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THE VARK-FLEMING MODEL AND SELF-CONCEPT: DOES IT AFFECT MATHEMATICAL CONCEPTS UNDERSTANDING?

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Abstrak

Kemampuan pemahaman konsep sangat dibutuhkan dalam proses pembelajaran matematika yang harus dikuasai untuk menunjang keberhasilan proses pembelajaran. Penelitian kuantitatif ini mengkaji kemampuan pemahaman konsep matematis siswa dengan mengimplementasikan model *VARK-Fleming* dan *self-concept* sebagai variabel kovariat. Penelitian ini bertujuan untuk mengetahui pengaruh model *VARK-Fleming* terhadap kemampuan pemahaman konsep matematis dengan mengontrol *self-concept* siswa dan pengaruh variabel kovariat *self-concept* terhadap kemampuan pemahaman konsep matematis siswa, serta pengaruh secara simultan model *VARK-Fleming* dan *self-concept* terhadap kemampuan pemahaman konsep matematis siswa. Partisipan dalam penelitian ini berjumlah 64 siswa SMP, dengan rincian 32 siswa belajar menggunakan model *VARK-Fleming* dan 32 siswa belajar dengan model ekspositori. Alat yang digunakan untuk mengumpulkan data adalah angket dan tes uraian. Pengujian hipotesis menggunakan *analysis of covariance* (*one-way ancova*). Hasil penelitian ini menunjukkan bahwa terdapat pengaruh lebih baik model pembelajaran *VARK-Fleming* dibandingkan model ekspositori dan *self-concept* terhadap kemampuan pemahaman konsep matematis siswa baik secara parsial maupun simultan.

Kata kunci: Pemahaman Konsep, *Self-concept, VARK-Fleming*.

Abstract

Concept understanding is required for the learning process to be successful. This quantitative study investigates students' mathematical concept understanding abilities using the VARK-Fleming model and self-concept as a covariate variable. The purpose of this research is to determine the effect of the VARK-Fleming model on students' ability to understand mathematical concepts by controlling for students' self-concept and the effect of the covariate variable of self-concept on students' ability to understand mathematical concepts, as well as the simultaneous concept of the VARK-Fleming model and self-concept on students' ability to understand mathematical concepts. Sixty-four junior high school students participated in this research, with 32 learning the VARK-Fleming model and 32 learning the expository model. Questionnaires and descriptive tests were employed to collect information. The analysis of covariance was utilized for hypothesis testing (one-way ANCOVA). The findings of this research reveal that the VARK-Fleming learning model has a better effect on students' mathematical concept understanding capacity than the expository model and self-concept, both partially and concurrently.

Keywords: Concept Understanding, Self-concept, VARK-Fleming.

INTRODUCTION

Mathematical concept understanding refers to students' ability to recall a concept, explain it in their terms, apply it to a problem, and then connect one concept with another (Febriani et al., 2019). Concept Understanding Understanding is a fundamental mathematical ability every student must possess (D. Y. Sari et al., 2021). The ability to grasp mathematical concepts considerably enhances other numerical understanding, such as thinking skills (Gunur et al., 2019), relational skills (Ningsih, 2017), reasoning skills (Astuti et al., 2018), communication skills (Putra, 2016), and many others (F. Y. Sari et al., 2022). Because every concept in mathematics subject matter is related to one another, students are expected to understand concepts in mathematics lessons thoroughly. Understanding concepts is also crucial for solving mathematical issues (Nur et al., 2021; Nurani et al., 2021; Lestari & Rukmigarsari, 2021). The difficulty in mastering the mathematical ability to understand mathematical concepts is the most significant contributor to the bad quality of mathematics learning outcomes (Anggraini & Kartini, 2020), particularly in terms of assessing the inclination to solve concept difficulties faced (Febriani et al., 2019; Handayani, 2016; Mayasari et al., 2021).

Mathematical concept understanding helps absorb and understand mathematical ideas (Khofifah et al., 2021). Unfortunately, many students still struggle with concept understanding (Kaushal Kumar Bhagat, 2016; Luritawaty, 2018; Murdin et al., 2019; Sarniah et al., 2019). Several studies show that many students with concept understanding abilities are still in the poor category (Fajar et al., 2019; Hendrayana, 2017; Khairani et al., 2021).

The effectiveness of selecting a learning model will improve teachers' concept understanding ability (Pranata, 2016). The Visual, Auditory, Read, Kinesthetic (VARK) learning model is a learning model that focuses on giving direct and engaging learning experiences by utilizing the four learning modalities that students have: seeing (visual), hearing (auditory), reading (read), and moving (kinesthetic) (N. Fleming, 2006; N. D. Fleming, 2012; Hawk & Shah, 2007; Hussain, 2017; Nurhidayah, 2021; Othman & Amiruddin, 2010). VARK-Fleming is a learning model that optimizes the four learning modes to make learning effective and engaging (Hariyani & Sejati, 2019). The VARK-Fleming model is learning that involves physical movement and student participation by employing the five senses they have in the learning process (Monariska & Komala, 2020).

Several researchers have researched the VARK-Fleming model, including the findings of Erawati et al. (Erawati et al., 2020; Monariska & Komala, 2020; Prihaswati & Purnomo, 2021), which discovered that employing the VARK-Fleming model can improve connection skills and mathematical proof abilities. However, the sample was at the university level, so whether this model improved mathematical abilities at the junior high school level was unknown. Also, VARK-Fleming can increase communication skills and mathematical thinking (Didit Chayono & Nuriyatin, 2019; K et al., 2021; Tahir, 2021). However, the sample utilized was at the high school level; thus, whether this model affected junior high school students' mathematical abilities was unknown. Meanwhile, Agusriandi discovered an improvement in mathematical creativity in junior high school students, but the study did not account for external variables; therefore, it concentrated on mathematical ability (Agusriandi, 2020).

The VARK-Fleming model used in this research adheres to Ngalimun's syntax (Ngalimun, 2012), namely stage 1, preparation. This first stage is concerned with preparing students to participate in the learning process by providing motivation and placing them in an optimal situation to prepare students to receive learning. Stage

2 is delivery, which refers to the range of methods and media in the learning process that maximizes the utilization of students' five senses in the form of visual, aural, read/write, and kinesthetic modalities so that the students can be actively engaged with the educational process. Learning movies, colorful markers, questions and answers, debates, notes, reading books, and demonstrations are the methods and media used. Stage 3 is training, which is concerned with deepening the material taught by the teacher using various methods and media in the form of material or questions connected to the material. Students receive training, which can be completed individually or in groups. Stage 4 is presentation, which is concerned with the disclosure of the findings of the students' thinking about the material learned. The results are disclosed through student presentations, which the teacher then checks. Stage 5 is the conclusion concerned with consolidating the material taught. The learning outcomes conclusion is provided as a summary created by students based on their learning styles (Hariyani & Sejati, 2019). Figure 1 depicts the syntax of VARK-Fleming.

Figure 1. VARK-Fleming Cycles

Concept understanding ability has a strong association with self-concept. This statement is consistent with research demonstrating a favorable and substantial link between self-concept and concept understanding ability (Satriani et al., 2021; Lestari & Rukmigarsari, 2021). The self-concept is a person's views, attitudes, feelings, and expectations when confronted with and addressing problems in general, scientific, and social contexts (Andinny, 2015; Hattie, 2014; Markus & Wurf, 1986; Juniarti & Margunayasa, 2020; Pamungkas et al., 2015). According to Zahra and Guay et al., self-concept is closely associated and determines student academic achievement (Manik & Radjah, 2017). A person's self-concept is established first concerning the person closest to them (Kartika, 2017). Positive experiences from family can help a person develop a positive self-concept and vice versa (Sumartini, 2015). Based on past research, no researcher has investigated the influence of the VARK-Fleming model and self-concept on students' mathematical concept understanding ability. As a result, this research will disclose the impact of the VARK-Fleming model and self-concept on junior high school student's ability to understand mathematical concepts.

RESEARCH METHODS

a. Research Design

This research employs a quantitative approach and a quasi-experimental design. This research has one independent variable, the VARK-Fleming model, one covariate variable, self-concept, and one dependent variable, concept understanding ability. The sample was chosen randomly using the cluster random sampling technique, yielding two samples: the experimental class, which received treatment with the VARK-Fleming model, and the control class, which received treatment with the expository model. This research employs a 1 X 2 factorial design.

Table 1. The Factorial Design

Group			
Experimental		Control	
x_1	y_1	x_2	y_2
$x_{1.1}$	$y_{1.1}$	$x_{2.1}$	$y_{2.1}$
$x_{1.2}$	$y_{1.2}$	$x_{2.2}$	$y_{2.2}$
$x_{1.3}$	$y_{1.3}$	$x_{2.3}$	$y_{2.3}$
…	…	…	…
…	…	…	…
…	…	…	…
$x_{1.n}$	$y_{1.n}$	$x_{2.n}$	$y_{2.n}$

b. Instrument of Data Collection

In this research, questionnaires and descriptive tests were employed. The questionnaires measured students' self-concept, and descriptive tests measured students' concept understanding ability. The research questionnaire was adapted from (Widyastuti et al., 2020). It included subscales such as seriousness, distinguishing between qualities and deficiencies, optimism, collaboration, respecting opinions, communication skills, and understanding the function of learning mathematics. The questionnaire consisted of 30 statements with four possible responses, each with a score depending on its degree on a Likert scale, such as strongly disagree (score 1), disagree (score 2), agree (score 3), and strongly agree (score 4) (Satriani et al., 2021). The responses are chosen range from very positive to very negative. Positive and negative statement scores are inversely proportional to one another. After the validation, the questionnaire was administered to 32 students, yielding 28 valid and reliable items with a Cronbach's Alpha value of 0.850. The concept understanding ability test comprised 14 essay questions representing 7 indicators of concept understanding ability. Additionally, 32 students were tested, and 8 questions were confirmed valid and reliable, with a Cronbach's Alpha value of 0.733. Thus, 8 questions were utilized to assess concept understanding ability.

c. Research Participants

This research involved 64 students between the ages of 12 and 15, with 32 students learning with the VARK-Fleming model and 32 with the expository model. The 64 were ninth-grade junior high school students in South Lampung Regency, Lampung Province. The problems in that area were particularly pertinent to our research; hence students from South Lampung Regency were selected. It turned out that many students had difficulty understanding mathematical concepts. Table 2 lists the demographics of the participants in this research.

Table 2. Demographic Characteristics of Samples

Demographic		Frequency	Percentage (%)
Sex	Male	31	48,4%
	Female	33	51,6%
Residence	City	14	21,9%
	Village	50	78,1%
Ethnicity	Javanese	50	78,1%
	Sundanese	10	15,6%
	Lampungese	4	6,3%

Note. N = 64; the average age of 15 years ($SD = 0{,}056$ $S.E = 0{,}445$).

d. Data Collecting Technique

In this research, a questionnaire and test were utilized to collect data, with the questionnaire used to examine self-concept and the test used to measure concept understanding ability. The tests employed in this research were the first (pretest) and the final (posttest). The pretest was conducted before using the VARK-Fleming model to compare the starting ability of the experimental and control classes. Following the implementation of the VARK-Fleming model, a posttest was administered to determine whether there was a significant difference between the experimental and control classes. Table 3 shows the self-concept indicators employed in this research.

Table 3. Self-concept Indicators

No	Indicators	Description
1	Seriousness (interest, motivation, courage, and seriousness)	Seriousness, interest, motivation, courage, and seriousness in learning mathematics
2	Distinguishing personal qualities and shortcomings	Distinguishing personal qualities and shortcomings in learning mathematics
3	Optimistic	Confident in carrying out mathematical tasks
4	Collaborative and tolerant	Collaborate and tolerate others in learning mathematics
5	Respect for opinions	Respect other's and individual opinions during mathematics learning
6	Communication skills and self-esteem	Communication skills and being able to place oneself during mathematics learning
7	Understand the function of learning mathematics	Understand the function of learning mathematics

According to Table 3, there are seven indicators of self-concept used in constructing the questionnaire, namely seriousness (interest, motivation, courage, and seriousness), distinguishing the self-qualities and shortcomings, optimism, collaborating and tolerant, respecting opinions, communication skills and being able to place themselves, and understanding the function of learning mathematics(Afri, 2019). Indicators of concept understanding ability used in this research are shown in Table 4.

Table 4. Indicators of Concept Understanding Ability

No	Indicators
1	Restate concepts that have been learned.
2	Classify objects based on certain properties following the concept.
3	Provide examples or non-examples of the concepts learned.
4	Presenting concepts in various forms of mathematical representations.
5	Explain the necessary condition of a concept.
6	Determine and use and refer to certain procedures or operations.
7	Apply concepts or algorithms to problem-solving.

Table 4 displays the indicators of concept understanding ability employed in this research. According to Regulation of the Ministry of Education and Culture (Permendikbud) Number 59 of 2014, the indicators are restating concepts that have been learned, classifying objects based on certain properties following the concept, giving examples or not examples of concepts learned, presenting concepts in various forms of mathematical representation, explaining the necessary conditions for a concept, determining and using and referring to certain procedures or operations, and applying concepts or algorithms to problem-solving (Baiduri et al., 2021).

e. Data Analysis

The analysis of the covariance (one-way ANCOVA) test was utilized to analyze the data in this research. The one-way ANCOVA test is a hypothesis test performed onCE the prerequisite tests have been completed. The four prerequisite tests are normality, data variation homogeneity, regression linearity, and regression coefficient homogeneity tests (Rinaldi & Novalia, 2020; Sudjana, 2003; Zunita, 2018). This research used SPSS 26 for Windows software for hypothesis testing and prerequisite tests.

RESULT AND DISCUSSION

Prerequisite Test of Analisis of Covariance (One-Way ANCOVA)

The first test that is performed is the normality test. The normality test was used to examine whether or not the research findings in questionnaires and questions in the experimental and control classes were normally distributed. Posttest data were used for the prerequisite test. Kolmogorov Smirnov and SPSS 26 were employed to calculate the normality test. Table 6 shows the results of the normality tests.

Table 6. The Normality Test Result

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Classes	Statistic	df	Sig.	Statistic	df	Sig.
Self-concept	Experimental class	.139	32	.121	.923	32	.025
	Control class	.106	32	.200*	.968	32	.452
Concept understanding	Experimental class	.139	32	.116	.949	32	.132
	Control class	.103	32	.200*	.958	32	.249

Note. Normality test with n = 64

The results of Table 6 show the results of the normality test of self-concept and students' concept understanding ability at the α = 0.05 level. Therefore, it can be concluded that the data obtained in the control and experimental classes are normally distributed because *p-value* is greater than α. The next prerequisite test is the homogeneity test. The results of the data variation homogeneity test can be seen in Table 7.

Table 7. Data Homogeneity Test Results

Levene's Test of Equality of Error Variances[a]

Dependent Variable: Concept understanding

F	df1	df2	Sig.
,414	1	62	,523

Note. Levene's homogeneity test with n = 64

Table 7 reveals that the homogeneity test of self-concept and concept understanding ability results came from the same variance or were homogeneous because the p-value (0.523) is greater than α (0.05). The regression linearity test is the next required test. The regression linearity test is satisfied if there is a linear relationship between the covariates and the dependent variable. Table 8 displays the results of the regression linearity test.

Table 8. Regression Linearity Test Results

Tests of Between-Subjects Effects

Dependent Variable: Concept understanding

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1237,418[a]	2	618,709	19,609	,000
Intercept	123,966	1	123,966	3,929	,052
X_1 (model)	184,901	1	184,901	5,860	,018
X_2 (covariate)	432,278	1	432,278	13,700	,000
Error	1924,691	61	31,552		
Total	350525,000	64			
Corrected Total	3162,109	63			

a. R Squared = ,391 (Adjusted R Squared = ,371)

Note. Regression linearity test with n = 64

Table 8 shows that the covariate Sig value (X2) is less than α (0.00 < 0.05). This number suggests a linear association between the covariate variable (self-concept) and the dependent variable (concept understanding ability). The regression coefficient homogeneity test is the final prerequisite test. The regression coefficient homogeneity assumption test in this research is met if there is no linear relationship between the covariate and dependent variables. Table 9 displays the results of the regression coefficient homogeneity test.

Table 9. Homogeneity Test Results of Linear Regression Coefficient Data

Tests of Between-Subjects Effects

Dependent Variable: Concept understanding

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1321,494[a]	3	440,498	14,359	,000
Intercept	36,427	1	36,427	1,187	,280
$X_1 * X_2$	84,076	1	84,076	2,741	,103
X_1 (model)	70,245	1	70,245	2,290	,135
X_2 (Covariate)	516,335	1	516,335	16,831	,000
Error	1840,615	60	30,677		
Total	350525,000	64			
Corrected Total	3162,109	63			

a. R Squared = ,418 (Adjusted R Squared = ,389)

Note. Regression linearity test with n = 64

Table 9 displays the results of the homogeneity test of regression coefficients. Because the value of Sig (0.103) is higher than 0.05, there is no linear relationship between the covariate variable and the independent variable. Therefore, the assumption test is met.

Hypothetical Test of the Analysis of Covariance (One-Way ANCOVA)

Analysis of covariance has been employed to test hypotheses (one-way ANCOVA). This test is a distinct or comparative test in which the independent variables combine factorial and numerical data, and the dependent variable is interval or ratio (quantitative) data. By removing treatment effect bias, the ANCOVA technique adjusts the dependent variable score (Montgomery, 2013). Eliminating treatment effect bias aims to reduce error variance by controlling for the influence of covariate factors that are thought to affect analysis outcomes. Statistical covariance analysis can equalize groups based on the influence of variables other than the treatment variable (Kadir, 2019). The one-way ANCOVA test was performed using SPSS 26 program in this research. Table 10 displays the outcomes of the one-way ANCOVA test.

Table 10. The Result of One-Way ANCOVA

Tests of Between-Subjects Effects

Dependent Variable: Concept understanding

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1237,418[a]	2	618,709	19,609	,000
Intercept	123,966	1	123,966	3,929	,052
X_2 (covariate)	432,278	1	432,278	13,700	,000
X_1 (model)	184,901	1	184,901	5,860	,018
Error	1924,691	61	31,552		
Total	350525,000	64			
Corrected Total	3162,109	63			

a. R Squared = ,391 (Adjusted R Squared = ,371)

Note. Regression linearity test with n = 64

In Table 10 row X1, the value of $F_{observed}$ is 5.860, with a p-value of 0.018 at a significance level of 0.05. This result suggests that the p-value is lower than 0.05, indicating that H_0 is rejected and H_1 is accepted. In conclusion, the VARK-Fleming model affects students' mathematical concept understanding ability by influencing self-concept.

Table 10 shows that the value of $F_{observed}$ is 13,700 with a p-value of 0.000 at a significance level of 0.05. This finding demonstrates that the p-value is lower than 0.05. As a result, H_0 is rejected, and H_1 is accepted. The conclusion is that self-concept covariate variables affect students' mathematical concept understanding ability.

The corrected model findings in Table 10 indicate a $F_{observed}$ value of 19,609 with a p-value of 0.000 at a significance level of 0.05. This number demonstrates that the p-value is lower than 0.05. Therefore, H_0 is rejected, and H_1 is accepted. In conclusion, students' mathematical concept understanding ability is simultaneously influenced by the VARK-Fleming model and self-concept.

The results of the one-way ANCOVA test reveal that the VARK-Fleming model has a greater influence than the expository model on concept understanding ability. Students taught using the VARK-Fleming model had a higher posttest score of concept understanding ability than those taught with the expository model, particularly on presenting concepts in diverse forms of mathematical representation. This result is due to the numerous benefits of the VARK-Fleming model. The benefits of VARK-Fleming can make the learning environment energetic and interesting, causing students to appear eager during the learning process. According to its benefits, learning activities are more effective because it integrates the four learning styles and provides direct experience by integrating students as much as possible in understanding mathematical concepts. This model makes it easier for students to understand mathematical concepts (Monariska & Komala, 2020; Nurhidayah, 2021).

Similarly, students' self-concept influences their ability to understand concepts. Students with positive self-concept answer mathematics problems better than students with negative self-concepts. This finding can be seen in the results of the posttest of concept understanding ability, where students with positive self-concept tend to solve concept understanding ability problems correctly, particularly on indicators of determining, using, and referring to certain operating procedures. It happened because self-concept is closely related to concept understanding ability (Musriandi, 2017; Rofika Hasan et al., 2021; S. M. Sari & Pujiastuti, 2020). According to the findings, the VARK-Fleming model and self-concept simultaneously influence students' concept understanding ability. In addition, post hoc tests with t-statistics were performed in Table 11.

Table 11. Post-Hoc Test Results

Parameter Estimates

Dependent Variable: Concept understanding

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	23,734	12,573	1,888	,064	-1,406	48,875
X2	,582	,157	3,701	,000	,267	,896
[X1=1,00]	3,967	1,639	2,421	,018	,690	7,244
[X1=2,00]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Note. Regression linearity test with n = 64

Table 11 in the row [1 = 1.00] shows that the value of t0 is 2.421 with a p-value of 0.018 at a significance level of 0.05. This number demonstrates that the p-value is lower than 0.05, indicating that H_0 is rejected and H_1 is accepted. In conclusion, after adjusting for student self-concept, the mathematical concept understanding ability taught to students using the VARK-Fleming model is superior to that taught using the expository model. Because the VARK-Fleming model combines the four learning styles of visual, auditory, read/write, and kinesthetic, it not only provides direct experience by involving students as much as possible in understanding mathematical concepts (Mulabbiyah, Ismiati, 2018), but it also makes the learning environment active and fun to get students excited so that they do not experience difficulties understanding mathematical concepts. According to this statement, other research (Almola, 2022; Jumrah et al., 2022) discovered that the VARK-Fleming model is more effective in boosting concept understanding and mathematics learning achievement because it integrates the four learning styles. Based on the previous description, it is possible to conclude that the VARK-Fleming model is superior to the expository model.

CONCLUSION AND SUGGESTION

The VARK-Fleming framework employed in this research follows the syntax proposed by Ngalimun (Ngalimun, 2012). This model has five steps: preparation, delivery, training, presentation of findings, and conclusion. By managing students' self-concept, the VARK-Fleming learning model and self-concept had a better effect than the expository model on students' mathematical concept understanding ability. Self-concept influences concept understanding ability in addition to VARK-Fleming. Students with positive self-concepts have a good concept understanding ability, and vice versa. This finding suggests that the VARK-Fleming model and self-model simultaneously affect students' mathematical concept ability.

Based on the research findings and field data, the VARK-Fleming learning model can be employed in teaching and learning activities, particularly in mathematics learning. The VARK-Fleming learning model enables students to be more active, independent, and creative. Also, they can absorb the learning material more quickly. Teachers must foster a positive student self-concept of mathematics to foster an internal drive to strive for mathematical achievement. Hopefully, the research will be useful and generate ideas for educators in general.

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