

# Analysis of Field Dependent and Field Independent Cognitive Styles in Solving Science Problems in Elementary Schools

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**Abstract:** This research aims to determine the results of the Science Problem Solving Test, describing students' Field Dependent and Field Independent cognitive styles in solving science problems. The research method used is Mixed Methods, which uses Sequential Explanatory Design. The research results showed that the field-independent and field-dependent students' science problem-solving tests were good. This is proven by using a one-sample t-test with a Sig (2-tailed) result of 0.005, which is smaller than 0.05. The cognitive style of field-dependent students in solving science problems, according to the Polya Stage theory, have difficulty absorbing information, so they do not understand the problem and are unable to explain using their sentences, think globally. The cognitive style of field-independent students in solving science problems is effortless to absorb information so that they can understand the situation thoroughly, analytically, and systematically so that they can present the correct solution steps by determining arithmetic operations that are relevant to the problem.

**Keywords:** Cognitive style; Field dependent; Field independent; Solving science problems

## Introduction

Science is one of the extracurricular lessons in the independent curriculum that students must take at various levels, especially in elementary school (Hardiansyah et al., 2022). Not all students think that science is a fun science, but some students believe that science is a complex and very dull subject because, when learning science, most teachers only explain the material and use the lecture method, and science material is a concept that is still abstract (Qian et al., 2020). Therefore, teachers must create a fun learning atmosphere for students and exciting learning strategies. Teachers must be able to eliminate students' negative views and fears in science learning and create a fun and creative learning atmosphere (Lacko et al., 2021).

Science learning trains and teaches students to think logically and analytically and trains students' literacy and numeracy skills (Gao et al., 2022; Menap, Bayani et al., 2021). This is in line with (Franić &

Drnovšek, 2019), who says that science learning equips students to think logically, analytically, and systematically and can solve problems in everyday life. Therefore, science learning is essential as the initial capital for students to improve their literacy and numeracy skills. One of the goals of learning science is that students can combine the knowledge they have to solve problems and focus more on processes and strategies in solving science problems (Hardiansyah et al., 2023).

In solving problems, students have different abilities and methods; not only that, but how they capture and receive learning is also another. Through problem-solving, students are also able to find solutions to the problems they face (Wang et al., 2022). Problem-solving is not just about students being able to solve problems; it must also provide challenges for students, meaning they can analyze, understand, and solve problems well. Students' thinking abilities depend on the quality of their understanding of concepts and are very influential in the problem-

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solving process (Armstrong et al., 2020; Yun et al., 2022). Students' thinking abilities vary according to the characteristics and learning styles of the students. Therefore, an essential element that teachers must pay attention to is the student's cognitive style (Kitayama et al., 2019).

Cognitive style is a person's ability to absorb, learn, organize, and process information to solve problems and apply it in everyday life (Hardiansyah & Wahdian, 2023). This is in line with (Aggarwal & Woolley, 2019), who says that style Cognition is how a person processes, stores, and uses information to respond to a task or various environmental situations. A teacher must know the cognitive style or thinking style of students in problem-solving activities, especially mathematics lessons. If the cognitive styles and problem-solving processes between students are known, then the teacher can optimize each student's strengths (Margunayasa et al., 2019).

Psychologically, cognitive styles are divided into 2, namely, field-dependent and field-independent. The two cognitive styles have different characteristics (Na et al., 2020). Field-dependent cognitive style is a cognitive style or student's thinking ability that is dependent (tied to) sources of information from the teacher and is social (does not stand alone), while field-independent cognitive style is a cognitive style or student's thinking ability that is spirited (free), not bound with other people and is not dependent on teachers and has a high level of independence (individual) in observing information (Zhou et al., 2023).

The most fundamental difference between field-dependent and field-independent cognitive styles lies in the advantages and disadvantages of each (Koc et al., 2019). Students with a field-dependent cognitive style have benefits, including being stronger at remembering information of a social nature, such as interpersonal conversations, preferring and quickly understanding learning such as languages, social sciences, history, and literary lessons (Aggarwal et al., 2019). The disadvantage is that students with a field-dependent cognitive style are less good at solving problems and prefer to avoid learning mathematics, natural sciences, and exact learning. Meanwhile, students with a field-independent cognitive style have advantages, such as students who find it easier to explain complex things, find it easier to solve problems, and like learning mathematics and natural sciences as well as exact learning (Chuang et al., 2021). The weakness of students with a field-independent cognitive style is that they don't like and need help understanding social learning, such as social sciences, history, literature, and non-exact education (Hardiansyah & Mas'odi, 2022; Hardiansyah & Mulyadi, 2022).

The problem that often occurs when students solve science problems is that students need help understanding the meaning of the questions given by the teacher due to the different thinking abilities of each student and students' lack of interest in learning science (De Keersmaecker et al., 2020). Apart from that, there is a lack of accuracy in analyzing the questions, and they are in a hurry when working on science questions, so the answers they get are not entirely correct. Many students must improve when working on science questions due to carelessness or lack of accuracy, errors in understanding the questions, and errors in transforming information (Andri Nugroho, 2023). A unique thing happened to a student who was thought to be able to solve the problem, but the process was prolonged. Because these students are careful and thorough in working on the questions and then correcting them again before collecting them, the teacher is happier with students like this because the majority answer the questions correctly and get good results (Usmiyatun et al., 2021).

Based on researchers' findings in one of the elementary schools located in Sumenep district, students have different cognitive styles; there are students with high abilities, meaning students can solve questions well. Some students with low skills need help understanding the meaning of the questions given by the teacher. This can be seen in the average score of students' daily tests in science subjects obtained based on document recording, which is 68, with a minimum completion score of 73. The low competence of students' science knowledge is caused by several things, including teachers not paying attention to students' internal and external factors. Teachers can create optimal learning activities by knowing the factors that influence students' science knowledge competency. The internal factors include body condition, intelligence, interests, talents, motives, and so on, while the external factors are the family environment, school, learning process, learning tools, and so on (Hardiansyah & Zainuddin, 2022). The relationship between internal and external factors dramatically influences students' knowledge competency. The difference between internal and external factors possessed by students is one of the aspects that teachers must pay attention to in designing optimal learning, namely, individual differences in students.

Based on the researcher's experience in solving science problems, it was found that there were students who showed excellent abilities, students who showed ordinary skills, and students who experienced difficulties. In solving problems, almost all students write down systematic steps, starting with writing

down what is known and being asked and then solving the problem. Even though they show similarities in writing recurring problem-solving steps, differences are seen in identifying things that are known and asked about a problem-solving problem, which has implications for differences in problem-solving. This fact shows that different cognitive factors among these students influence problem-solving abilities.

Previous research conducted by Aggarwal et al. (2019) shows a significant contribution between learning style and learning motivation to Indonesian language learning outcomes. Furthermore, research conducted by Menap et al. (2021) also shows a correlation between scientific attitudes and student learning achievement. Research conducted by Margunayasa et al. (2019) shows a significant influence between students' learning styles and science knowledge competencies. Based on the results of previous research, there is a contribution between cognitive style and scientific attitudes toward students' knowledge competence. There is still no research that specifically discusses the analysis of cognitive types in solving science problems for students, so researchers are trying to analyze cognitive techniques in solving science problems. It is hoped that the results of this research can provide maximum contribution to the science learning process and increase teacher sensitivity to the differences in cognitive styles possessed by each student.

In this research, the researcher chose to focus on the field-dependent-field-independent type of cognitive style. The primary difference between the two cognitive styles is in terms of how to see a problem. Based on

several studies in the field of psychology, it was found that individuals with a field-independent cognitive style tend to be more analytical in looking at a problem compared to individuals with a field-dependent cognitive style. The primary characteristics of these two cognitive styles are very suitable for application in research that involves thinking processes in solving natural science problems, which contribute significantly to technological developments in various sectors of society. In addition, the characteristics of these two cognitive styles are in accordance with the conditions of many students encountered by researchers in the field who have not been able to develop critical, creative, productive, and innovative thinking skills optimally to obtain knowledge independently through the scientific process, so this is the reason for researchers to choose the Field Independent-Field Dependent cognitive style to be the focus of the research.

### Method

This type of research uses Mixed Methods, namely a method that combines qualitative and quantitative methods. The research design used is sequential explanatory design, an integrated research method that combines quantitative and qualitative methods sequentially. In the first stage, the researcher uses quantitative methods; in the second stage, researchers use qualitative research methods. Mixed Methods research steps in Sequential Explanatory design.

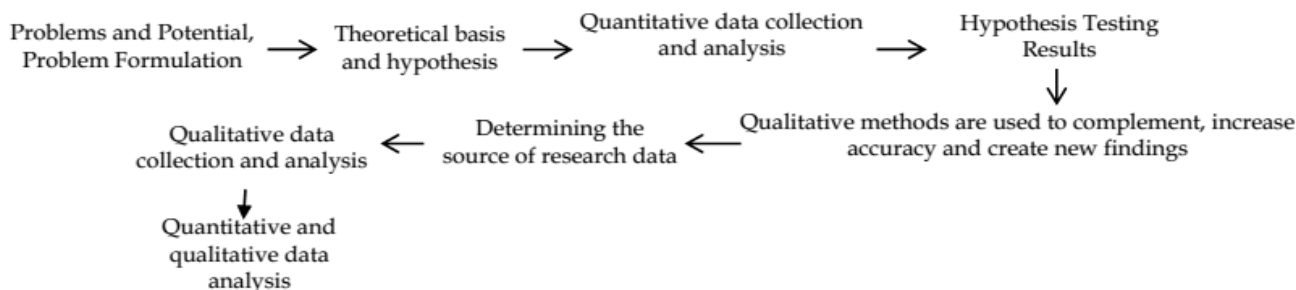


Figure 1. Combination method, sequential explanatory design

Based on Figure 1, it can be explained that in the first stage, the research used quantitative methods, and in the second stage, it used qualitative research methods. Thus, this research is used to answer quantitative problem formulations and qualitative problem formulations, or problem formulations that are different but complementary. The sample in this study was all 4th-grade students at Baban 1 elementary school. The sample determination in this study was

carried out using a cluster sampling technique, namely, taking one class at random.

Data collection techniques in this research: The GEFT test (Group Embedded Figure Test) consists of 25 questions divided into three parts to be taken in 15 minutes. Part 1 consists of 7 questions with a time limit of 3 minutes. Parts II and III each comprised nine questions, which were done for 6 minutes each. Each correct answer was given a score of 1. In this study,

students who scored  $> 9$  were classified as FI and subjects who scored  $\leq 9$  were classified as FD. The Science Problem Solving Test, the test instrument, was created by first studying the science problem-solving ability test grid, then tested on grade 4 students at Pandian 1 Elementary School. The test instrument given to students was a test of students' conceptual understanding ability in the form of essay questions.

The data analysis technique for this research uses a normality test in the form of the Kolmogorov-Smirnov test using the SPSS program; the criteria for whether the sample data is standard or not is that if the significance value is  $> 0.05$ , then the sample is declared to be normally distributed, and statistical analysis uses parametric statistics; hypothesis testing uses one sample t-test. The basis for decision-making is one sample t-test. If the Sig. (2-tailed)  $< 0.05$ , then  $H_0$  is rejected, and  $H_a$  is accepted. If the Sig. (2-tailed)  $> 0.05$ , then  $H_0$  is accepted, and  $H_a$  is rejected. Qualitative data collection techniques include structured observation and structured interviewing, meaning that the researcher uses an interview guide that has been arranged systematically. Interviews were conducted with the research sample, namely all grade 4 students.

## Result and Discussion

### GEFT Test Instrument

The validity test is used to measure the level of validity or authenticity of an instrument. The significant test compares  $r_{count}$  with  $r_{table}$  for the degree of freedom ( $df = n-2$ ; the number of samples is 20 grade 4 students. Decision-making is If  $r_{count} > r_{table}$ , then it can be concluded that all indicators are valid.

**Table 1.** GEFT Validity Test Results

No.	$r_{table}$	$r_{count}$	Information
1	0.468	0.545	Valid
2	0.468	0.788	Valid
3	0.468	0.822	Valid
4	0.468	0.682	Valid
5	0.468	0.501	Valid
6	0.468	0.544	Valid
7	0.468	0.822	Valid
8	0.468	0.541	Valid
9	0.468	0.541	Valid
10	0.468	0.822	Valid
11	0.468	0.549	Valid
12	0.468	0.601	Valid
13	0.468	0.539	Valid
14	0.468	0.578	Valid
15	0.468	0.588	Valid
16	0.468	0.543	Valid
17	0.468	0.599	Valid
18	0.468	0.581	Valid

The validity test results show that all GEFT test items used to determine students' field-dependent and field-independent cognitive styles are valid, as seen from the value of  $r_{count} > r_{table}$ . Furthermore, the reliability test aims to see whether the instrument has consistency if measurements are carried out with the instrument repeatedly. The instrument is reliable if the Cronbach alpha value is  $> 0.6$ .

**Table 2.** GIFT Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
0.906	18

The reliability test results show that all GEFT test items used to determine students' field-dependent and field-independent cognitive styles are reliable.

### Science Problem Solving Instrument Test

The validity test is used to measure the validity of the Science Problem Solving Test instrument. The significant test is carried out by comparing  $r_{count}$  with  $r_{table}$  for the degree of freedom ( $df = n-2$ ; in this case,  $n$  is the number of samples, namely 20 grade 4 students. Decision-making is If  $r_{count} > r_{table}$ , then it can be concluded that all indicators are valid.

**Table 3.** Test the validity of Science Problem Solving

No.	$r_{table}$	$r_{count}$	Information
1	0.468	0.807	Valid
2	0.468	0.676	Valid
3	0.468	0.814	Valid

The validity test results show that all the Science Problem Solving Test items used to determine students' problem-solving abilities are valid. Furthermore, the reliability test aims to see whether the instrument has consistency if measurements are carried out with the instrument repeatedly. The instrument is reliable if the Cronbach's alpha value is  $> 0.6$ .

**Table 4.** Science Problem Solving Reliability Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.628	0.650	3

The reliability test results show that all the Science Problem Solving Test items used to determine students' problem-solving abilities are reliable, as seen from the Cronbach's alpha value of 0.628, which means a high level of reliability. The calculation of differentiating power measures the extent to which the items can distinguish students who have mastered the competency from those who still need to get the competency.



**Table 5.** Differentiating Power Test

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	5.55	2.682	599	353
2	6.40	2.884	265	777
3	5.85	2.239	507	423

Based on the discriminating power test results, the data obtained for all questions 1 and 3 were in the outstanding category with a corrected item-total correlation greater than 0.40. Meanwhile, question number 2 is in the relatively good category. Calculating the difficulty level of a question is a measurement of the degree of difficulty of the question. If the question has a balanced level of difficulty, then it can be good. A test question should be easy enough.

Based on the Difficulty Level Test results, it was found that the difficulty level of questions 1 and 2 was in the easy category. Meanwhile, question number 2 is in the medium category. In this research, the GEFT test research instrument developed by Witkin states that students who answer correctly >9 are categorized as field-independent, and those who answer correctly <9 are classified as field-dependent. From the results of filling in the GEFT Test instrument, the following data was obtained:

**Table 6.** Student Cognitive Style

Cognitive Style	Amount
field-dependent	8
field-independent	12

Based on the cognitive style category of 20 grade 4 students, 8 had a field-dependent cognitive style, and 12 had a field-independent cognitive style. Next, the normality test determines whether the data is usually distributed. The normality test used in this research is the Shapiro-Wilk test, carried out using the SPSS program. Based on the normality test results, the significance value of the Shapiro-Wilk normality test results is 0.126, which means the significance value is > 0.05, so the data is usually distributed.

Hypothesis testing was conducted to determine the results of field-dependent and field-independent students' mathematical problem-solving tests. The researcher used a one-sample t-test to answer the research hypothesis because it fulfilled the prerequisites for the one-sample t-test, namely that the data was normally distributed. The results of the hypothesis testing carried out can be seen in table 7.

Based on the hypothesis test results, Sig (2-tailed), namely 0.005, is smaller than 0.05, so H0 is rejected, and Ha is accepted. Thus, the results of field-dependent and

field-independent students' mathematical problem-solving tests are good.

**Table 7.** Hypothesis testing

Test Value = 61					
		Sig. (2- tailed)	Mean Difference	95% Confidence Interval of the Difference	
T	Df			Lower	Upper
3.174	19	005	13.100	4.46	21.74

The qualitative results of this research were obtained through the results of the Science Problem Solving Test and the effects of interviews conducted by researchers with the subjects. Subjects S3, S7, S8, S11, S14, S15, S16, and S17 with Field Dependent Cognitive Style solve science problems using the Polya Stages, namely understanding the problem, planning a solution, implementing the plan, and checking again. The results of the written test on questions 1, 2, and 3 for subjects S3, S7, S8, S11, S14, S15, S16, and S17 with a field-dependent cognitive style could not understand the questions thoroughly. Subjects S3, S7, S8, S11, S14, S15, S16, and S17 tend to give answers that are less relevant to the questions, so they get answers that are less precise and are less able to carry out problem-solving because the solutions are not complete and there are errors when understanding the form of the questions. Meanwhile, the results of interviews with subjects S3, S7, S8, S11, S14, S15, S16, and S17 said that the questions were quite tricky, and they were not able to understand the questions entirely because when the researcher asked the subjects to re-explain the meaning of the questions using their sentences, the subjects instead read the questions.

Subjects S1, S2, S4, S5, S6, S9, S10, S12, S13, S18, S19, and S20 with Field Independent Cognitive Style solve science problems using the Polya Stages, namely understanding the problem, planning a solution, implementing the plan, and checking again. The written test results of subjects S4, S6, S18, and S20 on questions numbers 1, 2, and 3 subjects S1, S2, S4, S5, S6, S9, S10, S12, S13, S18, S19, and S20 were able to understand the problem thoroughly, directly change story problems into science sentences, and be able to plan solutions well and correctly according to the purpose of the problem. Students also arrange what they will do to solve the question and write the conclusion by reaffirming the answer according to what the question asks. The results of interviews with subjects S1, S2, S4, S5, S6, S9, S10, S12, S13, S18, S19, and S20 said they were able to explain the meaning of questions numbers 1, 2, and 3 using their sentences well and correctly without experiencing any difficulties. In answering questions, students always

recheck the results of their work, feel confident in the answers, and can conclude reasonably and correctly.

When understanding the problem, the field-dependent cognitive style focuses on the solution, pays little attention to searching for answers, and tends to have difficulty absorbing information. Students with a field-dependent cognitive style need help absorbing information (Hardiansyah, 2022). This is in line with the opinion of (Hardiansyah et al., 2023; Lacko et al., 2021), which states that students with a field-dependent cognitive style are immediately focused on solving solutions and do not pay too much attention to the process of finding answers. When planning a solution, the field-dependent cognitive style tends to think globally or use its way when encountering complex problems. Students with a field-dependent cognitive style tend to think globally or use their methods when facing complex issues (Wang et al., 2022). When implementing field-dependent cognitive-style solutions, you get the wrong answer because you need help understanding the problem and planning the solution properly and correctly. This is in line with (Armstrong et al., 2020), who say that field-dependent students solving issues often need help to get the correct answer. At the re-examination stage, the field-dependent cognitive style tends to be in a hurry when doing something so that it is less thorough in what it is doing and feels safe; the important thing is that the work is finished. This is similar to Aggarwal et al. (2019), who says that field-dependent students tend to be in a hurry when doing something, so they are less careful with what they are doing and feel safe; the important thing is that their work is completed.

At the stage of understanding the problem, the field-independent cognitive style tends to be analytical, which means being logical and systematic in collecting relevant information based on facts and being able to break down problems into small and organized parts. This is similar to (Lacko et al. (2021), who say that students with a field-independent cognitive style tend to be analytical, which means they are logical and systematic in collecting relevant information based on facts. At the solution planning stage, the field-independent cognitive style makes it easier to capture information after reading the problem and linking important information to the problem received. This is similar to Ince et al. (2018) and Kuttner (2020), who said that students with a field-independent cognitive style find it easier to capture information after reading the problem and relate important information to the problem they receive. Obtain the correct answer while carrying out field-independent cognitive-style solutions. This is similar to Irawatie et al. (2019) and Kozhevnikov et al. (2022), who says field-independent

students who solve problems can get the correct answer. At the re-examination stage, the field-independent cognitive style tends to be more careful when doing things and is more independent and not easily influenced by others. This aligns with Hardiansyah et al. (2022) and Kallery et al. (2022), who says that field-independent students tend to be careful when doing things and are more independent and not easily influenced by others.

## Conclusion

The results of the field-independent and field-dependent students' science problem-solving tests were good. The cognitive style of field-dependent students in solving science problems, according to the Polya Stage theory, is that they have difficulty absorbing information, so they do not understand the problem and are unable to explain using their sentences, think globally, or use their strategies so they present irrelevant steps, get wrong answers and are in a hurry and a little unsure about the artistry. The cognitive style of field-independent students in solving science problems, according to the Polya Stage theory, is that they readily absorb information. Hence, they can understand the situation thoroughly, analytically, and systematically to present correct and relevant solution steps to the problem, obtain correct and thorough answers, and always recheck the answers.

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## Conflicts of Interest

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