Development of multiple representation based mechanics lectures using dependent and independent field (MR-FD & FI)

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Abstract. This study aims to develop mechanics lectures based on multiple representations using field dependent and field independent cognitive styles (MR-FD & FI), in understanding the mastery of the concept of mechanics. In the context of physics learning based on multiple representations is to combine two or more representations as a form of learning development that is used to understand and convey physics concepts. Cognitive style can be divided into two, namely: dependent field cognitive style (FD) and independent field cognitive style (FI). The third semester student research subjects numbered 21 students from a university in Jakarta Indonesia. The first instrument used consisted of modules containing MR-based content consisting of 4 mechanical contents namely; gravity and central force (GGS), particle system dynamics (DSP), rigid body rotation (RBT) and rigid body rotation in three dimensions (RBT3D) that must be filled. The second instrument is a student worksheet (LKM) in which there are questions in accordance with the indicators and objectives of MR-based lectures undertaken by students. Descriptive quantitative and qualitative research methods were carried out to get a clear picture of the implementation of MR using the cognitive styles of FD and FI. The results showed that most students have a field dependent thinking style (FD) seen in the post-test results on GGS material 61.90%, RBT 61.90%, DSP 57.14% and RBT3D 57.14%. For independent field thinking (FI), the results of post-tests results were 42.86% DSP, RBT 38.10%, RBT3D 38.10% and GGS 33.33%. It is concluded that students' thinking styles can change from thinking styles that were initially field dependent (FD) can change to field independent (FI). This can occur due to various factors, including: 1) Health conditions, classrooms and students focus; 2) The level of difficulty and ease of conceptualization of the material being studied; 3) Basic math and physical abilities. Limitations in this study involve only subjects from small classes from one university, so the results are not strong enough to represent the overall situation, this could be a way to conduct further research with more students and various subjects. This study is the first to map the understanding of the concept of mechanics based on multiple representations using the cognitive style of FD and FI, the results of the study find new discoveries, where all students have a cognitive style of either FD or FI.

1. Introduction

The lecture process for the past 5 years resulted in unsatisfactory learning outcomes. This is based on the findings that students encounter difficulties when attending lectures with many abstract concepts
Individuals who are like this are called Independent Field cognitive style (FI). Witkin describes those individuals who tend to express something apart from the background of the image, and are able to separate themselves from their surroundings or are analytically influenced by the environment. Individual types who are field dependent (FD) are referred to as Dependent Field cognitive style. While individuals who are analytic are individuals who tend to express something apart from the background of the image, and are able to distinguish objects from the surrounding context. They look at their surroundings more analytically.

Classifying students into independent field types (FI) if they are able to separate substances from their context or from the global area, they have analytical tendencies. Whereas students are categorized as Field dependent (FD) if they have a better tendency to recall social information such as conversation and an overall picture of the given context. Summarizing the general tendencies of the learning styles of FI and FD students, namely FI students during the learning process do not follow the standard procedures stated in a problem, he better understands it by transferring the problem to a new structure based on the main concept of the problem. Cognitive style is a typical way of functioning perceptual activities, namely: the habit of giving attention, receiving, capturing, feeling, selecting, organizing stimulus or information and functioning intellectual activities, namely: interpreting, classifying, changing the form of intellectual information. This particular method is consistent and can enter into all behaviors, both in the cognitive and affective aspects. Cognitive style can be divided into two, namely: dependent field cognitive style and independent field cognitive style. In learning activities each individual can be divided into two groups, namely global and analytic.

Individuals who are global are individuals who accept something more globally and have difficulty separating themselves from their surroundings or are more influenced by the environment. Individuals who are like this are called cognitive style Dependent Field (FD). While individuals who are analytic are individuals who tend to express something apart from the background of the image, and are able to distinguish objects from the surrounding context. They look at their surroundings more analytically. Individuals who are like this are called Independent Field cognitive style (FI). Witkin describes...
cognitive style based on global-analytical. Witkin determines the extent to which a person copes with the effects of deceptive background elements when they try to distinguish relevant aspects of a particular situation. The more independent someone is about being deceitful, the more analytic. People who can operate in an analytical way are called dependent fields and people who operate in a global way are called dependent fields. Based on the description above, Witkin distinguishes a person's cognitive style into two types, namely: a. Independent field. People who can overcome the effects of deception by analytic. b. Field dependent.

People who overcome the effects of deception in a global way. Characteristics of individuals who are dependent fields and independent fields, as follows: a) In carrying out a task or solving a problem, an independent field individual will work better if given freedom. Whereas individuals who are dependent fields will work better if given extra instructions or guidance (more). b) Individuals who are independent fields have a tendency not to be easily influenced by the environment, and conversely individuals who are dependent fields have a tendency to be more easily influenced by the environment. c) In completing a task or solving a problem (problem solving) that requires a skill, individuals who are independent fields will produce better than individuals who are field dependent. The classification of individuals into one cognitive style is done by giving a perceptual test. states that The Embedded Figures Test (EFT) is a perceptual test that uses images. The reference to the outer framework which is substituted in the form of a complex picture, which hides a simple picture [9,10].

Characteristics of FI students; 1) Tend to be more comfortable learning by themselves and find (discovery), 2) In proving something more concepts using reasoning skills and have autonomy for their actions, 3) Learning inquiry-based experimental methods, 4) Articulation will perceive analytically, 5) In learning tend not to need intensive guidance, autonomy for their actions, and in proving something the concept can use more reasoning skills, 6) Can separate stimuli in the context, but perceptions are weak when context changes occur, 7) Usually use internal factors as direction in process information, 8) In social situations it is better to feel external pressure, and respond to situations coldly, distance, insensitive. Individuals who have the Field Independent cognitive style have their own characteristics: (1) have the ability to analyze in separating objects from things contained in their environment; (2) has the ability to organize an object; (3) impersonal oriented; (4) choosing a profession that tends to be individual; (5) objectives described individually; and (6) internal reinforcement and intrinsic motivation are preferred. Field dependent if they have a better tendency to recall social information such as conversation as well as an overall picture of the given context.

Characteristics of FD students; 1). In addition to enjoy learning in groups, 2) Students are influenced by figures and pay attention to others, 3) Global perceptual feels a heavy burden difficult to process, easy to perceive if information is manipulated according to context, 4) Need to get guidance and reinforcement from the teacher when learning take place, 5) Tends to be more kind, including being warm, sociable, friendly, responsive, always wanting to know more, when compared to FI people, 6) As often as possible interacting with the teacher and requiring extrinsic reinforcement. 7) In proving something tends to lack the ability of reasoning. Field Dependents have characteristics including: (1) tend to have global thinking; (2) the tendency to accept existing structures, due to lack of restructuring capabilities; (3) has a social orientation so that it looks good, friendly, wise, kind, and loving towards others; (4) tend to choose professions that emphasize skills; (5) tend to follow the goals that already exist; and (6) tend to work with the importance of external motivation and more interested in strengthening external motivation such as praise, gifts, or external motivation from others.

2. Methods
The research subjects are students of Physics Education FKIP - UHAMKA academic year 2018/2019, semester. The study design uses modified development research. The research was conducted at one private university in Jakarta, involving third year undergraduate students (N=21) as participants, started from December 2018 to January 2019. This is a mixed method research quantitative and qualitative triangulation approach.
3. Results

![Graph showing average percentage values for Thinking Style Categories](image)

Figure 1. Analysis results thinking Field Dependent (FD) and Field Independent (FI).

On the data graph analysis of students' thinking patterns, the results are obtained:

- On the matter of gravity and the central force (GGS) the results obtained percentage of pre-test students with FD 42.86% thinking style and 57.14% FI. After being given treatment and post-test results in the percentage of FD 61.90% thinking style and 33.33% FI.
- On the particle system dynamics material (DSP) the percentage of students pre-test results obtained with FD thinking style is 52.38% and FI 47.62%. After being given treatment and post-test results in the percentage of FD 57.14% thinking style and 42.86% FI.
- In the material rotation of rigid objects (RBT), the results obtained percentage of pre-test students with FD 61.90% thinking style and 38.10% FI. After being given treatment and carried out post-tests produced a percentage of FD 61.90% thinking style and 38.10% FI.
- In the material rigid objects in three dimensions (RBT3D) obtained the results of the percentage of pre-test students with FD 66.67% thinking style and FI 33.33%. After being given treatment and carried out post-tests produced a percentage of FD 57.14% thinking style and 38.10% FI.

It is concluded that students' thinking styles can change from thinking styles that were initially field dependent (FD) can change to field independent (FI). This can occur due to various factors, including; 1) Health conditions, classrooms and students focus; 2) The level of difficulty and ease of conceptualization of the material being studied; 3) Basic math and physical abilities.

4. Conclusion

From this it can be concluded that students' thinking styles can change from thinking styles that were initially field dependent (FD) can change to field independent (FI) this can occur due to various factors, including; 1) Health conditions, classrooms and students focus; 2) The level of difficulty and ease of conceptualization of the material being studied; 3) Basic math and physical abilities. Overall, it can be concluded that the students used as research samples show that most students have a field dependent thinking style (FD) seen in the post-test results on GGS material 61.90%, RBT 61.90%, DSP 57.14% and RBT3D 57.14%. For independent field thinking (FI), the results of post-test results were 42.86% DSP, RBT 38.10%, RBT3D 38.10% and GGS 33.33%.
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