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Analysis of The Relationship Between Cognitive Style and Creativity of Pre-Service Physics Teachers

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Abstract: This research aims to examine the relationship between cognitive style and creativity of prospective physics teachers in terms of two domains of creativity, namely personality and product. This research is quantitative and descriptive. The population of this study was 60 prospective physics teachers who were studying at Mataram University, Indonesia with a sample size of 40 people selected using the Simple Random Sampling technique. The instruments used in this research consisted of the standard Group Embedded Figures Test (GEFT) instrument, the Creative Personality test instrument, and the product creativity observation sheet. GEFT is used to identify differences in the cognitive styles of prospective physics teachers. The Creative Personality test instrument is used to determine the creativity of prospective physics teachers in terms of the aspects of fluency, flexibility, originality, and elaboration. Meanwhile, the observation sheet is used to assess the creativity of prospective teachers in producing products in the form of learning media in terms of novelty, utility, aesthetics, and authenticity. The results of the data analysis show that there is a relationship between cognitive thinking and the creativity of prospective physics teachers. Prospective physics teachers who have the FI cognitive style tend to have a better Creative Personality compared to FD (FI=1.94 > FD=1.44). However, on the contrary, the creativity of products carried out collaboratively shows that the FD group tends to get a better creative score (FI=3.01 < FD=3.41).

Keywords: Cognitive Style; creativity; Pre-Service Physics Teachers

Introduction

Creativity is one of four competencies that every individual must have in the 21st century (Jones et al., 2013; Verawati et al., 2020). Creativity is no longer a compliment but has become the main factor that every individual must have to face the challenges of a dynamic era (Clegg et al, 2006). Without creativity, a person will tend to use outdated (old-fashioned) solution ideas to face new challenges or problems even though sometimes the solutions or solutions offered are no longer appropriate to the situation and conditions (Kusuma, 2010).

Creativity is defined differently depending on the point of view used by the definition maker. Based on emphasis, definitions of creativity can be divided into process, person, and product dimensions (Amabile, 1983). A definition of creativity that emphasizes the process aspect was expressed by Munandar (1977): "Creativity is a process that manifests itself in fluency, in flexibility as well as in originality of thinking". A definition that emphasizes the personal dimension was put forward by Guilford (1950): "Creativity refers to the abilities that are characteristics of creative people". Barron (1976) emphasized the product aspect, namely: "the ability to bring something new into existence"; while Amabile (1983) stated, "Creativity can be regarded as the quality of products or responses judged to be creative by appropriate observers". Mayer (Kharkurin, 2014), Corazza (2016), and Runco & Jaeger (2012) created a standard definition for creativity, namely activities or products that contain elements of originality and effectiveness. From the opinions above, it can be concluded that creativity is a person's ability to give birth to something new, either in the form of an idea or a real work, which is relatively different from what has existed before.

As explained above, creativity can be divided into three dimensions, namely process, person, and product

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(Amabile, 1983). Of these three dimensions, the criteria or indicators of creativity that are most widely used in research are person and product creativity (Supriadi, 1994). This process criterion is rarely used in research, because it is considered not to touch the core issue, namely real creative work.

Creative Personality according to Guilford is in the cognitive dimension. According to this theory, creative people have personalities and thoughts that are significantly different from less creative people. Guilford, Torrance, Silver, and Munandar explained 4 (four) personality characteristics of creative people, namely; fluency, flexibility, originality, and elaboration (Busyairi, 2021). Fluency is the ability to generate many ideas, ideas, and answers, solve problems and questions, provide many ways or suggestions for doing various things, and always think of more than one answer. Flexibility is the ability to see questions or topics from various perspectives or points of view, as well as being able to change approaches or ways of thinking. Originality is being able to give birth to new and unique expressions, thinking of unusual ways to express oneself, and being able to create unusual combinations of elements. Elaboration is the ability to produce ideas, ideas, or solutions that are equipped with detailed and interesting reasons and explanations. (Isaksen, 1995; Silver & Edward, 1997; Treffinger, et al., 2006; AL-Khatib, 2012).

Creative products emphasize aspects of creative products whose degree of creativity is assessed by expert observers. Amabile (1983) stated that a product is said to be creative if according to the assessment of an expert or observer who has authority in that field, it is creative. Thus, creativity is the quality of a product or response that is considered creative by expert observers. This criterion is seen as the most explicit for determining a person's creativity, so it is called the "peak criterion" for creativity (Amabile, 1983; Shapiro, 1973). Mayer (Kharkurin, 2014), Corazza (2016), Runco & Jaeger (2012), Boden (2004), Simonton, 2012, Piffer (2012) and Kharkurin (2014) explain 4 (four) criteria for creative products, namely; Novelty, Utility, Aesthetic, and Authentic.

The influence of thinking styles on students' creativity has long been discussed in the past (Ward, & Kennedy, 2017) of the 20th century when Guilford proposed a multifactorial Structure Model of Intellect (Guilford, 1967) in which creative thinking includes convergent thinking (CT) and thinking. divergent (DT). CT is stated as the ability to think to find the best (single) solution to a given problem. DT is expressed as the ability to find many solutions to a given problem. People who have a divergent thinking style tend to be more fluent and flexible in their thinking (Runco, & Acar, 2012). This thinking style is also called cognitive style. Cognitive style is an important factor that can determine a person's creative tendencies (Lei, 2022).

Cognitive style is a person's style or characteristics in responding, processing, storing, thinking, and using information to respond to a task or various types of environmental situations (Kozhevnikov, 2007). Witkin divides cognitive style into two forms, namely field-independent (FI) and field-dependent (FD) (Onyekuru, 2015). Individuals who have a field-independent cognitive style tend to think analytically, in detail, competitively, and individualistically, are not easily influenced by external factors (internal references), and tend to rely on intrinsic motivation. Meanwhile, someone who has a field-dependent cognitive style is more group-oriented, thinks globally, is sensitive to social interactions, accepts criticism, is easily influenced by external factors (external references), and tends to rely on extrinsic motivation (Ford & Chen, 2001; Altun & Cakan, 2006). The aim of this research is to determine the extent to which cognitive style can influence the creativity of prospective physics teachers, especially for the dimensions of Creative Personality and Products.

Method

This research is quantitative descriptive research. This research aims to determine the relationship between cognitive style and the creativity of prospective physics teachers. The population of this study was 60 prospective physics teachers who were studying at Mataram University, West Nusa Tenggara, Indonesia. The number of samples used was 40 people selected using the Simple Random Sampling technique.

There are three main instruments used in this research, namely the standard Group Embedded Figures Test (GEFT) instrument, the person creativity test instrument, and the product creativity observation sheet. GEFT (Group Embedded Figures Test) is a form of standard test developed by Witkin, et.al., (1971). The GEFT standard test instrument consists of 25 image pattern items. The 25 image pattern items are divided into 3 parts. The first part consists of 7 items with very simple image patterns, and the second and third parts each consist of 9 items. In this test, prospective teachers have to find simple pictures hidden in complex pictures. This test aims to determine and classify the cognitive styles of prospective teachers into two forms of cognitive styles, namely field-independent (FI) and field-dependent (FD). The personal creativity test instrument used in this research is in the form of descriptive questions in the form of open problems which enable prospective physics teachers to provide various solutions/answers (Wang et.al., 2002). This instrument is used to determine the level of fluency, flexibility, originality, and elaboration of prospective physics teachers. Meanwhile, observation sheets are used to assess the creativity of prospective teachers in producing

products in the form of learning media. The creativity indicators in this research use Cropley (2013) and Kharkhurin (2014) product creativity indicators, namely: novelty, utility, aesthetics, and authenticity.

By considering the characteristics of the problem given, the assessment technique used in this research adapts the assessment and categorization technique developed by CCSS ELA (Busyairi, 2022), namely as follows.

Table 1. Techniques for scoring Creative Personality

Category	Fluency	Flexibility	Originality	Elaboration.
High	Can provide ≥ 3 relevant solutions	Can provide ≥ 3 relevant solutions and from different points of view	Can provide ≥ 3 relevant and unique solutions	Can provide ≥ 3 relevant, detailed, and interesting explanations of each given solution.
Moderate	Can provide 2 relevant solutions	Can provide 2 relevant solutions and from different points of view	Can provide 2 relevant and unique solutions	Can provide 2 relevant, detailed, and interesting explanations of each given solution.
Low	Can only provide 1 relevant solution	Can only provide 1 relevant solution	Hanya dapat memberikan 1 solusi yang relevan dan unik	Can only provide 1 relevant, detailed, and interesting explanation of each given solution.
Not Creative	Unable to provide relevant solutions	Unable to provide relevant solutions	Unable to provide relevant and unique solutions	Unable to write a relevant, detailed, and interesting explanation of any given solution.

The personal creativity categorization technique can be seen in Table 2.

Table 2. Categories of creative personality

Average score	Category
$2{,}25 < \boldsymbol{x} \leq \mathbf{3{,}00}$	High
$1{,}50 < \boldsymbol{x} \leq \mathbf{2{,}25}$	Moderate
$0{,}75 < \boldsymbol{x} \leq \mathbf{1{,}50}$	Low
$0{,}00 \leq \boldsymbol{x} \leq \mathbf{0{,}75}$	Not Creative

Meanwhile, the scoring and categorization technique for product creativity is based on the Likert scale questionnaire scoring and categorization technique, which is as follows (Ratumanan & Laurens, 2011).

Table 2. Categories of creative Product.

Average score	Category
$3{,}25 < \boldsymbol{x} \leq \mathbf{4{,}00}$	High
$2{,}50 < \boldsymbol{x} \leq \mathbf{3{,}25}$	Moderate
$1{,}75 < \boldsymbol{x} \leq \mathbf{2{,}50}$	Low
$1{,}00 \leq \boldsymbol{x} \leq \mathbf{1{,}75}$	Not Creative

Result and Discussion

Comparative data on the personality creativity of prospective physics teachers in terms of learning styles can be seen in the following graph.

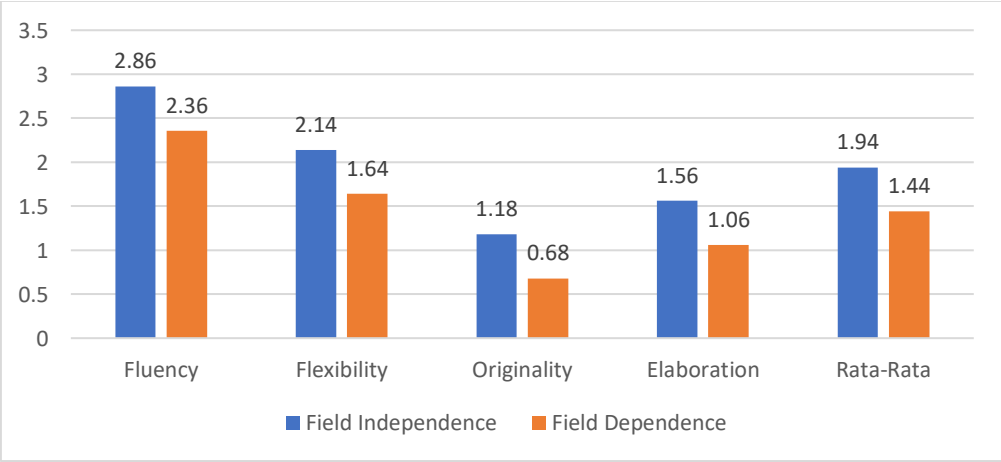

Figure 1. Comparison of creative personality in terms of cognitive style

The data in the graph above shows that the average personality creativity of prospective physics teachers who have the Field Independence (FI) cognitive style tends to be higher than Field Dependence (FD). The personality creativity of prospective physics teachers who have the FI cognitive style is included in the Moderate category (1.94) while FD is included in the low category (1.44). If we look at each indicator of

personality creativity, starting from fluency, flexibility, Originality, and Elaboration, FI tends to be higher for all indicators of personality creativity compared to FD.

The form of test instrument used to measure personality creativity in this research is an open problem whose solution requires analytical, critical, and creative problem-solving skills. Someone who has the FI cognitive style is an individual who has an impersonal orientation, chooses an individual profession, prioritizes analytical and systematic thinking skills (convergent thinking), and prioritizes motivation from within oneself. Someone who thinks convergently tends to be more critical, and analytical and has better solving abilities compared to people who think divergently. This statement is reinforced by research results (Ulya, 2015) that students who have the FI cognitive style have better problem-solving abilities compared to students who have the FD cognitive style. Furthermore, Zhang (2014) explained that individuals who have an FI cognitive style usually show less difficulty in separating information from the surrounding context and generally focus more on relevant information, inhibiting attention to the arrival of irrelevant information.

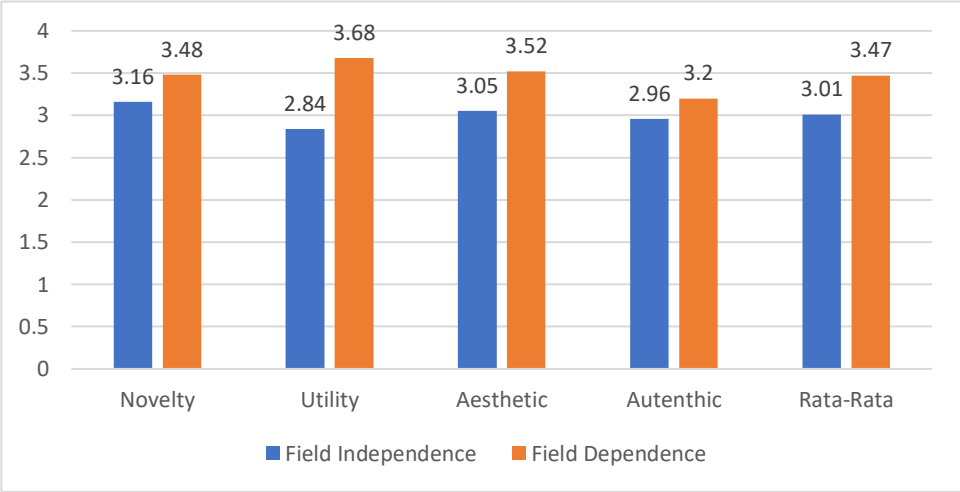

Figure 2. Comparison of creative products in terms of cognitive style

The data in the graph above shows that the average product creativity of prospective physics teachers who have the Field Dependence cognitive style tends to be higher than that of Field Independence. The product creativity of prospective physics teachers who have the Field Independence cognitive style is included in the Moderate category (3.01) while Field Dependence is included in the high category (3.47). Furthermore, if we look at all indicators of product creativity, it can be seen that prospective teachers who have the FD cognitive style are always greater than FI for all aspects of creativity (novelty, utility, aesthetics, and authenticity).

By looking at the characteristics of the two groups of cognitive styles, it can be seen that someone who has a field-independent cognitive style tends to be closed, does not accept criticism, and is too self-confident so he always views problems from his own point of view. In contrast to field dependence, someone who has a field-dependent cognitive style tends to more easily accept criticism, suggestions, and other people's points of view so that the product produced is more universal in accordance with the needs of many people (utility). Therefore, creativity, especially for the usefulness aspect, shows a greater FD score than FI. Moreover, the products in this research were completed in groups (collaboratively). The usefulness referred to here can be seen in whether the resulting media can clarify the concepts conveyed by the teacher, represent actual natural phenomena, make it easier for teachers to convey teaching material, is able to stimulate and motivate students and act as a medium for conveying messages between teachers and students.

For the aesthetics aspect, it can be seen that FD's creativity score tends to be greater than FI's. This means that prospective physics teachers who have the FD cognitive style tend to pay more attention to or take into account the factors of beauty, neatness, attractiveness, suitability, ease of operation, and color harmony in creating learning media. Likewise, for the authenticity aspect, the creativity scores of prospective physics teachers who have FD cognitive richness tend to be better than those with FI. The authenticity aspect relates to whether the media product produced is truly authentic and is an idea that comes from within the student. and authenticity together.

Conclusion

It can be concluded that there is a relationship between cognitive thinking and the creativity of prospective physics teachers. Prospective physics teachers who have the FI cognitive style tend to have a better Creative Personality compared to FD. The personality creativity of prospective physics teachers who have the FI cognitive style is included in the Moderate category (1.94) while FD is included in the low category (1.44). However, on the contrary, the creativity of products carried out collaboratively shows that the FD group tends to get better creative scores. The product creativity of prospective physics teachers who have the FI cognitive style is included in the Moderate category (3.01) while FD is in the high category (3.47)..

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