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Learning Styles and Cognitive Styles of Prospective Mathematics Teachers in Matrix Algebra Courses

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Abstract. In studying matrix algebra, prospective mathematics teachers must master, understand, and solve given problems. For prospective mathematics teachers to understand and solve the problems given, lecturers in teaching must pay attention to the learning and cognitive styles of prospective mathematics teachers. Because learning styles and cognitive styles are closely related to how the prospective mathematics teacher obtains, processes information and interacts in the classroom. The learning styles in question are visual, auditory and kinesthetic. Meanwhile, the cognitive styles discussed in this study are field-dependent (FD), field-neutral (FN), and field-independent (FI). This study aims to determine prospective mathematics teachers taking matrix algebra courses learning and cognitive styles. The research method used is descriptive qualitative, where data collection uses a learning style questionnaire and the Group Embedded Figure Test (GEFT). The population in this study were prospective mathematics teachers at Gunung Jati Swadaya University. The sample of this study was 23 prospective mathematics teachers who took matrix algebra courses. The results showed that prospective mathematics teachers had visual (V) 69%, auditory (A) 13%, kinesthetic (K) 17.4%, cognitive style FD 34.8%, FN 43.5%, and FI 21.7%. The combination of learning styles and cognitive results obtained is FD-V 21.7%, FN-V 34.8%, FI-V 13%, FD-A 4.3%, FN-A 4.3%, FI-A 4.3%, FD-K 8.7%, FN-K 4.3%, and FI-K 4.3%. Identifying learning and cognitive styles in the learning process is crucial so prospective mathematics teachers have a solid potential to manage their learning better.

Key words: Learning Styles; Cognitive Styles; Matrix Algebra.

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INTRODUCTION

Prospective mathematics teachers as individuals who are studying have different abilities in receiving lecture material and have their own uniqueness and characteristics (Sellah et al., 2015). This uniqueness causes prospective mathematics teachers to have different responses when attending lectures, both in absorbing and processing information. The more mature the prospective math teacher is, the easier it is to adapt to the way the lecturer teaches. Even though prospective math teachers are more adaptable, they still have characteristics in how they learn and understand the information provided by lecturers. Characteristics and distinctive ways of learning will affect the ability to understand concepts. The understanding of the concept of future mathematics teachers is still weak in building relationships between algorithms, this is due to the conceptual knowledge they have is immature so it is necessary to find a solution (Dewi et.al, 2021).

Agoestanto & Sukestiyarno (2017) state that individual differences in solving a problem are caused by psychological differences, one of which is cognitive style. *Cognitive style* is a term used to see a person's learning tendencies which refer to individual characteristics and consistency in feeling, remembering, organizing, processing, thinking, and solving problems (Cataloglu & Ates, 2014; Hsieh et al., 2020). The concept of cognitive style is also expressed by Kozhevnikov (2007), where cognitive style shows individual variations in feeling, remembering, and thinking as well as the psychological dimension describing the unique way individuals process information.

Prospective mathematics teachers with different cognitive styles will have different approaches to processing information, building knowledge, and solving problems (Almolhodaei, 2009; Sellah et al., 2017). Many types of cognitive styles are currently developing, including, according to Witkin et al. (1977) namely, field-dependent (FD), field-neutral (FN), and field-independent (FI), which are further referred to in this article as FD, FN, and FI. FD learners tend to be extrinsically motivated and enjoy cooperative or collaborative learning, FI learners tend to be intrinsically motivated and enjoy individual learning in the learning process, and FN learners refer to learners who do not have a strong tendency towards FI cognitive style or FD cognitive style (Liu & Ginther, 1999;

Mulyono, 2012).

In addition to aspects of cognitive style as described, learning styles are unique aspects that identify and determine how a person learns. Learning styles can be identified through visual, auditory and kinesthetic learning modalities (DePorter & Hernacki, 2013). Visual learners learn through what they see, auditory learners learn through what they hear, and kinesthetic learners learn through movement and touch. Although prospective mathematics teachers can own these three modalities simultaneously, they will be more inclined to choose one of the three (Jaenudin et al., 2017).

Learning style can be interpreted as how someone wants to learn in the most effective way (Cardino & Cruz, 2020). Mahasneh et al. (2020) state that visual, auditory and kinesthetic learning styles are insufficient to see prospective mathematics teachers' complexity and variety of thinking to acquire knowledge. Therefore, synergy and collaboration are needed to see how prospective mathematics teachers get and build their knowledge by paying attention to cognitive style.

Learning styles and cognitive styles are considered to have an essential role in the process of teaching and learning activities. Understanding learning styles and cognitive styles do not make someone bright, but by understanding learning styles and cognitive styles, a person will be able to determine a more effective way of learning. In teaching prospective mathematics teachers in the Mathematics Education Study Program, especially in matrix algebra courses which are a prerequisite for taking linear algebra lectures, lecturers need to ensure that the delivery of material in lectures can be well received and understood. Lecture material will be better understood and accepted by prospective mathematics teachers if lecturers in teaching accommodate learning styles and cognitive styles because each prospective mathematics teacher has a unique way of cognitive processing and a unique way of learning (Peterson et al., 2009; Bakar & Ali, 2018). Therefore, the researcher deems it necessary to identify prospective mathematics teachers' learning and cognitive styles who take matrix algebra lectures.

METHODS

This study uses a descriptive qualitative approach describing the sample's characteristics and behaviour (Dudovskiy, 2016). The population in this study were prospective mathematics teachers at Gunung Jati Swadaya University. The sample of this study was 23 prospective mathematics teachers who took matrix algebra courses.

Collecting data to determine the cognitive style of prospective mathematics teachers using the Group Embedded Figure Test (GEFT) has very high reliability, which has to measure by previous researchers of 0.82 (Johnstone & Al-Naeme, 1991; Bahar & Hansell, 2000; Bahar, 2003; Somyurek et al., 2008) and is 0.90 according to the results of Nicolaou (2011). Giving a score of 1 if the prospective mathematics teacher answered correctly and a score of 0 if the prospective mathematics teacher responded incorrectly, the maximum score achieved by the prospective mathematics teacher after completing the test was 18 points. The total processing time is 15 minutes. Adopting the GEFT manual cognitive style grouping proposed by Witkin et al. (1971), El-Banna (1987), and Oh & Lim (2005), in Table 1 given the criteria for determining the cognitive style of prospective mathematics teachers seen from the achievement of scores on the GEFT.

Table 1. Cognitive Style Criteria

GEFT Test Score	Cognitive Style Criteria
$0 \leq$ score ≤ 8	Field dependent (FD)
$9 \leq$ score ≤ 14	Field neutral (FN)
$15 \leq$ score ≤ 18	Field independent (FI)

Witkin, *et.al* (1971); El-Banna (1987); Oh & Lim (2005)

Data collection uses a learning style questionnaire with 30 statements consisting of 10 statements each to reveal visual, auditory, and kinesthetic learning styles. Each statement has an answer choice of 0 = never, 1 = rarely, 2 = sometimes, 3 = often, and 4 = always. Of the 30 items, the questionnaire has a reliability of 0.702, which means that the learning style questionnaire used can be trusted as a data collection tool.

RESULTS AND DISCUSSION

Much literature uses the terms learning style

and cognitive style as the same term, according to Evans (2006), but in fact, there is also much literature that supports that learning style and cognitive style are two different terms (Smith, 1997; Cassidy, 2004; Cook, 2004). 2006). In this study, the author distinguishes the terms between learning style and cognitive style, where learning style is a typical way of doing learning activities. In contrast, cognitive style is a typical way of doing thinking activities.

The learning styles of prospective mathematics teachers are identified using a learning style questionnaire adopted from Cohen et al. (2002) and were consulted with supervisors and experts, previously tested to determine the level of reliability of statements in the questionnaire. To identify the cognitive style of prospective teacher students using the Group Embedded Figure Test (GEFT).

Learning styles have a major influence on education, learners from elementary to tertiary levels are accustomed to a distinctive way of receiving and processing information (Marfuah et al., 2016). From the results of the learning style questionnaire given to 23 prospective mathematics teachers and coded M1 to M23, the data is obtained in Figure 1.

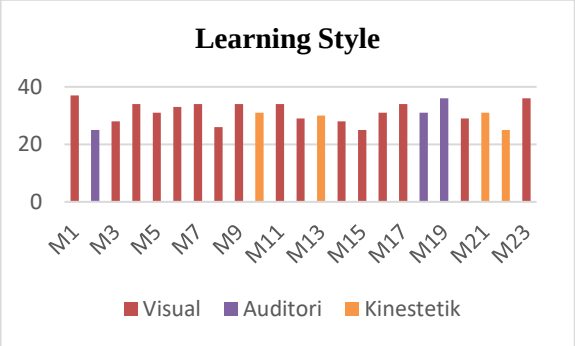

Figure 1. Learning Style of Prospective Mathematics Teachers

It can be seen clearly in Figure 1 that the majority of the learning style tendencies possessed by prospective mathematics teachers are visual. In learning to understand the material, prospective mathematics teachers with a visual learning style pay more attention to body language, the lecturer's expressions when explaining, and the material written or displayed by the lecturer in front of the class. So it focuses more on the lecturer explaining during the learning process. Prospective mathematics teachers with auditory learning styles are more comfortable and find it easier to capture information from lecturers who only explain or discuss systems. Prospective mathematics teachers with a kinesthetic learning style tend to be uncomfortable and restless if they are forced to sit and listen to explanations without meaningful activities throughout the learning process in class. This shows that visual, auditory, and kinesthetic learning styles provide different perspectives to understand and explain the choices of prospective mathematics teachers in receiving and processing information, as revealed by Evans et al. (2006) in their research.

The results of the classification of learning styles of prospective mathematics teachers in more detail are shown in Figure 2. Visual learning styles of prospective mathematics teachers are 16 people with a percentage of 69.6%, auditory learning styles of prospective mathematics teachers are three people with a percentage of 13%, and kinesthetic learning mathematics teacher candidates amounted to 4 people with a percentage result of 17.4%.

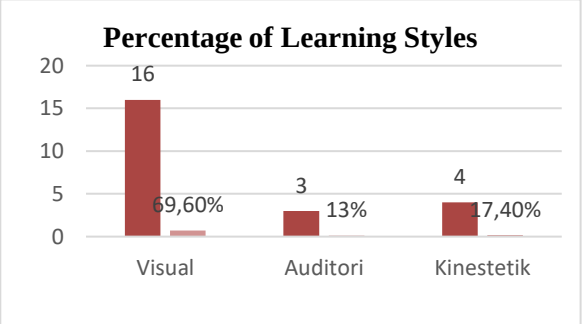

Diagram 2. Percentage of Prospective Mathematics Teacher Learning Styles

It is undeniable that if prospective mathematics teachers apply their learning style, the learning process will be maximized, as the results of research by Bire & Bire (2014). Therefore, lecturers should not only pay attention to how prospective mathematics teachers understand the material well but need to know how they want to learn most effectively according to them.

Learning is a cognitive activity where a person has a unique behaviour consistent with acquiring and constructing knowledge and how the brain receives and processes information. From Diagram 3 on the results of the Group Embedded Figure Test (GEFT) given to 23 prospective mathematics teachers, the majority have FN cognitive style, which means they do not have a strong tendency towards FD or FI.

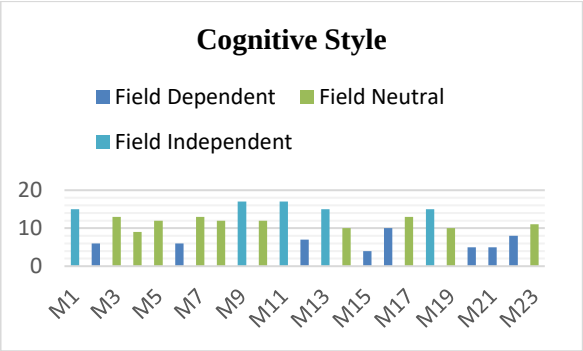

Diagram 3. Cognitive Style of Prospective Mathematics Teacher

In line with Umah's statement (2020), each prospective mathematics teacher has a different way and style of thinking in solving mathematical problems, causing prospective FD mathematics teachers and FI mathematics teacher candidates to have different tendencies in responding to the context of the problem. Based on the results of the GEFT test, it can be seen in Diagram 4 that ten prospective mathematics teachers or 43.5% of all subjects have an FN cognitive style which indicates that they do not have consistent behaviour in acquiring, building knowledge and how the brain receives and processes information.

A total of 8 prospective mathematics teachers, with a percentage of 34.8%, have a tendency of FD cognitive style, which has the characteristics of 1) being more interested in working in groups; 2) requiring direction in understanding something; 3) less structured and independent in learning. In contrast, the remaining five prospective mathematics teachers, with 21.7%, have a tendency for the FI cognitive style with characteristics that are contrary to the FD cognitive style. The characteristics of FD describe the tendency of prospective mathematics teachers to rely on other people or outside influences, and the characteristics of FI tend to be independent and confident, in line with Atsuwe & Thaddeus (2019).

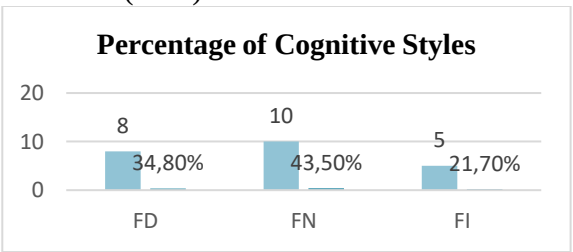

Diagram 4. Percentage of Prospective Mathematics Teacher Cognitive Styles

Learning style is part of cognitive style (Singh, 2017), where cognitive style is a choice of a stable attitude in thinking and solving problems, while learning style is a person's way of storing and using knowledge. Of the 23 prospective mathematics teachers, the tendency of cognitive and learning styles can see in Table 2.

Table 2. Learning Style and Cognitive Style of Prospective Mathematics Teacher

Learning Style	Cognitive Style		
	Field Dependent (FD)	*Field Neutral* (FN)	*Field Independent* (FI)
Visual (V)	5	8	3
Auditori (A)	1	1	1
Kinestetik (K)	2	1	1

Based on Table 2, it can see that prospective mathematics teachers have a combination of varied learning and cognitive styles. The results of this study will use as a basis for further research. Prospective mathematics teachers with FN cognitive style who do not have a strong tendency towards FI cognitive style or FD cognitive style will be eliminated as subjects so that their abilities and thought processes in understanding the material are transparent. It is hoped that with the variety of learning and cognitive styles, various thinking processes and understanding of prospective mathematics teachers will be found in the material in matrix algebra.

CONCLUSION

The results showed that prospective mathematics teachers had visual (V) 69%, auditory (A) 13%, kinesthetic (K) 17.4%, cognitive style FD 34.8%, FN 43.5%, and FI 21.7%. The combination of learning styles and cognitive results obtained is FD-V 21.7%, FN-V 34.8%, FI-V 13%, FD-A 4.3%, FN-A 4.3%, FI-A 4.3%, FD-K 8.7%, FN-K 4.3%, and FI-K 4.3%.

Learning styles and cognitive styles are different and separate things. Identifying learning and cognitive styles in the learning process is crucial so prospective mathematics teachers have a solid potential to manage their learning better. Thus, it is the conclusion that the role of learning and cognitive styles cannot be ignored in the learning process in the classroom or in learning outside the classroom. The results of this study

will then be used as a basis for lecturers to determine the appropriate method for learning and analysing the thinking process in understanding the concept of linear equations system material in matrix algebra courses.

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