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Vocational High School Students' Perceptions of Mathematics and Performance on Basic Matrix Operations

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Abstract
This exploratory study examined the linear association between students' self-reported perceptions of mathematics and their performance on basic matrix operations. Participants were seven Grade XII Computer and Network Engineering (TKJ) students at SMK Samudra Nusantara in Cirebon Regency. The study used a 10-item questionnaire with five response options and a two-item written test on matrix addition and subtraction. The mean perception score was 37.29 (SD = 3.638, range = 30–41), and the mean test score was 64.29 (SD = 47.559, range = 0–100, median = 100). Simple linear regression yielded R = .021, B = 0.270, t = 0.046, and p = .965. The approximate 95% confidence interval for the slope ranged from −14.82 to 15.36. The analysis detected no linear association in this group. The wide interval and limited evidence of questionnaire reliability restrict the conclusions that can be drawn.

Keywords: perceptions of mathematics, matrix operations, vocational high school, mathematics achievement

INTRODUCTION

Mathematics in vocational education develops general reasoning and supports the technical knowledge students need in their fields of specialization. In Computer and Network Engineering (TKJ), matrices provide a way to represent structured information and support computational reasoning. Vocational mathematics instruction can also connect mathematical content to situations students encounter in their fields (Doli & Armiati, 2020).

In this study, perceptions of mathematics refer to students' self-reported evaluations of the subject's difficulty, usefulness, and accessibility as captured by the questionnaire. Wen and Dubé (2022)& Dubé (2022) describe mathematics attitudes as multidimensional, encompassing cognitive components such as perceived value and confidence, affective components such as enjoyment and anxiety, and behavioral intentions. The present study focuses on a general evaluation of mathematics. Self-efficacy, interest, and anxiety refer to more specific beliefs, inclinations, and emotional responses.

Students who perceive mathematics favorably may be more willing to attempt tasks, persist through difficulty, and engage in classroom activities. These behaviors may support achievement. Prior knowledge, instructional experience, procedural

fluency, and attendance may also contribute to performance. The study therefore examines perceptions as one possible correlate of achievement.

Matrix addition and subtraction require students to identify matrix dimensions, match corresponding entries, and calculate accurately. Performance on these largely procedural tasks may depend on prior knowledge and familiarity with the operations. Research in vocational schools has also documented difficulties with higher-order reasoning in matrix tasks (Pertiwi, 2018). A broad perception score may therefore have a limited association with performance on a small set of procedural items.

The association between students' general perceptions of mathematics and performance on specific procedural tasks remains an open question in this vocational setting. The present study explores that association in one group of Grade XII TKJ students.

The study asked whether students' perceptions of mathematics were linearly associated with their scores on a test of basic matrix operations. The exploratory hypothesis predicted a positive association.

METHODS

Research Design and Setting

This quantitative, exploratory study used an associative design and was conducted in a Grade XII Computer and Network Engineering (TKJ) class at SMK Samudra Nusantara, Cirebon Regency.

Participants and Sampling

The study purposively selected seven Grade XII TKJ students. With seven observations, individual scores can substantially influence the estimated association.

Measures

The study used a 10-item questionnaire with five response options to assess perceptions of mathematics. Item analysis identified seven items that met the validity criterion. The criterion and internal-consistency estimate were unavailable.

Students completed two written items on matrix addition and subtraction. Both items reportedly met the validity criterion. Item-level validity coefficients, scoring criteria, and evidence of scoring agreement were unavailable. The test score represents performance on these two tasks.

Data Collection Procedure

Students first completed the perception questionnaire, then received a brief explanation of basic matrix concepts before taking the achievement test.

Data Analysis

Descriptive statistics summarized both measures. The analysis used the Shapiro–Wilk

test to examine score distributions and simple linear regression in SPSS to estimate the association between perception and achievement scores. The small sample limits assessment of regression assumptions and the precision of inference.

The approximate standard error for the slope was obtained by dividing the rounded slope estimate by its t statistic. The 95% confidence interval used the t distribution with five residual degrees of freedom.

RESULTS AND DISCUSSION

Descriptive Statistics

All seven students completed both measures. Perception scores ranged from 30 to 41 (M = 37.29, SD = 3.638). The mean fell in the "good" category according to the study's scoring criteria.

Achievement scores ranged from 0 to 100 (M = 64.29, SD = 47.559), with a median of 100. Table 1 summarizes scores for both measures.

Table 1. Descriptive Statistics for Perception and Achievement Scores

Variable	N	Mean	Minimum	Maximum	SD
Mathematics perception (X)	7	37.29	30	41	3.638
Matrix learning outcomes (Y)	7	64.29	0	100	47.559

Distribution and Regression Results

Table 2 presents the distributional and regression statistics. The Shapiro–Wilk test yielded W = .877 and p = .216 for perception scores and W = .732 and p = .008 for achievement scores. For the square-root-transformed achievement scores, the test yielded p = .004. These tests describe the distributions of the measured variables. The assessment of regression assumptions would require examining the residuals.

Table 2. Shapiro–Wilk Tests and Simple Linear Regression Results

Analysis	Statistic	Reported value
Shapiro–Wilk: perception	W	.877
Shapiro–Wilk: perception	p	.216
Shapiro–Wilk: learning outcomes	W	.732
Shapiro–Wilk: learning outcomes	p	.008
Regression model	R	.021
Regression model	R^2	≈ .000
Regression ANOVA	F	.002
Regression ANOVA	p	.965
Perception coefficient	B	.270
Perception coefficient	t	.046
Perception coefficient	p	.965

The fitted regression equation was $\hat{Y} = 54.227 + 0.270X$, where X is the perception score. A one-point difference in perception score corresponded to an estimated 0.270-point difference in predicted achievement. The model yielded $R = .021$ and R^2 rounded to .000. The slope had a t statistic of 0.046 and a p value of .965.

The 95% confidence interval for the slope was approximately −14.82 to 15.36. This interval is based on rounded output and indicates substantial uncertainty in the estimated association.

Discussion

The regression detected no linear association between perceptions of mathematics and matrix test performance in this group. The wide confidence interval for the slope leaves both positive and negative associations compatible with the data. Ma and Kishor (1997) found that the association between mathematics attitudes and achievement varied across studies with different grade levels and sampling characteristics. In the present study, favorable perception scores covered a relatively narrow range, while the two-item achievement test captured only matrix addition and subtraction. The small sample and the lack of questionnaire reliability evidence further limit the interpretation.

Students completed the matrix test after a brief explanation of the topic, and their scores may also reflect differences in prior knowledge and procedural fluency. Tasya et al. (2018) documented errors with negative signs and the placement of corresponding entries in matrix calculations among Indonesian vocational students. These are plausible sources of score variation on addition and subtraction tasks. The available total scores do not show whether the students in the present study made those errors.

Wen and Dubé (2022) distinguished several dimensions of mathematics attitudes in their review of secondary education research. In a study of mathematics self-efficacy, Pajares and Miller (1995) found that confidence in solving specific problems predicted performance on those problems more strongly than broader judgments about mathematics tasks or courses. This finding suggests that students' confidence in performing matrix operations could be examined alongside their general perceptions of mathematics. Suriyanti et al. (2022) examined perceptions and mathematics outcomes in a vocational-school group using group investigation. Differences in instructional setting and measures limit direct comparison with the present study.

Gaspard et al. (2015) found that classroom activities connecting mathematics to adolescents' lives improved their beliefs about its value. In Computer and Network Engineering, a questionnaire could ask separately whether students see matrix operations as useful for representing structured data and whether they feel confident

performing those operations. The present questionnaire provided an overall perception score, so the contribution of perceived vocational relevance could not be estimated separately.

The observed variation in test scores highlights the value of assessing students' performance on matrix operations alongside their views of mathematics. A larger study could use a documented perception scale and a wider range of matrix tasks with explicit scoring criteria.

The sample comprised seven purposively selected students from one school. The outcome scores were highly dispersed, and individual paired scores were unavailable for examining influential observations or checking the association with a rank correlation. The relationship between perceptions of mathematics and matrix achievement remains uncertain beyond this group.

CONCLUSION

Among seven Grade XII TKJ students, the mean perception score was 37.29 and the mean score on matrix addition and subtraction was 64.29. The regression detected no linear association ($R = .021$, $p = .965$), and the confidence interval for the slope was wide. The results provide preliminary evidence from one vocational-school group. A larger sample and better-documented measures would allow a more precise estimate of the association.

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