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Students' Critical Thinking Ability in Solving PISA Problems Based on Field Dependent and Field Independent Cognitive Styles

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ABSTRACT: This study aims to describe students' critical thinking skills based on students' cognitive styles, namely field dependent (FD) and field independent (FI). The research subjects consisted of 4 students of class VIII-B of SMP Negeri 4 Jember which consisted of 2 FD students and 2 FI students. The data collection technique in this research is a test technique in the form of a GEFT test to measure students' cognitive style and a student's critical thinking ability test in the form of PISA questions with Quantity and Space and Shape content and non-test techniques in the form of interviews. The results showed that (1) subjek FD only capable on ability 4; (2) subjek FI capable on all ability of critical thinking according to (Ennis, 2011); This study suggests teachers to familiarize FD and FI students to develop observational skills and provide various information about definitions or understandings in a given material so that students are able to use correct evidence and be able to act by providing further explanations.

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Cognitive Styles, Critical Thinking, PISA

1. INTRODUCTION

Mathematics is a broad science and its influence is very large on everyday life. The role of mathematics as a basic science is very important in the development of science and technology, because mathematics is a means to develop reasoning power, logical, systematic, and critical thinking (Arafah, Kurniati, Lestari, Pambudi, & Yuliati, 2023; Kurniati & As'ari, 2021). In addition to the difficulty of progress and development regarding science and technology, abilities are also discussed which include critical, creative, and logical thinking abilities (Chairunnisak, 2020; Changwong, Sukkamart, & Sisan, 2018) The main ability needed is critical thinking ability.

Critical thinking skills are an effort made by students to find solutions through in-depth thinking processes, rechecking, and reasonable reasoning so that the results of the decisions obtained are not in doubt (Sima, Jamiah, & Yusmin, 2022). The desire or inspiration to find answers and understand concepts is effectively demonstrated by students' critical thinking processes (Rani, Napitupulu, & Hasratuddin, 2018). Several studies have shown that students' critical thinking is classified as low. This is supported by (Fatmawati, Mardiyana, & Triyanto, 2014) around 72.2% of students with low critical thinking skills. This is also evidenced by the results of a survey from PISA (Program for International Student Assessment). PISA is a study conducted by the OECD (Organization for Economic Co-operation and Development), where the study assesses students' abilities. The achievements of 15-year-old students in PISA in reading, mathematics, and science are studied every three years. PISA is not based on a national curriculum. Instead, its purpose is to assess core knowledge and skills essential for participation in modern society and to examine how students can apply knowledge in different settings (Pulkkinen & Rautopuro, 2022). PISA provides robust data on, among others, indicators of IBT (Inquiry-based teaching), critical thinking, and school climate (Gómez & Suárez, 2020). Indonesia's participation in the PISA test is to find out how education programs in developing countries compare to other countries in the world. According to the results of research conducted by PISA, students' mathematics abilities in Indonesia are still low when compared to other countries. In the last study in 2015, Indonesia was ranked 62 out of 70 countries (OECD, 2016).

The PISA test is different from other learning achievement tests because the PISA test focuses more on how students apply the knowledge and concepts they receive to problems related to everyday life (Polat, 2022). Each student has their own way of solving problems. Various strategies will also be driven by the habits of each student (Bailey, 2022).

Therefore, the processing of information in solving problems for each student is different. The selection of different solutions is due to cognitive styles (Putri, Husna, & Agustyaningrum, 2021; Vendiagrys, Junaedi, & Masrukan, 2014) In addition to the importance of critical thinking in solving problems, several studies have stated that cognitive style also has a very important role (Syafiti, Budayasa, & Masriyah, 2022). Cognitive style is needed to process information and solutions systematically in mathematics (Nisa *et al.*, 2024; Silma, Sujadi, & Nurhasanah, 2019). Differences in finding ways to solve problems will also differ from students' critical thinking abilities, because when students have different cognitive styles, the way they solve problems will also be different, so these differences will trigger differences in critical thinking (R Nisa', 2016).

Cognitive style is a variation in the way individuals understand information, remember, and think (Lwande, Muchemi, & Oboko, 2021; Yuliana, Waluyo, & Halqi, 2021). Cognitive style is an individual's characteristic of consistent information processing such as understanding, organizing, analyzing and solving problems (Sholahuddin, Susilowati, Prahani, & Erman, 2021). Witkin classifies this cognitive style into two, namely field independent (FI) and field dependent (FD) cognitive styles (Busyairi, Harjono, & Zuhdi, 2022). FI cognitive style is an individual's cognitive style with a high level of independence in observing a stimulus without dependence on the teacher, while FD cognitive style is a person's cognitive style that tends to be very dependent on information sources from the teacher (Mohammadi & Amjadiparvar, 2022). So the difference between the two cognitive styles is seen in terms of dependence on the teacher's explanation will produce different critical thinking skills, especially in mathematics learning (Rifqiyana, 2015)

According to research conducted by (Khairat & Fauzan, 2019) states that statistically there is a relationship between cognitive style and students' critical thinking skills, students who have a cognitive style FD show a fairly high ability in identifying assumptions, while students who have a cognitive style FI show a fairly high ability in checking the truth of statements, formulating questions and solving mathematical problems. The results of an interview with one of the teachers at SMP Negeri 4 Jember obtained information that the critical thinking skills of grade VIII students are relatively low, so this study aims to describe students' critical thinking skills based on their cognitive style using PISA questions and also to introduce PISA questions to grade VIII students of SMP Negeri 4 Jember. Students' critical thinking skills in solving PISA questions based on their cognitive style need to be known because they are useful for teachers to assess how high students' abilities are and students' readiness to answer PISA-type questions contained in the AKM questions or upcoming exams and to find out what causes the low critical thinking of these students. Based on the description above, a study will be conducted entitled "Students' Critical Thinking Skills in Solving PISA Questions Based on Field Dependent and Field Independent Cognitive Styles".

2. LITERATURE REVIEW

2.1 Critical Thinking

One of the most important thinking skills for someone to have is critical thinking (Arafah et al., 2023). Critical thinking means thinking correctly in pursuing relevant and reliable knowledge about the world (Nurmayani, 2020). Basically, critical thinking depends on two dispositions, the first is the effort to be able to do something right, to be honest and clear to convince someone of the answer. Second, it depends on the evaluation process applied to determine the criteria for assessing the possibility of correct answers that will appear either explicitly or implicitly (Kholid, Hamida, Pradana, & Maharani, 2020).

How to find out someone's critical thinking ability can be linked to the critical thinking indicators put forward by several experts, according to (Ennis, 2011) there are 12 indicators of critical thinking ability which are summarized in 5 stages, namely as follows: (a) **basic classification**, this stage is divided into three indicators, namely (1) formulating questions, (2) analyzing arguments, (3) asking and answering questions; (b) **providing reasons for a decision**, this stage is divided into two indicators, namely (1) assessing the credibility of information sources and (2) conducting observations and assessing observation reports; (c) **concluding**, this stage is divided into three indicators, namely (1) making and assessing deductions, (2) making and assessing inductions, and (3) evaluating; (d) **further clarification**, this stage is divided into two indicators, namely (1) defining and assessing definitions, and (3) identifying assumptions; and (e) **assumptions and integration**, this stage is divided into two indicators, namely (1) guessing and (2) integrating.

2.2 Cognitive Styles

Cognitive style is a term used in cognitive psychology to describe the way individuals think, understand, and remember information. Cognitive style is a difference in intellectual behavior, thinking, and memory, which influences individual behavior and activities both directly and indirectly (Setiawan, Degeng, Sa'dijah, & Praherdhiono, 2020). Cognitive style reflects individual characteristics in learning. Cognitive style is very important because it determines how individuals process information when solving problems, making decisions, or when interpreting stimuli and responses (Surur, Degeng, Setyosari, & Kuswandi, 2020). So that it can influence students in solving mathematical problems. A person with a field dependent cognitive style generally has a high social attitude, is able to blend in with the environment around them, and usually has empathy and understands the thoughts of others. For someone with a field independent cognitive style tends to have an individualistic, competitive, and more confident attitude. There are several types of measuring instruments used to identify cognitive styles. Crozier (in Haloho, 2016) said that the differences in cognitive styles of FI and FD can be studied using the EFT (The Embedded Figure Test) or RFT (The

Rod and Frame Test) measuring instruments. Witkin developed EFT into GEFT (Group Embedded Figure Test) and CEFT (Children's Embedded Figure Test). In this study, the GEFT test was used.

2.3 PISA

PISA (Programme for International Student Assessment) is a study of an international student assessment program organized by the Organisation for Economic Cooperation and Development (OECD). PISA is a comprehensive international survey program that basically assesses students' reasoning abilities which also include critical thinking skills (Katoningsih & Sunaryo, 2020). One of the mathematics activities that supports students' ability to think mathematically is PISA mathematics problems (Satiti & Wulandari, 2021). PISA is designed to collect three-year assessment information to determine students' literacy skills, especially in reading, mathematics and science. The components of mathematics content according to PISA (OECD, 2010) are divided into four parts, namely: 1. Space and Shape; 2. Change and Relationship; 3. Numbers (Quantity); 4. Uncertainty and Data.

3. METHODOLOGY

The method used in this study is a qualitative descriptive method. Qualitative descriptive research produces data that describes 'who, what, and where events or experiences' from a subjective perspective (Kim & Park, 2017). The area used as a research location is SMP Negeri 4 Jember with research subjects in class VIII-B. The steps taken in this study began with the preparation of research instruments in the form of GEFT test questions to see students' cognitive styles adopted from (Shofia et al., 2018) PISA questions on Quantity and Space and Shape content for critical thinking ability tests and interview guidelines then conducting instrument validation tests carried out by the validator. The validity category is determined based on Table 1.

Table 1. Validity Category

V_a Value	Category
$1 \leq V_a < 2$	Not Valid
$2 \leq V_a < 3$	Enough Valid
$V_a = 3$	Valid

If the instrument has at least reached the category of sufficient or valid, and has received a few revisions by the validator, then the instrument can be used. If the instrument is not valid or there are still some revisions in certain parts, then revisions are made until the instrument reaches the category of sufficient or valid.

The next step is to give the GEFT test, analyze the results of the students' GEFT tests, then from the test results students with FD and FI cognitive styles are selected, in this case the students selected are 4 students with 2 weak and strong cognitive styles each, namely weak FD (FDL), strong FD (FDK), weak FI (FIL) and strong FI (FIK) through consideration of the highest and lowest scores and the ability to express opinions and their way of thinking, the grouping of strong and weak categories aims to find out and compare critical thinking skills between the two categories. Furthermore, the students will work on PISA questions and be interviewed to dig up more information from students' critical thinking skills. Data validity testing is carried out using the triangulation method.

4. RESULTS AND DISCUSSION

The results of the analysis of the validation data of the PISA test questions and interview guidelines obtained Va values of 2.78 and 2.67, respectively. Based on the instrument validation criteria in Table 1. the instrument is declared valid enough so that it can be used in research.

The Group Embedded Figure Test (GEFT) was conducted on March 22, 2022, which was attended by all class VIII-B of SMP Negeri 4 Jember as many as 21 students. The results of the GEFT test analysis showed that out of 21 students, 14 students had a field dependent cognitive style and 7 students had a field independent cognitive style. The results of the students' GEFT tests can be seen in Figure 1.

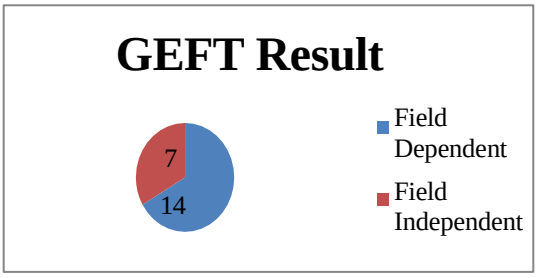

Figure 1. GEFT Test Results

The critical thinking ability test was conducted on March 28, 2022. This test was completed by 4 students with each weak and strong cognitive style, then an interview was conducted to dig up further information about students' critical thinking abilities based on cognitive style. The results of the description of students' critical thinking abilities on each question from the analysis of student work results and interviews are presented as follows.

Critical Thinking Skills Field Dependent (FD) Subjects

The following is an example of data analysis conducted on the FDL subject in question number 2.

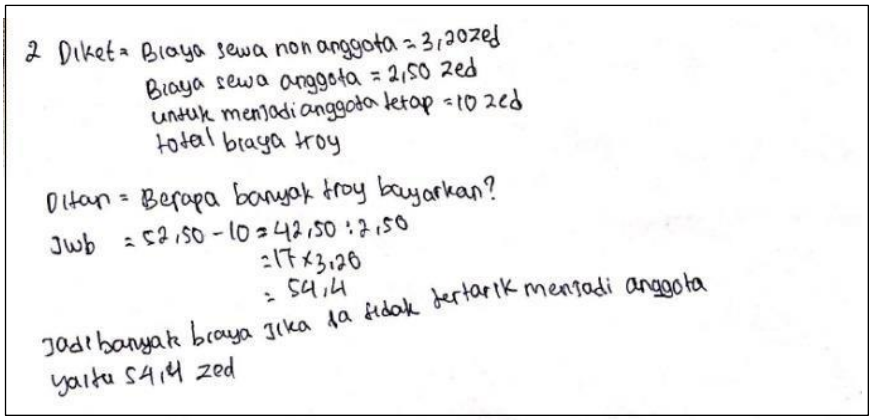

Figure 2. Results of the FDL Subject's Work in Question Number 2

From the results of the FDL subject's answers, the indicators of critical thinking skills achieved by the FDL subject are then determined. The following is an analysis of the FDL subject's answers to question number 2.

Table 2. Analysis of FDL Subject Answers to Question Number 2

No	Critical Thinking Ability	The Answer
1	Formulate the problem	Berapa banyak Troy bayarkan?
2	Determine the existing facts	Biaya sewa non anggota = 3,20 zed Biaya sewa anggota = 2,50 zed Untuk menjadi anggota tetap = 10 zed
3	Use the correct evidence	Total Biaya Troy 52,50-10 = 42,50
4	Draw conclusions according to the facts	Jadi, banyak biaya jika ia tidak tertarik menjadi anggota yaitu 54,4 zed
5	Act by providing explanations	15,75 x 81
6	Combine tendencies and abilities in making decisions	52,50-10 =42,50:2,50 =17x3,20 =54,4

From the results of the answers, they were then triangulated with the results of interviews with FDL subjects. The following are the results of data analysis on FDL subjects on question number 2.

Table 3. Critical Thinking Ability Data Analysis for FDL Subjects on Question Number 2

No	Sub Indicator	Test	Interview	Conclusion
1	Formulate the problem	Many shortcomings (2)	Many shortcomings (2)	Less capable
2	Determine the existing facts	Many shortcomings (2)	Many shortcomings (2)	Less capable
3	Use the correct evidence	Incomplete (3)	Incomplete (3)	Less capable
4	Draw conclusions according to the facts	Capable (4)	Capable (4)	Capable
5	Act by providing explanations	Incomplete (3)	Incomplete (3)	Less capable
6	Combine tendencies and abilities in making decisions	Incomplete (3)	Incomplete (3)	Less capable

The results of the data analysis show that FDL subjects were only able to master sub-indicator 4, namely drawing conclusions according to facts, while FDK data analysis was able to master sub-indicators 2 and 4.

Critical Thinking Skills Field Independent (FI) Subjects

The following is an example of data analysis conducted on the FIK subject in question number 2.

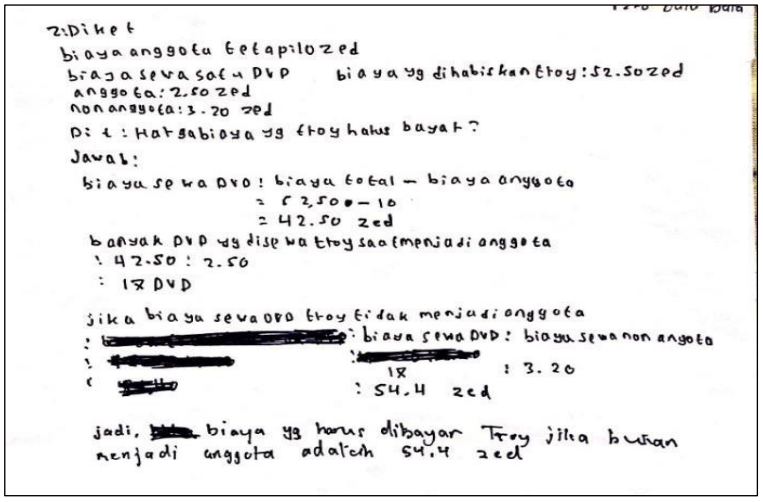

Figure 3. Results of the FIK Subject's Work in Question Number 2

From the results of the FIK subject's answers, the indicators of critical thinking skills achieved by the FIK subject are then determined. The following is an analysis of the FIK subject's answers to question number 2.

Table 3. Analysis of FDL Subject Answers to Question Number 2

No	Critical Thinking Ability	The Answer
1	Formulate the problem	Harga biaya Troy habis bayar?
2	Determine the existing facts	Biaya anggota tetap = 10 zed Biaya sewa satu DVD anggota = 2,50 zed
3	Use the correct evidence	Biaya sewa DVD = biaya total – biaya anggota = 52,50 – 10 zed = 42,50 zed Banyak DVD yang disewa Troy selama menjadi anggota = 42,5 : 2,50 = 17
4	Draw conclusions according to the facts	Jadi, biaya yang harus dibayar Troy jika bukan menjadi anggota adalah 54,4 zed
5	Act by providing explanations	Jika biaya sewa DVD Troy tidak menjadi anggota = biaya sewa DVD : biaya sewa non anggota = 17 x 3,20 = 54,4 zed
6	Combine tendencies and abilities in making decisions	Biaya sewa DVD = biaya total – biaya anggota = 52,50 – 10 zed = 42,50 zed Banyak DVD yang disewa Troy selama menjadi anggota = 42,5 : 2,50 = 17 Jika biaya sewa DVD Troy tidak menjadi anggota = biaya sewa DVD : biaya sewa non anggota = 17 x 3,20 = 54,4 zed

From the results of the answers, they were then triangulated with the results of interviews with FIK subjects. The following are the results of data analysis on FIK subjects on question number 2.

Table 3. Critical Thinking Ability Data Analysis for FDL Subjects on Question Number 2

No	Sub Indicator	Test	Interview	Conclusion
1	Formulate the problem	Capable (4)	Capable (4)	Capable (4)
2	Determine the existing facts	Capable (4)	Capable (4)	Capable (4)
3	Use the correct evidence	Capable (4)	Capable (4)	Capable (4)
4	Draw conclusions according to the facts	Capable (4)	Capable (4)	Capable (4)
5	Act by providing explanations	Capable (4)	Capable (4)	Capable (4)
6	Combine tendencies and abilities in making decisions	Capable (4)	Capable (4)	Capable (4)

The results of the data analysis showed that FIK subjects were able to master all sub-indicators, while FIL subjects were only able to master sub-indicators 1, 2 and 4.

Critical Thinking Skills of Field Dependent (FD) Students

The results of this study indicate that the critical thinking skills of FDL and FDK subjects have several similarities and differences. The similarities include being able to formulate problems correctly and completely, being able to use correct evidence, being able to make inductions and assess inductions, being less able to act by providing further explanations, being less able to combine abilities and tendencies in making decisions. The differences between the two subjects are shown in the indicators of asking and answering questions. The difference is that FDL subjects are less able to determine the facts in the entire question given. While FDK subjects are able to determine the facts in the entire question given. In general, FDK subjects have the ability to determine the facts in the entire question correctly. This is in accordance with (Ulya, 2014) who argues that FDL subjects can write down what is known about the problem clearly but incompletely, while FDK subjects are able to write down what is asked in the question correctly. From this description, the critical thinking skills of FDK subjects are better than the critical thinking skills of FDL subjects. Based on the discussion of FDL and FDK, it can be concluded that FD subjects are only able to master the fourth ability, namely drawing conclusions according to facts.

Critical Thinking Ability of Field Independent (FI) Students

According to (Ngilawajan, 2013)subjects with a score of 10-18 on the GEFT test are included in the Field Independent cognitive style. FI subjects can process information well when compared to FD subjects. This study is in line with this even though there are differences in scores.

The results of this study indicate that the critical thinking abilities of FIL and FIK subjects also have several similarities and differences. The similarities between the two subjects are being able to formulate questions on the entire problem correctly and completely, being able to determine the facts in the entire problem correctly and completely, being able to draw conclusions correctly and completely. The differences between the two subjects are shown in the indicators of conducting observations and assessing observation report results, indicators of defining and assessing definitions and indicators of combining. While FIK subjects are able to master all indicators well. From this description, the critical thinking abilities of FIK subjects are better than the critical thinking abilities of FIL subjects. Based on the discussion of the FIL and FIK subjects, it is concluded that FI subjects are able to master skills 1, 2 and 4, namely formulating problems, determining existing facts and drawing conclusions according to the facts. Based on the discussion of the description of critical thinking skills in terms of cognitive style, the findings in this study are that the critical thinking skills of subjects from the strong group are better than those of subjects from the weak group. In addition, students with the same cognitive style do not always have the same critical thinking skills. This is in line with (Surur et al., 2020) which states that categories of subjects with the same cognitive style do not always have the same level of thinking.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of data analysis and discussion, it can be concluded that FD subjects are only able to master the fourth ability, namely drawing conclusions according to facts with an overall percentage of critical thinking indicators of 79%, then FI subjects are able to master abilities 1, 2 and 4, namely formulating problems, determining existing facts and drawing conclusions according to facts with an overall percentage of critical thinking indicators of 93%. Suggestions from this study are that teachers should accustom FD students to make a list of questions related to the problems given and answer the questions so that students are able to determine the existing facts, teachers should accustom FD and FI students to develop observation skills and provide various information regarding definitions or understandings in a given material, teachers should accustom FD and FI students to involve themselves in discussions so that students are accustomed to analyzing and evaluating opinions so that they are able to combine information with each other.

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