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Optimizing student learning in Computer Numerical Control subject: A comprehensive analysis of influential factors

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Abstract: The learning outcomes achieved by students are influenced by many factors. This study aims to determine the level of support of factors (motivation, interest, family, teacher's role, learning methods and learning facilities) that influence the learning process in achieving student learning outcomes in CNC learning in class XI. The subjects in the study were Class XI students majoring in Mechanical Engineering at SMK Negeri 5 Padang in the 2022/2023 academic year totalling 37 people. Because the number of research subjects (population) is less than 100 people, so all of them are taken as samples or total sampling. Data collection was carried out using observation, questionnaires and documentation. Data analysis techniques using descriptive statistical techniques. From the data analysis, it shows that of each factor studied, the learning facility factor has the lowest level of support for student academic success compared to other factors that have been studied by researchers. Therefore, learning facilities at SMK Negeri 5 Padang in CNC subjects need to be improved again to support the student learning process and achieve better learning achievements for students.

Keywords: CNC; Practical learning; Mechanical engineering course; Vocational high school

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1. Introduction

Vocational high schools (Bahasa: *Sekolah Menengah kejuruan*/SMK) are part of the national education system, a form of formal education unit (Asrifan et al., 2020; Muliyah & Aminatun, 2020; Mulyanti et al., 2020). In the learning process at SMK, the quality of graduates is very important, in this case SMK is a producer of workers who are ready to enter the world of work based on their respective expertise and abilities. Preparing qualified and competent graduates begins with shaping student character throughout classroom learning (Maryanti et al., 2020). The subject of CNC Machining Technique is a lesson obtained by class XI in the first and second semesters, as for the basic competencies studied, namely: (1) Understand the meaning of CNC machines, (2) Understand CNC programming, (3) Understand CNC coordinates, (4) Understand the process and workings of CNC machines. Through this CNC learning, students are expected to be able to master the competency standards in accordance with Permendiknas No. 28 of 2009, namely setting up CNC machines, programming and operating CNC machines which are shown through the learning outcomes obtained by students in the form of numerical and letter grades (Prasetya, Fajri, et al., 2023; Prasetya, Syahri, et al., 2023).

The results of observations during field teaching practice at SMKN 5 Padang, it was found that during field teaching practice at SMKN 5 Padang, many students had low learning outcomes in CNC subjects. More than 50% are below the minimum completeness criteria, which is in accordance with what is determined by the school which is 75. From the observations made by researchers and discussions with student class teachers, the low learning outcomes that students get are due to the learning process of students who are less than optimal. Many

students do other activities during the learning process. For example, there are students who sleep, play mobile phones, and do other activities during the learning process. The learning achievement obtained by students is highly dependent on whether the learning process is good or bad, optimising student learning is certainly influenced by many factors (Anaman et al., 2022; Wayan Santyasa et al., 2021). Academic achievement is the result of academic effort which is strongly influenced by general abilities that we can measure (Surur et al., 2020). The learning outcomes achieved by a person are the result of interactions due to factors that influence it both from within the individual (internal factors) and from outside the individual (external factors) (Hayat et al., 2020; Ibáñez et al., 2020).

There are two factors that affect student success in learning activities (Alyahyan & Düştegör, 2020). The first concerns internal factors that come from within the individual, such as fatigue, physical factors, and psychological factors. Secondly, external factors that come from outside the individual, such as the school, family and community environment. To find out the extent to which factors affect the student learning process and see which factors are weak to learning outcomes which then need to be corrected to achieve good learning outcomes, the author wants to conduct research to find out the extent to which these factors affect the student learning process. Factors that affect student learning outcomes in CNC subjects.

2. Methods

2.1 Type of research

This research was conducted using a descriptive method. Descriptive research is used to describe, explain or summarise various conditions, situations, phenomena or variables depending on the events that occur (Mõttus et al., 2020).

2.2 Population and sample

The participants in this study consisted of students enrolled in the eleventh-grade Mechanical Engineering program at SMK Negeri 5 Padang during the even semester of the January-June 2022/2023 academic year. The school is situated at Jl. Beringin Raya No.4, Lolong Belati, Kec. Padang Utara, Padang City, West Sumatra Province. Due to the limited population size of 37 students, the entire population was included in the sample. According to (Avery et al., 2019), when dealing with populations of fewer than 100 subjects, it is advisable to employ a whole sampling approach, encompassing all individuals within the population for research purposes.

2.3 Research procedures

Throughout the research process, the author meticulously undertook several essential steps to ensure optimal outcomes. These stages encompassed planning, preparation, research implementation, and the final analysis. The planning phase involved the deliberate design of the research framework, detailing what actions would be taken and how. This encompassed activities such as formulating the research problem, defining research objectives, and outlining the research methods (Sinclair et al., 2023). Preparation, as a preliminary step, involved getting everything ready for the actual research endeavor. This includes assembling all necessary resources and materials required for the research process as indicated by Sinclair et al. (2023). The research implementation stage in this study involved the distribution of questionnaires to the targeted student participants. This phase constituted the direct execution of the planned research activities. The final stage of the research process involved the meticulous processing and analysis of the collected data by the researcher. Subsequently, the researcher drew meaningful conclusions based on the results obtained from the study.

2.4 Research instruments

In this study, a questionnaire instrument was employed as the primary data collection method. The questionnaire was distributed to students who had successfully completed the Class XI CNC curriculum. Table 1 displays the structured elements used for reporting the questionnaire questions.

Table 1. Indicator of instrument

No	Indicators	Description
		Student attention during the CNC lesson process
1	Motivation	Students' awareness of the importance of CNC learning
		Student independence in doing assignments
		Students' feelings during the learning process
2	Interests	Student engagement while learning
		Feedback on CNC lessons
		Family economic conditions
3	Family	Relationships between families
		Attention from family
		Scientific competence
4	Teacher's role	Approach to students
		Passion for teaching
5	Learning Methods	Understanding of the method provided
6	Learning Facilities	Comfort, satisfaction and ease of access to learning facilities

2.5 The validity and reliability of the instrument

The validity test is conducted utilizing the Pearson correlation formula known as the Product Moment Correlation (Sultoni et al., 2020). Reliability serves as an indicator reflecting the degree of dependability and trustworthiness inherent in a given tool (Hayes & Coutts, 2020). Items failing to meet stipulated requirements will be excluded from further consideration. In the validation process of the instrument, Eq.1 is employed to ascertain the validity value.

$$r_{xy} = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{\{(N\sum x^2 - (\sum x)^2\}\{N\sum y^2 - (\sum y)^2\}}} \quad (1)$$

Reliability is assessed through the utilization of the Alpha formula (Surucu & Maslakci, 2020), Eq. 2.

$$r_{II} = \left[\frac{(K)}{(K-1)}\right]\left[1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right] \quad (2)$$

The outcomes of both the validation tests are presented in table 2 and and reliability tests are presented in table 3.

Table 2: Validity test results

Instrument	Total	Valid	Invalid
Questionnaire	30	27	3

In the validity test conducted on 15 students who had completed CNC learning at SMK Negeri 5 Padang in the previous semester, utilizing the provided questionnaire, the results revealed assessments for 30 statements. Among these, 27 statements were deemed valid, while 3 statements were identified as invalid.

Table 3. Instrument questionnaire reliability test

No	Indicators	Testing criteria	
		Alpha	Description
1	Motivation	0,918	Reliabel
2	Interests	0,916	Reliabel
3	Family	0,861	Reliabel
4	Teacher's role	0,625	Reliabel
5	Learning Methods	0,825	Reliabel
6	Learning Facilities	0,665	Reliabel

All six learning factors employed as research variables exhibit a Cronbach Alpha value greater than 0.60. Consequently, the questionnaire is deemed reliable and consistent.

2.6 Data analysis technique

The learning factors to which students responded upon completing the learning process were included in the dataset used to compute the percentage and value of student learning factors. The formula Eq. 3 was employed to determine the percentage of student learning factors.

$$P = \frac{F}{N}\ 100\ \% \tag{3}$$

The scoring of learning factors was followed by the determination of factor scores utilizing Formula Eq. 4.

$$\text{Value} = \frac{\text{Score obtained}}{\text{Maximum score}} \text{x}\ 100 \tag{4}$$

Grouping student learning factor scores into high, medium, and low categories. The categories of high, medium, and low (Syahril et al., 2021), presented in table 4:

Table 4. Categorisation of student learning factors

No	Value interval	Category
1	M ≥ X + SD	High
2	M – SD ≤ X < M + SD	Medium
3	X < M – SD	Low

3. Results and discussion

Based on the conducted data analysis, several conclusions can be drawn. Each variable or learning factor exhibits distinct levels, determined by the percentages derived from the calculation of questionnaire scores. The study results provide values for specific factors, such as desert factors, along with the corresponding percentages, indicating their influence on the student learning process.

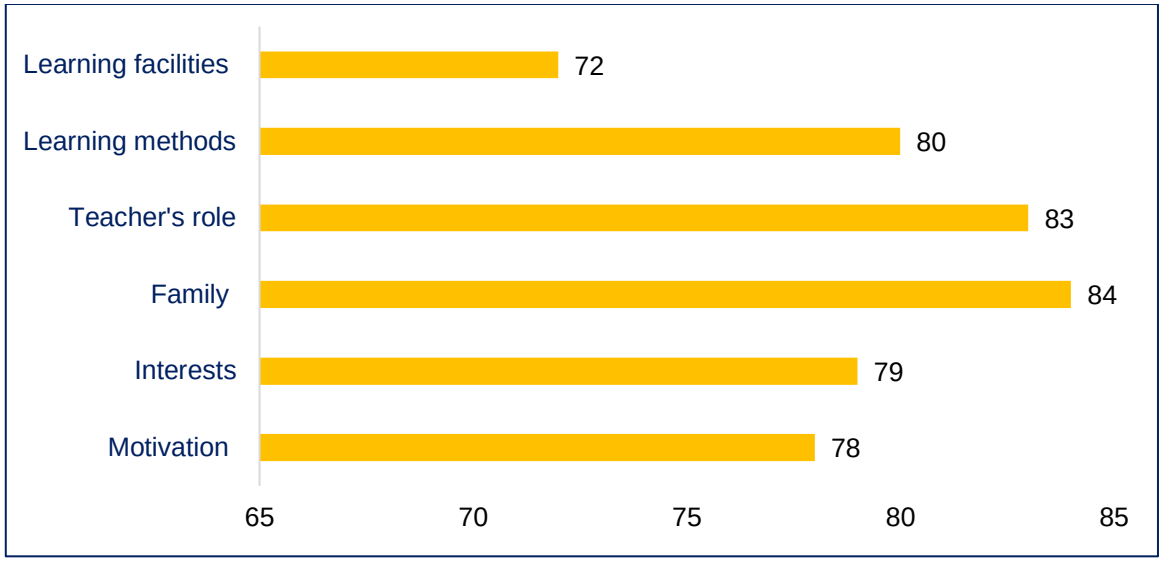

Figure 1. Percentage distribution of each student learning factor

Each variable or learning factor exhibits distinct levels based on the percentages derived from the calculation of questionnaire scores. Student motivation emerges as a pivotal factor influencing student learning behavior in the CNC Machining Technique class for grade XI at SMK Negeri 5 Padang. Consequently, it can be inferred that a considerable proportion of Class XI mechanical engineering students engaged in CNC learning possess moderate motivation, falling within the standard range. Interest, defined as an increasing tendency or desire for something, plays a crucial role in driving student engagement in learning (Wang & Chen, 2020). The data indicates that the number of students with low interest in learning surpasses those with high interest. Additionally, the family environment significantly impacts each student's learning approach, with the level of education and family habits shaping a child's learning attitude. Therefore, a predominant trend is observed in the class, although further details could enhance the comprehensiveness of the conclusion.

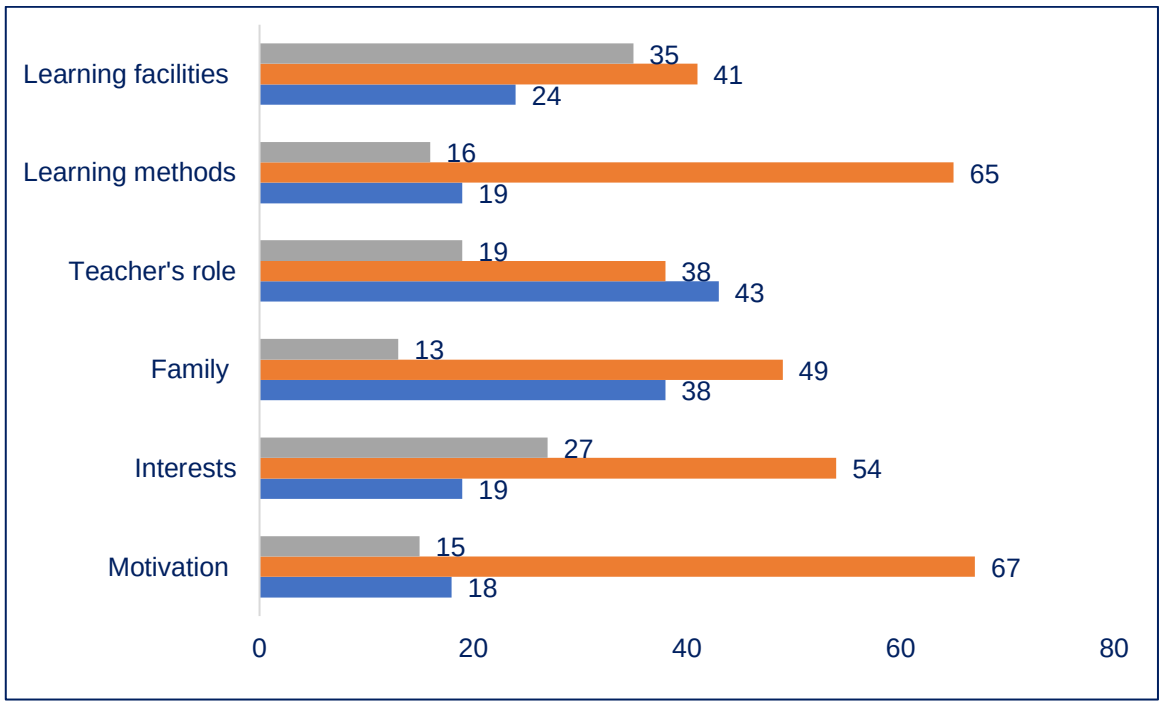

Figure 2. Factor levels of influence on the student learning process

Teachers should pay attention to attitudes that can actively motivate students to learn seriously. According to (Sishchuk et al., 2020), qualified teachers will be more capable of creating an effective and enjoyable learning environment, designing their instruction in a manner that yields favorable student learning outcomes. This underscores the crucial role of teachers in CNC (Computer Numerical Control) education, emphasizing the need for its preservation. Sound instructional methods contribute to students' success in achieving positive learning outcomes. While most students believe that the instructional methods employed by teachers support the CNC learning process, it still falls within a moderate range and is open to improvement. Therefore, teachers should consider enhancing creativity in their use of instructional methods. Learning opportunities within the school setting also impact students' learning conditions. According to (Castro & Tumibay, 2021), learning opportunities have proven beneficial in facilitating the learning process. The majority of classes imply that the state of learning opportunities in this school could serve as an impediment to student learning regarding the availability of these opportunities.

Based on the conducted data analysis, each learning factor is characterized by distinct levels determined by the percentages derived from the questionnaire score calculations. The learning facility factor exhibits a lower assessment level compared to other factors, whereas the teacher's role factor, as assessed through statements provided to students, demonstrates a higher value in comparison to other factors.

4. Conclusion

Based on the discussion, it can be concluded that there are certain factors requiring improvement to optimize the student learning process and enhance overall learning outcomes. The researchers categorized observation levels into three groups: high impact, medium impact, and low impact factors. These categories provide insights into which factors demand maintenance, attention, and enhancement. Out of the six factors investigated—motivation, interest, family environment, teacher role, learning methods, and learning facilities—the learning facility factor stands out at the lowest level compared to the others. Specifically, 35% of students perceive the current learning facilities as inadequate, and 41% consider them at a moderate level in supporting learning achievement, resulting in a cumulative score of 72 for the learning facility factor. Consequently, it is imperative to address and improve the learning facilities at SMK Negeri 5 Padang, especially in the CNC subjects, to bolster student learning and attain superior academic achievements.

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Declarations

Author contribution

Muhammad Al Fadri as the researcher and data collector, and Yufrizal A as the person in charge of the thesis process, starting from the creation, method, and process. Yolli Fernanda and Febri Prasetya considered the results of the data that the researchers had collected.

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Competing interest

The author states that there was no conflict when conducting the research.

Ethical clerance

The involvement of human subjects in this research complies with the Declaration of Helsinki.

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Nomenclature

rxy	Produck moment correlation coefficient
N	Number of respondents
∑xy	The sum of multiplication between item scores
∑x	The sum of multiplication between item scores
∑y	Sum of the prices of the total score
r_{II}	Reliabilitas instrumen
K	Number of instrument items
$\Sigma\sigma_b^2$	Sum of item variances
σ_t^2	Varians total
X	Value Learning factors
M	Average score
SD	Standard deviation of learning factor scores