92.5 and the lowest of 57.5. So it can be seen that there are no students who have a value of 0 this is because there is no human being whose intelligence is zero (Treffinger in Supriadi, 1994). Likewise with creative thinking, it means that there are no students who do not have the ability to think creatively (Armandita, 2017)

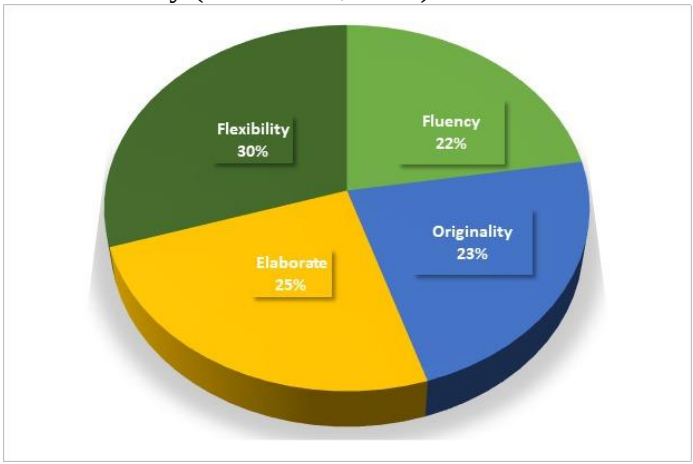


Figure 5. Average of CT Indicator

Figure 5 shows that the highest indicator of students' creative thinking abilities is *flexibility* (flexible thinking) by 30% with an average value of 3.60 and the lowest is *fluency* (thinking fluently) by 22% with an average value of 2, 70. This is in contrast to Fajrina's research (2018) which reveals that the CT indicator that has the highest average value is *fluency* while the lowest is *flexibility* and *elaborate*. In a study conducted by Vendiktama (2016) the CT indicator that has the highest average value is *originality* and the lowest is *flexibility*. Meanwhile, research conducted by Nurhakiki (2020) states that the highest CT indicator is *fluency* and the lowest is *originality*. So in this case it can be seen that the students of class X UMIPA 2 at MAN Bojonegoro are still lacking in *fluency*, such as formulating a problem and providing many solutions in problem solving, so they need to be retrained in their fluent thinking skills.

CONCLUSION

Based on the discussion and analysis of research data, it can be concluded that 10 items of creative thinking skills instrument questions on work and energy materials are declared theoretically valid with V Aiken values in the material, construction, and language domains of 0.91 each; 0.91; and 0.85 in the very high valid category. All instruments are also declared empirically valid by having values: (a) Empirical validation of items with a range of values of r_{xy} by 0.34 to 0.64; (b) Instrument reliability is obtained by the value of r_{11} of 0.564 in the sufficient category, (c) The level of difficulty of the instrument questions as much as 30% of the questions are in the medium category and 70% of the questions have the easy category, (d) the distinguishing power of the instrument has 10% good questions, 40% sufficient questions, and 50% less questions. good. So that the assessment instrument that has been developed can be declared valid theoretically and empirically.

The students of class X UMIPA 2 at MAN 1 Bojonegoro have the percentage of creative thinking ability in the medium category, high category, and very high category

respectively 11.7%; 58.8%; and 29.5%. Then the indicator of creative thinking ability that has the highest value is *flexibility* and the lowest is *fluency* of 3.60 and 2.70, respectively.

RECOMMENDATION

In future research, it is hoped that researchers can develop instruments using more trial samples in order to get better empirical validity results.

REFERENCES

Aiken, L. R. 1985. *Three Coefficients for Analyzing the Reliability, and Validity of Ratings. Educational and Psychological Measurement*. 45, 131-142.

Amalia, Andi A., Jusniar, & Taty S. 2021. *Analisis Kemampuan Berpikir Kreatif Peserta Didik melalui Penerapan Model Creative Problem Solving (CPS) Kelas XI MIA 2 SMAN 1 Tellu Siattinge (Studi pada Materi Pokok Termokimia)*. ChemEdu, 2(3), 1-10.

Armandita, Puspa, Dkk. 2017. *Analisis Kemampuan Berpikir Kreatif Pembelajaran Fisika di Kelas XI MIA 3 SMA Negeri 11 Kota Pati*. JPIP. 10(2), 129-135.

Arnyana, Ida Bagus P. 2019. *Pembelajaran untuk Meningkatkan Kompetensi 4C (Comunication, Collaboration, Critical Thinking dan Creative Thinking) untuk Menyonsong Era Abad 21*. Prosiding Konferensi Nasional Matematika dan IPA Universitas PGRI Banyuwangi.

Aziz, Rahman. 2014. *Psikologi Pendidikan. Malang*: UIN Maliki Press.

Bagiyono. 2017. *Analisis Tingkat Kesukaran dan Daya Pembeda Butir Soal Ujian Pelatihan Radiografi Tingkat 1*. Widyanuklida, 16(1), 1-12.

Batlolona, John R. Diantoro, M., Wartono, & Latifah. 2019. *Creative Thinking Skills Students in Physics on Solid Material Elasticity*. Journal of Turkish Science Education. 16(1), 48-61.

Branch, Robert Maribe. 2015. *Survey On Instructional Design Models*. New York: Associaton for Educational Communications and Technology.

Collins, R. 2014. *Skills for The 21st Century*: *Teaching Higher–Order Thinking*. Curriculum Leadership Journal, 12(14), 1-7.

Fajrina, R. A. N. A., Supriyono K. H., & Arif Hidayat. 2018. *Peran Model Projrct Based Learning Dalam Kemampuan Berpikir Kreatif Kelas XI IPA Melalui Materi Fluida Statis*. Jurnal Pendidikan, 3(3), 291-295.

Farida, Ida. 2017. *Evaluasi Pembelajaran Berdasarkan Kurikulum Nasional*. Bandung: PT. Remaja Rosdakarya.

Fuad, N. M., Siti Zubaidah, Susriyati M., & Endang S. 2015. *Profil Hasil Belajar, Keterampilan Berpikir Kritis dan Kreatif Siswa serta Strategi Pembelajaran yang Diterapkan Guru SMP di Kediri*. Malang: Jurusan Biologi UM, pp. 807-815.

Harni. 2021. *Pengembangan Instrumen Tes Kemampuan Berpikir Kreatif Pada Materi Gelombang Bunyi di SMA Negeri 9 Sinjai*. Makasar: Universitas Negeri Makasar.

Irmaya, Ferna Pristia, dan Titin Sunarti. 2020. *Validitas Instrumen Penilaian Berbantuan Google Form untuk Mengukur Kemampuan Berpikir Kreatif Fisika Pada Bahasan Fluida Dinamis*. Jurnal Inovasi Pendidikan Fisika. 9(2).

Ismara, L., Halini, & Dede Suratman. 2017. *Kemampuan Berpikir Kreatif Matematis Siswa dalam Menyelesaikan Soal Open Ended di SMP*. Jurnal Pendidikan dan Pembelajaran Untan, 6(9).

Kemendagri. 2022. *273 Juta Penduduk Indonesia Terupdate*. https://dukcapil.kemendagri.go.id/berita/baca/1032/273-juta-penduduk-indonesia-terupdate-versi-kemendagri. diakses pada tanggal 2 Mei 2022.

Kemdikbud. 2022. *Standar Nasional Pendidikan Pusat Kurikulum dan Pembelajaran*. https://kurikulum.kemdikbud.go.id/standar-nasional-pendidikan. Dikases pada tanggal 2 Mei 2022.

Kiryak, Z., dan Calik, M. 2017. *Improving Grade 7 Students' Conceptual Understanding of Water Pollution Via Common Knowledge Construction Model.* International Journal of Science and Matemathics Eduvation, 1(1),1-22.

Kowsalya, D. N. 2012. *Development and Validation of a Scale to Asses Self Concept in Mild Intellectualy Disabled Children*. International journalsoc. Sci & Education.

Lestari, Annisa Dwi., dkk. 2021. *Pengembangan Modul Fisika Berbasis Science, Environment, Technology, and Society (SETS) untuk Melatihkan Keterampilan Berpikir Kreatif Siswa SMA Pada Materi Usaha dan Energi*. Jurnal Kumparan Fisika, 4(2), 147-154.

Marwiyah, S., Kamid, dan Risnita. 2015. *Pengembangan Instrumen Penilaian Keterampilan Berpikir Kreatif pada Mata Pelajaran IPA Terpadu Materi Atom, Ion, dan Molekul SMP Islam Al Falah*. Edu-Sains, 4(1).

Munandar, Utami. 2012. *Mengembangkan Bakat dan Kreativitas Anak Sekolah*. Jakarta: Gramedia Widiasarana Indonesia

Nasution, P. R. 2017. *Perbedaan Peningkatan Berpikir Kreatif Matematis dan Kemandirian Belajar Siswa pada Pembelajaran Berbasis Masalah dan Pembelajaran Konvensional di SMPN 4 Padangsidimpuan Puspa*. Peidagogeo, 2(1), 46-62.

Nurhakiki, Euis, dan Tri Isti Hartini. 2020. *Analisis Kemampuan Berpikir Kreatif Pada Pembelajaran Fisika Topik Bahasan Momentum Implus*. Prosiding Seminar Nasional Pendidikan Fisika FITK UNSIQ, 2(1), 174-178.

Putra, Sitiatava Rizema. 2013. *Desain Evaluasi Belajar Berbasis Kinerja*. Jogjakarta: DIVA Press.

Sintya, Wage Klaudhi, Andik P., dan Indra S. 2018. *Penerapan Model Pembelajaran Inkuiri Terbimbing untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa di SMAN 2 Kota Bengkulu*. Jurnal kumparan fisika.

Seyihoglu, A. & Kartal, A. 2010. *The Views of Teaching about Mind Mapping Technique in Elementary Life Science and Social Science Lesson Based Constructivist Method. Educational Science*: Theory & Practice, 10(3), 1637-1656.

Son, A. L. 2019. *Instrumen Kemampuan Pemecahan Masalah Matematis: Analisis Reliabilitas, Validitas, Tingkat Kesukaran Dan Daya Beda Butir Soal*. Gema Wiraloda, 10(1), 41-52.

Sugiyono. 2011. *Metode Penelitian Kuantitatif Kualitatif dan R&D*. Bandung: Alfabeta.

Supriadi, D. 1994. *Kreativitas, Kebudayaan dan Perkembangan IPTEK*. Bandung: Alfabeta

Susanto, Hery, Achi Rinaldi, & Novalia. 2015. Analisis Validitas Reabilitas Tingkat Kesukaran dan Daya Beda pada Butir Soal Ujian Akhir Semester Ganjil Mata Pelajaran Matematika. Al-Jabar, 6(2), 203-217.

Vendiktama, P. R., Mimien H. I, &Endang S. 2016. *Keterampilan Berpikir Kreatif Siswa SMAN 1 Krian Tahun 2016*. Pros. Semnas Pend. IPA Pascasarjana UM, Vol 1.

Wheeler, S., Bromfield, C. & Waite, S. J. 2002. *Promoting Creative Thinking through The Use of ICT*. Journal of Computer Assisted Learning, 18(1), 367-378.

Wulandarai, Astri. 2021. *Analisis Kemampuan Berpikir Kreatif Peserta Didik Kelas Xi Sma Di Masa Pandemi Covid-19 Pada Konsep Elastisitas Dan Hukum Hooke*. Jakarta: UIN Syarif Hidayatullah.

Yulius, Yosandi. 2021. *Manajemen Kreatif dan Inovatif*. Jakarta: UPI Y.A.I

Zubaidah, Siti. 2018. *Mengenal 4C: Learning and Innovation Skills untuk Menghadapi Era Revolusi Industri 4.0.* Prosiding 2nd Science Education National Conference. Malang: Universitas Negeri Malang.