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# Cognitive Style and Achievement in The Cell Division Test

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## Abstract

The basis of biology courses on genetics, production, growth, development and molecular biology is cell division. Research shows that despite efforts to improve their understanding and importance of cell division in biology, students often struggle with this concept. The aim of this study is to examine the relationship between cognitive styles and achievement in the cell division test. The study population consists of Form Four science students from rural secondary schools in the southwest coast of Sabah. 247 students were involved in this study. The Group Embedded Figures Test (GEFT) and the Cell Division Test (CDT) were the two instruments used for data collection in this study. SPSS version 29.0 was used for statistical analysis. The average score of the field-independent cognitive styles was higher than that of the field-dependent students. It was also found that the t-value is -2.016 and the significant level is  $p=0.045$ . Meanwhile, the correlation coefficient between cognitive styles and students' performance in the cell division test is 0.128 ( $p<0.05$ ). Based on the results, it can be concluded that field-independent students perform better in cell division test than field-dependent students. The research results provided valuable insights for teachers and are incorporated into the development of integrative teaching approaches and individual learning plans that take different cognitive preferences into account and ultimately increase the academic success of all students in biology classes.

**Keywords:** *Cognitive Style, Field Dependence, Field Independence, Achievement, Cell division test*

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## I. INTRODUCTION

The difficulties that students encounter when taking biology classes have been thoroughly studied in earlier studies conducted all over the world. Many biology topics in the science curriculum are considered extremely difficult [1]. Form Four Biology covers a range of topics including cell division, according to the Kurikulum Standard Sekolah Menengah (KSSM). All living forms are constructed from cells, which are the fundamental building block of all living things' structure and function [2]. Despite the importance of cell division in biology and efforts to improve students' understanding, research has shown that students often struggle with this concept [3]. [4] revealed that students have difficulty learning the topics of nutrition, cell division and chemical composition in cells. Cell division is the basis for genetics, reproduction, growth, development, and molecular biology courses in the biology curriculum. Failure to master the concept of cell division will have negative consequences as cell division plays a direct role in the field of genetics.

Cognitive style, a fundamental aspect of an individual's psychological makeup, has long been recognized as a crucial factor influencing academic performance. Recent studies have examined the complex relationship between cognitive style and subject-specific performance, with particular emphasis on the area of biology education.

A previous study found that cognitive styles significantly influence the relationship between motivation and students' achievement in biology [5]. Other researchers also found that cognitive styles significantly influenced student performance [6]. In contrast, other researchers found that biology students' performance is not influenced by cognitive styles [7].

A multifaceted approach to understanding cognitive styles can shed additional light on how students understand and interact with complex biological processes, particularly when it comes to the topic of cell division. Biology is a challenging subject that requires specific teaching strategies [8,9]. Understanding the different ways individuals absorb information and solve problems can provide educators with indispensable perspectives for

adapting their pedagogical approaches to different learning styles.

### A. Research Questions of the Study

1. What is the level of cognitive style among rural secondary school students in the southwest coast of Sabah?
2. Is there a relationship between cognitive styles and students' achievement in cell division among rural secondary school students in the southwest coast of Sabah?

### B. Hypotheses of the Study

H<sub>01</sub>: There is no significance relationship between cognitive styles and students' achievement in cell division test among rural secondary school students in southwest coast of Sabah

H<sub>02</sub>: There is no significant difference between the performances of field-independent and field-dependent students in the cell division test among rural secondary school students in the southwest coast of Sabah

In summary, the research results will make a significant contribution to existing knowledge on the role of cognitive styles in academic performance, particularly in the area of cell division. The study aims to highlight the importance of considering cognitive diversity in educational environments and provide actionable insights for educators to improve the learning experiences and academic success of all students. Ultimately, the goal is to bridge the gap between cognitive styles and pedagogical practices, paving the way for more inclusive and effective teaching and learning experiences.

## II. LITERATURE REVIEW

The theoretical framework of this study is based on the concept of cognitive style, which provides a way to understand individual differences in information processing and learning approaches. Witkin's field dependence-independence continuum provides valuable insights into the way individuals perceive and process visual information [10]. When processing visual stimuli, people with a field-dependent cognitive style rely more on outside references and contextual cues, whereas people with a field-independent cognitive style rely more on their own internal frame of reference. Understanding the effects of these cognitive styles on visuospatial processing is crucial to discern their potential influence on performance in the cell division test.

Researchers have defined cognitive styles in a variety of ways. However, these definitions have many similarities. [11] stated that a person's particular technique for organizing their observation of external stimuli constitutes their cognitive style. In other words, cognitive style is considered a personality dimension that influences attitudes, values and social interaction [12]. [13] said that cognitive style is related to the method of collecting and processing information presented to students. Furthermore, cognitive style influences how students deal with difficulties and decide how to interpret information that has a consistent pattern [14,15].

The present study took into account the cognitive styles of learners, both field-dependent and field-independent, since cognitive style is a significant factor in influencing students' academic decisions, career preferences, and knowledge processing methods [16]. The field dependence/field independence of the learner's cognitive style is related to his ability to find out the most important information, regardless of whether it is the most obvious or salient. [17] state that students with a field-dependent cognitive style typically approach learning and information processing from a broad perspective. [18] claims that field-dependent learning requires interactions with peers who act as learning amplifiers and advisors, in addition to learning activities conducted in a social environment. According to [10, 15], those who are field dependent are to some extent dependent on others, enjoy socializing, and are aware of social cues. They are also interested in the language and actions of others.

## III. RESEARCH METHODOLOGY

### A. Participants

This study used the purposive sampling approach. The study group consists of Form Four science students from rural secondary schools on the southwest coast of Sabah. 247 students participated in this study.

### B. Instrument

The Group Embedded Figures Test (GEFT) and the Cell Division Test (CDT) were the two instruments used to collect data for this study.

The Cell Division Test (CDT) was developed to examine the relationship between cell division performance and their cognitive style. Three experts in biology education were involved in the preparation of the multiple-choice test instruments. Rasch analysis shows that the infit and

outfit values of the MNSQ item range between 0.79 and 1.24 logit. It was also found that all ZSTD components of Infit and Outfit had logit values between -1 and 1.8. In addition, the point-measure correlation values (PTMEA-CORR) or item alignments for all items were positive (>0), indicating that the items can measure what they are intended to assess. The Rasch analysis accepted and validated each of the 22 multiple-choice test items in the biology assessment tool as they all met the requirements mentioned by [19]

**Table 1: Expert Panel in the Preparation of the Instruments**

Instrument	Expert Panel
Cell Division Test	<ul style="list-style-type: none"> <li>• A teacher with 15 years of experience as a biology teacher at a secondary school in Sabah, Malaysia.</li> <li>• A lecturer who has taught biology for more than 15 years. from the Institute of Teacher Education Malaysia.</li> <li>• A lecturer who has been teaching biology for more than 14 years at the local universities in Malaysia</li> </ul>

For the study, the Group Embedded Figure Test (GEFT) developed by Witkin *et al.* in 1971 was used. The instrument consists of 25 images. The Cronbach value was 0.91 and is considered high reliability. The ability of respondents to identify the marked simple shape within each pattern—which is thought to be the dominant visual field—determines whether they are classified as field-dependent or field-independent.

### C. Procedure

The relationship between cognitive styles and academic performance is investigated in the particular context of cell division using a quantitative research approach. Statistical techniques are used to assess the survey data that was gathered. The statistical analysis was conducted using SPSS version 29.0. While inferential statistics can be used to determine relationships between variables, descriptive statistics are used to summarize the data that was collected. The mean, frequency, and percentage were the descriptive statistics employed in this data study. In the meantime, inferential statistics were performed using the Independent T-test and the Pearson correlation coefficient.

## IV. FINDINGS

The percentage of respondents with each cognitive style was presented in Table 2 as a result of the study. The study's findings indicated that 140 respondents are field independent and 107 are field dependent. 51.3% of male respondents are field dependent and 63.8% of female respondents are field independent.

**Table 2: Descriptive Statistics Result**

	Level	Frequency	%
<b>Male</b>	Field dependent	60	51.3
	Field Independent	57	48.7
<b>Female</b>	Field dependent	47	36.2
	Field Independent	83	63.8

**Table 3: Pearson Correlation Coefficient**

	Achievement in Cell Division Test	
<b>Cognitive Style</b>	<b>r</b>	.128
	<b>p-value</b>	.045
	<b>N</b>	249

Results illustrated in Table 3 shows that the correlation coefficient between cognitive styles and students' achievement in cell division test is 0.128 ( $p < 0.05$ ). A statistically significant relationship was found between the two variables. The hypothesis that "there is no significance relationship between cognitive styles and students' achievement in cell division test among rural secondary school students in southwest coast of Sabah" is rejected.

As indicated in Table 4, the mean score of field-independent cognitive styles was higher than that of field-dependent students. It was found that the t-value is -2.016 and the significant level is  $p = 0.045$ . The significance level is below 0.05 ( $p < 0.05$ ). There is a statistically significant difference between field independent and field dependent students. The null hypothesis: "There is no significant difference between the performances of field-independent and field-dependent students in the cell division test among rural secondary school students in the southwest coast of Sabah" is therefore rejected.

**Table 4: Independent T-Test Result**

	Cognitive style	N	Mean	SD	Std. Error Mean
<b>Cell Division Test</b>	Field Dependent	107	2.03	.383	.037
	Field Independent	140	2.12	.324	.027

		Cognitive Styles		
		Equal variances assumed	Equal variances not assumed	
<b>Levene's Test for Equality of Variances</b>	F	2.742		
	Sig	.099		
<b>t-test for Equality of Means</b>	t	-2.016	-1.971	
	df	245	206.442	
	Sig. (2-tailed)	.045	.050	
	Mean Difference	-.091	-.091	
	Std. Error Difference	.045	.046	
	95% Confidence Interval of the Difference	Lower Upper	-.179 -.002	-.181 .000

## V. DISCUSSION AND CONCLUSION

The results of the study were reviewed in light of the underlying research questions and hypotheses. A review of all the studies shows that Witkin's theory of field-dependent-independent cognitive styles is increasingly applied in research. This study measures participants' ability to separate or decompose a specific object from a broader context using the Group Embedded Figures Test (GEFT). According to [13], when gathering and analyzing student data for information transfer, cognitive style is linked to the process. [20] defines cognitive style as "the way people think, perceive, and remember information." [17] said that Individuals who hold a field-dependent cognitive style view typically participate in the comprehension and processing of information. Field independent, on the other hand, is more analytical and independent [21].

This study found that the majority of fourth grade science students in the southwest coast of Sabah had a field-independent cognitive style. This finding is consistent with [22] results. It was also found that the majority of male students had a field-dependent cognitive style that was in contrast to that of female students. This result is similar to [23] study: men were more likely to be field dependent than women. In contrast, students with field-independent cognitive style levels outperformed those with field-dependent cognitive style levels on both dependent variables when it came to the cell division test.

In the cognitive style, a more field-independent subject finds it easier to overcome the effects of the broader context, while a more field-dependent subject finds it more difficult to do so. From this study, it appears that the majority of Form Four science students in the southwest coast of Sabah are those who can accurately locate a simple figure within a much more complicated figure. This student may perform better on analytical tasks, as evidenced by their ability to effectively complete the GEFT. In general, they are capable of resolving intricate issues, remembering details, discerning reality from illusion, identifying vital information from unnecessary data, recognizing a specific item against its backdrop, storing information quickly and precisely, excelling in standardized assessments, and organizing when needed. As an independent student, this student is less dependent on the support of his teachers or classmates. They may benefit from tasks such as advanced reading and writing that they can complete independently. [24] suggested that teachers should be sensitive to the learning needs of their students and be creative in approaching different teaching methods in the classroom.

In the area of cell division, a field-independent cognitive style allows students to systematically analyze the steps of mitosis and meiosis, while a field dependent cognitive style allows students to formulate new hypotheses and conceptualize alternative pathways within cell division. These findings about cognitive styles provide educators with the opportunity to adapt their teaching approaches to better support students'

diverse cognitive strengths. Furthermore, it's critical to acknowledge that cognitive processes are dynamic and that students can change and evolve their cognitive styles over time. This requires an adaptive and personalized learning environment that not only accommodates cognitive diversity but also promotes its growth and development. By recognizing the unique perspectives and problem-solving approaches that arise from different cognitive styles, educators can create a collaborative learning environment that enriches the entire learning experience for all students.

In this study, students from rural secondary schools on Sabah's southwest coast were found to have a significant relationship between their cognitive styles and their performance on the cell division test. This finding supported by [25], who found that academic performance of both male and female students was positively correlated with their field dependence and independence; girls outperform boys in academic performance; cognitive styles are a significant predictor of academic performance. Recognizing these different cognitive strengths and tailoring instructional approaches to them can lead to improved learning outcomes. By providing a variety of instructional strategies that address different cognitive styles, educators can create an inclusive learning environment that supports all students to achieve academic success.

Furthermore, the effects of cognitive styles extend beyond individual academic performance and influence collaborative dynamics within a classroom. When students with different cognitive styles come together to discuss and solve problems, their unique perspectives and problem-solving approaches enrich the entire learning experience.

Field-independent students outperform field-dependent students on their cell division test, as evidenced by the results and the discussion above. In addition, students' performance on the cell division test also correlates significantly with their cognitive styles.

## VI. IMPLICATION

By uncovering the relationships between specific dimensions of cognitive style and test performance, we contribute to improving the theoretical understanding of cognitive styles and their effects on academic performance. This deeper understanding can pave the way for the refinement and development of cognitive style models to accurately capture the different ways in which individuals process information and approach learning tasks.

Understanding the impact of cognitive styles in educational contexts has significant

implications for teaching approaches. Educators can adapt their methods to suit the different cognitive strengths of their students, creating a more inclusive and effective learning environment. By recognizing the dynamic nature of cognitive processes and students' potential to adapt and evolve their cognitive styles over time, educators can adapt their teaching approaches to accommodate this variability. By integrating cognitive style considerations into assessment practices, educators can gain a more holistic understanding of students' learning outcomes and knowledge of cell division concepts, thereby providing targeted support and personalized feedback to improve academic growth. Implementing individualized learning plans requires accurate assessment and understanding of each student's specific cognitive styles. This comprehensive understanding allows educators to develop personalized learning strategies and goals tailored to each student's unique cognitive preferences and abilities.

In summary, the study contributed to understanding how cognitive styles affect academic performance in the specific topic of cell division. The research results also provided valuable insights for educators and inform the development of integrative teaching approaches and individual learning plans that address different cognitive preferences and ultimately increase the academic success of all students in biology classes.

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