Differences in Mechanical Reasoning of Engineering Students

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ABSTRACT

This study aims to analyze the differences in engineering aptitude-mechanical reasoning among engineering students. This study is a quantitative study with a cross-sectional study design. This study was conducted at the Faculty of Engineering, Ogan Komering Ilir Islamic University, Kayuagung (UNISKI). The subjects of this study were selected by simple random sampling so that the number of samples obtained was 26 students of the mechanical engineering study program and 36 students of the civil engineering study program. The instrument used in this study was the aptitude-mechanical reasoning test developed by Mackellar (2015). This instrument consists of several topics, namely 1) Levers, 2) Pulleys, 3) Gears, 4) Springs, 5) Simple electrical circuits, and 6) Tools. The research data were analyzed using the RASCH Model Analysis using the WINSTEP application. The results showed no significant difference between mechanical engineering and civil engineering study programs in pulleys, springs, and electrical circuits. In the element of levers, gears and tools, the t count value is greater than the t table, so there is a significant difference between mechanical engineering and civil engineering study programs.

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Differences in Mechanical Reasoning of Engineering Students

1. Introduction

Aptitude is better understood as a potential ability that reflects how likely a person is to succeed in carrying out a given task (Tech & Reeping, 2019). Aptitude is measured by Aptitude tests, which are more specific and limited compared to intelligence tests. Intelligence tests concentrate on abstract functions, including verbal or numerical symbols, so that more specific interests related to more concrete or practical abilities are forgotten (Candiasa et al., 2018).

The appropriate aptitude test for engineering is mechanical reasoning. Mechanical reasoning aims to measure the ability to understand the basic mechanical principles of machines, tools, and motion. Each item consists of a mechanical situation presented in a pictorial manner and simple questions that require reasoning rather than special knowledge. It is intended for mechanics, engineers, electricians, and machine operators, including jobs that require good mechanical reasoning (Vyas & Vyas, 2023).

At present, there is no research on engineering aptitude-mechanical reasoning tests that uses current modeling analysis. The measurement conducted must use proper modelling analysis. The RASCH Model is an analytical model used to evaluate the measurement properties of the assessment scale using probability estimates that focus on the quality of the outcome measure. This analysis assumes that the possibility of someone passing a question in a test is related to the statement about someone's ability and the level of difficulty of the question whose empirical data is tested. Hence, the purpose of the Rasch model analysis is to provide more precise and accurate measurements of people and items that can support various aspects of validity and precision. (Stolt et al., 2022). Rasch analysis guides the development of tests that provide reliable evidence of student ability. This is important regardless of how test results are used. The accuracy of assessment results influences decisions about which students meet passing standards or who might qualify (Farlie et al., 2021).

Rasch analysis can also be used to determine differences with t-tests using the Winstep application. Determining the differences between various types of techniques is necessary to determine which technique excels in one field more than another. So, based on this, this study aims to analyze the differences in engineering aptitude-mechanical reasoning among engineering students.

2. Research methods

This research is a quantitative research with a cross-sectional study design. A *cross-*

sectional study is an observational study that analyzes data from a population at one point (Maier et al., 2023). This research was conducted at the Faculty of Engineering, Universitas Islam Ogan Komering Ilir Kayuagung (UNISKI). The subjects of this study were selected by simple random sampling so that the number of samples obtained was 26 students of the mechanical engineering study program and 36 students of the civil engineering study program.

Instrument the test used in this study was the aptitude-mechanical reasoning test developed by Mackellar (2015). This instrument consists of several topics, namely 1) Levers, 2) Pulleys, 3) Gears, 4) Springs, 5) Simple electrical circuits, and 6) Tools.

The research data were analyzed using the RASCH Model Analysis using the WINSTEP application. The RASCH Model is an analytical model used to evaluate the measurement properties of the assessment scale using probability estimates that focus on the quality of the outcome measure. This analysis assumes that the possibility of someone passing a question in a test is related to the statement about someone's ability and the level of difficulty of the question whose empirical data is tested.

A t-test was conducted to answer the research questions. Before the t-test was conducted, a validity and reliability test was conducted first. The validity test was conducted by looking at the item fit, which can be done by looking at the data column with the OUTFIT MNSQ header for the item. In general, a range of values between 0.5 and 1.5 indicates the suitability of the data that fits the model. To evaluate whether there is a significant difference between the values, WINSTEPS was used to conduct an independent t-test. The measurement results are said to significantly differ between the two groups if the t-count is greater than the t-table.

The hypothesis in this study is:

Ho: There is no significant difference in engineering aptitude between mechanical and civil engineering study programs.

Ha: There is a significant difference in engineering aptitude between mechanical and civil engineering study programs.

3. Results and Discussion

The data processing results on 26 participants of the mechanical engineering study program and 35 participants of the civil engineering study program obtained the results that show in Table 1.

Table 1. Analysis of Rasch Parameters

Criteria	Value	Category
MNSQ Outfit	1.00	Fit
Realiabiloty	0.88	Good

The MNSQ Outfit shows that the items on the engineering aptitude-mechanical reasoning instrument fit/matched the Rasch parameters, or in other words, are productive for use in measuring (Boonee· et al., 2013). The results of the reliability test are shown by the item reliability value of 0.88, which is included in the "Good" category (Maslahul et al., 2022). This shows that the items are consistent in measuring, so participants' answers can be consistent or stable over time (Sanaky et al., 2021). So, based on the results of the validity and reliability of the items, the instrument used to measure engineering aptitude in this study is valid and matches the characteristics of Rasch modelling.

Data processing results show that the average engineering aptitude-mechanical reasoning of participants in mechanical engineering and civil engineering study programs varies. This can be seen in Figure 1.

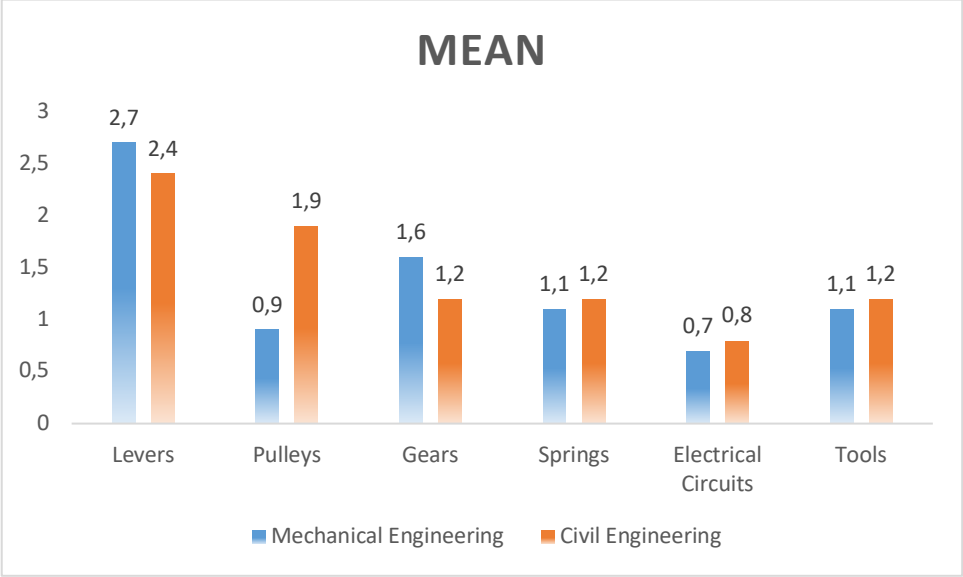

Figure 1. Mean of engineering aptitude-mechanical reasoning

The figure 1 shows that the mechanical engineering study program has a greater mean than civil engineering in the levers and gears aspect. Its importance in mechanical engineering can be caused by harmonic drive gears being widely used in aerospace applications, robotics, and precision positioning systems (Ilhomovna, 2022). Moreover, even the lever-gear

mechanism (GLM) application has become a part of the application applied in mechanical engineering (Rivkin et al., 2020).

Meanwhile, the civil engineering study program is superior in the aspects of pulleys, springs, electrical circuits, and tools. The mean difference shows that there is a difference in engineering aptitude-mechanical reasoning ability between the two study programs. A difference can be meaningful if it is significant. So, further tests are necessary to determine the significance of the difference between the t-tests, and the t-test results for each aspect are presented in Table 2.

Table 2. Results of the t-test for each aspect

Aspect	Lever	Pulley	Gears	spring	Electrical Circuits	Tools
t value	0.88	-3.71	1.30	-0.54	-0.59	-0.54
Probability	0.383	0.001	0.202	0.589	0.560	0.589
dF	57	51	44	54	55	54
t Table	-0.299	-3,258	-0.299	0.226	0.152	-0.596

Based on the data in Table 1, it can be seen that in the Pulleys, springs, and electrical circuits aspects, the calculated t value is smaller than the t table, so the Ho hypothesis is accepted. This shows that there is no significant difference in the pulleys, springs, and electrical circuits aspects between the mechanical engineering and civil engineering study programs. So, the mean difference between the two is interpreted as insignificant. Regarding levers, gears and tools, the calculated t value is greater than the t table, so Ho is rejected. This shows that there is a significant difference in the aspect of levers, gears and tools between mechanical engineering and civil engineering study programs. So, mechanical engineering has a higher ability than civil engineering in levers and gears. At the same time, the civil engineering study program has a higher ability than mechanical engineering in tools.

The results of this study are new; many other studies have measured engineering aptitude and differentiated it based on gender, such as the study (Miller, 2011), which shows the results that the results of previous experience show that male students spend more hours engaging in activities that have the strongest correlation to mechanical aptitude test performance. Other research results also show that gender comparisons on mechanical aptitude place men getting higher scores than women (Ringby, 2001).

4. Conclusions and Suggestions

The study results showed no significant difference in the aspects of pulleys, springs, and

electrical circuits between mechanical engineering and civil engineering study programs. While in the aspects of levers, gears, and tools, the calculated t value is greater than the t table, there is a significant difference between mechanical engineering and civil engineering study programs regarding levers, gears, and tools. It is hoped that this research can be continued to determine the aptitude of engineering students in other study programs.

5. Conflict of Interest

The author declares no conflict of interest.

6. Acknowledgement

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