



Measurement of Student's Mental Workload in Politechnic using Nasa-Tlx

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Abstract The vocational education system is one of the forms of the education system in Indonesia. This education system has distinctive characteristics that in vocational education the proportion of practical subjects is quite large. This is because vocational education focuses on graduates who are able to be practitioners. The aims of this research are to determine parameters in mental workload are the most dominant who felt by students at the diploma level and how much mental workload that students feel is due in vocational education. In this study vocational education became the object of research. Vocational education selected in this research is one of the vocational education with Diploma level in Industrial Engineering majors. The education system applied in this vocational education has study hours from Monday to Friday and from 07.00 to 16.00 every day. The curriculum applied to the research object has a large proportion of practical subjects. A large amount of practical subject is reflected through almost all of the subjects taught in practicum activities. The results of this research, it is known that in vocational education, students experience a dominant mental workload, namely mental demand, which are then followed by performance and physical demand with an average weighted workload of 73.19 which is included in the job category moderate level.

Keywords Vocational education, Mental Workload, NASA TLX, Mental Demand

1. Introduction

Education is one of the ways that humans take in the effort to increase knowledge so that humans are able to carry out their lives towards something better. The purpose of education is to obtain of knowledge, abilities, skills, enhancement of attitudes and values in the efforts of forming and developing students [1]. To achieve this goal, education is generally organized in three complementary forms, namely guidance, teaching and training [1]. In the form of guidance, the process is more focused on developing affective domains such as developing values, attitudes, interests, motivations, emotions, appreciation, and so on [1]. In the form of teaching, the process is more focused on developing the intellectual / cognitive domain and in the form of training, the process is more focused on developing psychomotor domains or skills [1].

In education, there is an interaction between teachers and students, where the interactions that occur leading to an interaction, that affects each other. It is all because the success cannot be separated from the role of teachers and students in the education process. The role of students in the education process is more as a recipient of influence which means that students in a passive position receive and get grades and in an active position, students develop the value that they have gained [1].

In Indonesia, there are many educational levels, one of them is a Diploma which is included in vocational education. In this study, a diploma level will be used as an object of study. According to Undang-Undang Republik Indonesia No. 12 (2012), about Higher Education in article 16 paragraph 1 it is said that vocational education is preparing students for jobs with certain applied expertise up to undergraduate programs. In vocational education, students are trained and coached in an effort to build the competencies of students who are able to directly become skilled and reliable practitioners in their fields after they graduate from education. This is



the reason why every vocational education has distinctive characteristics related to the ongoing education system, which is different from the characteristics of the undergraduate system or other education levels. One form of the distinctiveness of vocational education compared to other is about the proportion between theoretical subject and practice subject. In the vocational education curriculum, the proportion of practice subject is quite large. This is because vocational education focuses on graduates who are able to be practitioners. Objects in this study took case studies in diploma levels that implemented a service system. At this institution, lectures are conducted on Monday to Friday for 8 hours. The density of lecture time can certainly cause fatigue on students. As is known, fatigue can be divided into two major things, namely physical fatigue and mental fatigue. Learning activities can cause mental fatigue because in learning activities students do not do too much physical activity. Nofri et al [2] conducted a study related to the mental workload of third and fifth grade students in the Industrial Engineering Department. The results showed that the average mental workload was 80.04 which was categorized as rather heavy and the dominant scale is temporal demand. Looking at the study conducted by Nofri et al [2], this study tried to determine whether the same thing happened to students who took education in vocational education.

Therefore, the object of this study is a diploma level where in the previous explanation, it is said that in vocational education, the proportion of practice subject is quite large, which is different from undergraduate level. This study tries to determine what parameters in mental workload are the most dominant who felt by students at the diploma level and how much mental workload that students feel is due in vocational education.

2. Literature Review

2.1. Learning

Learning is a process in which a behavior arises or changes because of a response to a situation [2]. Meanwhile, Mulyadi et al [3] learning is a change in behavior or performance that is relatively permanent as a result of training or experience and not because of growth or fatigue or because of drugs. Based on these two definitions, we can know that learning is a process that directs a person to behavioral change because of input (training results) that are responding well where the change is permanent. There are eight types of learning [1], namely:

1. Signal Learning
A type of learning with an emphasis on recognizing and giving responses to a stimulus
2. Stimulus - Respons Learning
A type of learning with an emphasis on the relationship between stimuli and how the multiple stimulus will be responded.
3. Chaining
A type of learning with an emphasis on several activities that form a unity and sequential
4. Verbal Association
A type of learning with an emphasis on the concept of correlation
5. Discrimination Learning
A type of learning with an emphasis on building the ability to distinguish between one stimulus and another
6. Concept Learning
A type of learning with emphasis on understanding a concept
7. Rule Learning
A type of learning with emphasis on rules
8. Problem Solving Learning
A type of learning with emphasis on problem solving

The eight types of learning complement each other and their implementation is adapted to the need to meet the objectives to be achieved in the learning process.

In learning, there is a process that can be grouped into three [3], namely:

- a. Association
- b. At this stage, students try to link the knowledge received through the learning process to the knowledge they already have.



- c. Accommodation
- d. At this stage, students integrate knowledge received through the learning process with the knowledge they have.
- e. Equilibration
- f. At this stage, students move from one stage of thinking to the next.

We can be seen that the success of the learning process is determined by other factors that can be internal or external. For internal factors, it is of course directly related to the students themselves, which leads to the self-characteristics of students. Cronbach (1954, in Sukmadinata [1]) explained that students need to prepare themselves both physically and psychologically in the learning process. Cronbach (1954, in Sukmadinata [1]) also explained that external factors that influence the learning process are factors that are related to learning situations that can be infrastructure, the environment, tools and materials used in the learning process, and people (other students and teachers).

2.2. Mental Workload

When people do his job, in the process of execution, people will experience fatigue due to workload. The workload is defined as a condition that must be passed by someone in an effort to achieve work performance at a certain level [4]. The workload that a person receives when doing his work is divided into two categories: physical workload and mental workload. Physical workload is related to the work carried out in the form of physical activity while mental workload is related to the work done by involving a lot of cognitive functions [5-7].

Cognitive function relates to the workings of the human brain in processing information. This information is received from the surrounding environment through the five senses. Generally, humans will go through three major stages in processing information, namely understanding, processing and responding to information [5]. Jobs such as counting, remembering, analyzing, comparing, thinking and so on are included in the type of work with mental workload because many types of this work involve brain function. In this study, research was conducted on students. Therefore, the workload experienced by students as objects in this study is included in the category of mental workload.

2.3. NASA-TLX

NASA-TLX is a method of subjective measurement that can be used to measure human mental workload. In this method, participants are asked to give their opinions regarding the work done by giving values from 0 to 100 for each parameter. The parameters measured in the NASA-TLX consist of six parameters, namely mental demand, physical demand, temporal demand, performance, effort and frustration level. The following is an explanation of the six parameters [5-7]

- a. Mental Demand
This parameter measures things related to the mental and the perceptual needs on the job's activities.
- b. Physical Demand
This parameter measures things related to physical activity needs at work.
- c. Temporal Demand
This parameter measures things related to the need for time in completing the work.
- d. Performance
This parameter measures things that are related to the success level of work achievement.
- e. Effort
This parameter measures things related to effort needs in the completion of work.
- f. Frustration Level
This parameter measures things related to the frustration experienced during the work.



3. Materials and Methods

3.1. Vocational Education System

The vocational education system is one of the forms of the education system in Indonesia. This education system has distinctive characteristics that in vocational education the proportion of practical subjects is quite large. This is because vocational education focuses on graduates who are able to be practitioners. In this study vocational education became the object of study. Vocational education selected in this study is one of the vocational education with Diploma level in Industrial Engineering majors. The education system applied in this vocational education has study hours from Monday to Friday and from 07.00 to 16.00 every day. The curriculum applied to the study object has a large proportion of practical subjects. A large amount of practical subject is reflected through almost all of the subjects taught in practicum activities.

3.2. Partisipant

Participants in this study were 30 students who are at 2nd semester. The 30 students involved in this study consisted of 15 men and 5 women with an age range of 18 to 20 years. Studiers choose students at 2nd semester because they are considered to have been through the introduction phase of the teaching system, knowing and being able to adapt to the culture and education system that applies in vocational education.

3.3. Questionnaire

In this study, data collection was done using a questionnaire. The questionnaire consists of two parts, namely Part A and Part B. Part A measures the rating level of each variable and Part B compares the variables. After the data have been collected and validated that each question has been filled in properly by the participants, then data processing is carried out. Data processing will be done using NASA-TLX.

3.4. Data Processing(NASA-TLX)

NASA-TLX is a method that can be used to measure the mental workload. At NASA-TLX, mental workload is categorized into 6 parameters, namely mental demand, physical demand, temporal demand, performance, effort and frustration level. In this study, data processing was carried out using the NASA-TLX. In accordance with the purpose of this study, through data processing using NASA-TLX, the output of data processing with the NASA-TLX will be directed to find out what parameters are the most dominant of the 6 parameters of mental workload measured through NASA-TLX and how much average of perceived mental workload.

4. Results and Discussions

4.1. Partisipant's Data

This study involved 30 students as participants. The distribution of the participants' data is shown in Figure 1, Figure 2 and Figure 3.

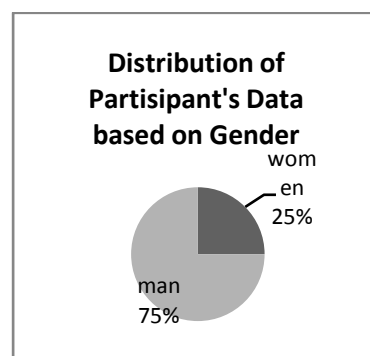


Figure 1: The Distribution of The Participant's Data Based on Gender

Figure 1 shows the distribution of participant data based on gender. It is known that in this study the participants consisted of men (75%) and women (25%). It can be seen from Figure 1 that the participants involved were more male than women. This is might because the object of study is the vocational education (Industrial Engineering program) were mostly vocational education based on engineering is dominated by men.



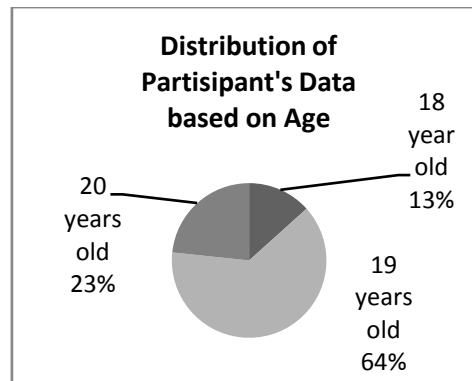


Figure 2: The Distribution of The Participant's Data Based on Age

Figure 2 shows the distribution of participant data based on age. In Figure 2 it can be seen that the distribution of participants' age is 18 years (13%), 19 years old (64%) and 20 years old (23%). The dominant age of the participants involved in this study was 19 years old. This is because they are enrolled in 2017 where in 2017 the average student is 19 years old.

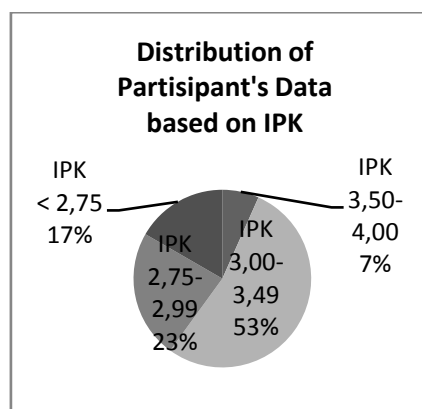


Figure 3: The Distribution of The Participant's Data Based on IPK

Figure 3 shows the distribution of participant data based on the GPA. In Figure 3 it can be seen that the distribution of participant data is divided into 4 groups: (1) students with a GPA between 3.50 to 4.00 (7%), (2) students with a GPA between 3.00 to 3.49 (53%), (3) students with a GPA between 2.75 to 2.99 (23%), and (4) students with a GPA less than 2.75 (17%). The dominant GPA of participants was in the range between 3.00 to 3.49. This shows that the participants involved in this study have a fairly good level of intelligence.

4.2. Data Processing with NASA-TLX

4.2.1. Mental Workload every Parameters

This study uses NASA-TLX as a method of processing and analyzing data. In the first stage, based on the data that has been collected, the data will be processed by finding the average value in each measured parameter. Based on the average value, then the data will be sorted from the largest value to smaller one so that the ranking of the parameters can be known and from that rank can be seen the most dominant parameter (the biggest value). Table 1 shows the average values of six parameters on NASA-TLX and Figure 4 shows the ranking of six parameters.

Table 1: The Average Value of Mental Workload

No.	Parameter	Average Value	Rank
1	Mental demand	79.83	1
2	Physical demand	75.17	3
3	Temporal demand	70.50	4
4	Performance	75.50	2
5	Effort	66.83	5
6	Frustration level	51.83	6



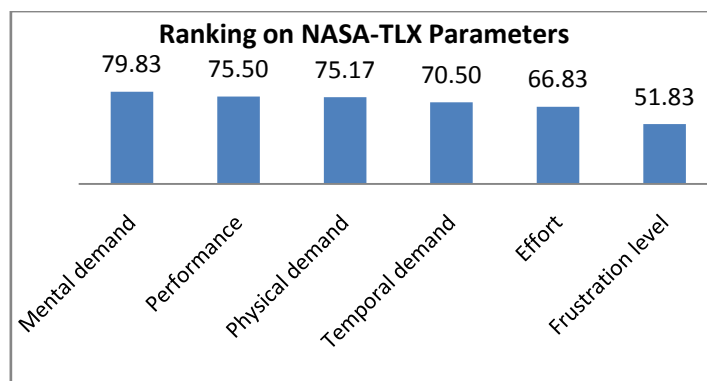


Figure 4: Ranking on NASA-TLX Parameters

Based on Table 1 and Figure 4 it can be seen that mental demand occupy the first rank followed by second and third order, namely performance and physical demand. This shows that vocational education is synergizing both mental demand and physical demand in the learning process. As is known that in learning activities in educational institutions, generally, mental demand is the dominant activity. This is because in the learning process, there are a lot of activities that involve brain functions such as counting, remembering, analyzing, comparing, thinking and so on. According to Piaget (1952 in Mulyadi et al [3]) in the learning process, there are three activities namely association, accommodation and equilibration. These three activities are related to the mental demand. Therefore, in vocational education, mental demand is still the dominant parameters because in vocational education occur the learning process.

In addition to mental demand, in vocational education, physical demand has also become a dominant parameter that is in the third place. This shows that in vocational education, the curriculum is not only given in a form that leads to mental demand but also in physical demand. This is reinforced by the conditions in which vocational education has a large proportion of practical subjects where practical subject is a superior value in vocational education. In the practice subject, students do a lot of physical activity in its application. In the practical subject, physical demand becomes dominant. Therefore, it can be concluded that in vocational education, there is a collaboration of mental workload between mental demand and physical demand.

The study conducted by Nofri et al [2] on students at a university showed that the parameters of physical demand ranked sixth (the last rank). This certainly shows something interesting when compared with the results in this study. In this study, physical demand is ranked third. This difference in ranking can be attributed to differences in curriculum applied between universities and polytechnics. As is known that the Polytechnic curriculum is designed based on theory and practice with practical subject that is quite dominant. This is because vocational education focuses more on education with graduates to meet practitioners. Therefore, in Polytechnic, mental workload in the form of physical demand will be more dominant compared to Universities.

In the second rank, there are performance. This is related to the student's GPA. Student success during the learning process can be seen from the GPA achieved. In vocational education which is the object of this study, a drop out system is applied. Students will experience a drop out when the student GPA is under 2.75. This shows that the GPA is one of a learning process parameter and this is important for students. Therefore the mental workload on vocational education can also be derived from performance parameters.

4.2.2. Weighted Workload (WWL)

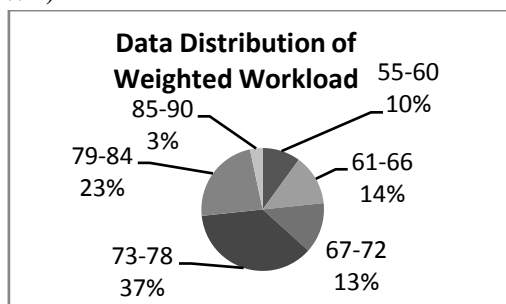


Figure 5: Data Distribution of Weighted Workload



Table 2: Score of Weighted Workload (WWL)

	Score of WWL
Minimum score	55.00
Maximum score	86.33
Average score	73.19

Table 3: Mental Workload Category [8]

	Category
> 80	Heavy work
50 - 80	Moderate work
< 50	Light work

Data processing using NASA-TLX will produce a weighted workload (WWL) value. The WWL value indicates the value of the mental workload received. Table 2 shows that the average value of mental workload felt by Polytechnic students is at 73.19 with the range between 55.00 to 86.33. If the value is converted into Table 3, it can be concluded that the mental workload of Polytechnic students is in the job category with a moderate mental workload. Based on Figure 5 it can be seen that the weighted workload value spreads widely in the range of 73 to 78. This shows that the mental workload felt by Polytechnic students is still in the medium category, but there is potential to be able to switch to heavy categories considering that the data distribution is weighted the second order workload is in the range 79 to 84.

5. Conclusions

The polytechnic is an institution which implements a curriculum that combines between theoretical subject and practical subject. At Polytechnic, practical subject has a large proportion in curriculum design. This is because vocational education focuses more on education with graduates to meet practitioners. Based on the study, it is known that in vocational education, students experience a dominant mental workload, namely mental demand, which are then followed by performance and physical demand with an average weighted workload of 73.19 which is included in the job category moderate level.

The dominant parameters in this study are different when compared to the dominant parameters conducted by Nofri et al [2] who the object of study namely university students. This may stem from different curriculum designs between Polytechnics and Universities. Therefore, as a suggestion, in subsequent studies, study can be conducted to see the influence of the curriculum on the mental workload of students.

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