Impact of cognitive styles on students' psychomotoric abilities on multimedia course practicum

I N E Mertayasa¹, I G B Subawa², K Agustini³, D S Wahyuni⁴

¹,²,³,⁴Department of Informatics and Engineering Education, Faculty of Engineering and Vocational, Universitas Pendidikan Ganesha 81116, Indonesia

Abstract. Cognitive style refers to the way person processes, stores or uses information to respond to a task and different types of environmental situations. Cognitive style determines the way students collect and use information. On the words, it relates to how students respond to the learning process in the classroom. The purpose of this study is to examine the relationship of a student's psychomotor abilities to a student's cognitive style. Using quantitative design, this research it will be scientifically known how much cognitive style contributes to a student's psychomotor abilities. The sample of this study is student who took Multimedia Technology courses in department of informatics and engineering education. Descriptive statistical analysis and inference statistical analysis were used to analyse the data. The results of this study revealed that there was a significant impact on the cognitive styles of the students in both dependent fields and independent fields.

1. Introduction
Evaluation is a process that determines a condition in which a goal has been achieved. This definition describes the relation of evaluation to the purpose of an activity that can be measured, where a goal is achieved. Evaluation contains of processes that must be precisely conducted towards the type of purpose usually expressed in the behavioural language.

Individual differences are influenced by: (1) proficiency and ability, (2) knowledge, skills, and attitudes, (3) personality and learning style, and (4) age and experience [1]. The differences that exist in individuals are: (1) intellectual development, (2) ability to use amperes or languages, (3) background experience, (4) learning style, (5) personality, and (6) self-description. Lack of interest in learning statistics can be influenced by various aspects. Learning disinterest can be caused by an inappropriate form of learning in the classroom. Learning forms that is commonly used in statistical learning are unprogrammed lecture and training techniques. Huang et al. classified the variables of learning conditions into three groups, namely: (1) the objectives and characteristics of the study field, (2) the constraints and characteristics of the study field, and (3) the characteristics of the learner. Characteristics of the learner are aspects or qualities of individual learners, such as talent, interests, motivation, goal orientation, intelligence, cognitive style, learning outcomes that have been possessed and so on [2].

Evaluation of learning outcomes can be carried out properly when the implementation follows three basic principles: (1) Overall Principles, (2) Principles of Sustainability, and (3) Principles of Objectivity [3]. One of the basic principles that must always be considered and upheld in the evaluation of learning outcomes is the principle of roundness. This principle requires the evaluator to thoroughly evaluate the learners, both in terms of their understanding of the materials given (cognitive aspects), and in terms of delusions (affective aspects) and his experience (psychomotor aspect).
One of the important aspects in learning process is psychomotor aspect. Informatics Engineering Education Study Program in Undiksha is one of programs that have dominant spread of practicum courses. This dominant practice should prioritize the student psychomotor ability in the lecture process. Good psychomotor abilities will certainly faster the process of achieving the study goal. In addition, the acceptance of the course material by student will also get better [4].

There are a lot of students who did not do the practicum lecture process optimally. This was due to the input of students from different schools. As an impact of these different inputs, thus resulted in an initial difference of their understanding, the acceptance of information will also be different, and will create an impact on the achievement of student learning outcomes. Furthermore, this difference also occurs due to the different cognitive style possessed by students, in which cognitive style is stated as one of the most defining aspects in learning. In addition to the different of comprehension skill backgrounds, the low and uneven psychomotor ability of each student resulted in a low student practicum learning outcome.

In addition to the psychomotor aspect, there are several factors that affect learning process, namely internal factors from within student and external factors from outside the student. One of the internal factors that play an important role is the absence of cognitive style. Cognitive style refers to the way a person processes, stores or uses information to respond to a task or different types of environmental situations [5]. In this case, environment is a place where students can learn. How students collect and process the information can be used to respond to the learning process in the classroom.

Generally, cognitive styles are distinguished into two: Field Dependence cognitive style and Field Independence cognitive style [6]. Students with Field Dependence cognitive style (FD) are individuals who receive something more globally and have difficulty in separating themselves from their surroundings or are more influenced by the environment. While student with Field Independence cognitive style (FI) is an analytical individual who tends to express a loose image from the background of the image, and is able to distinguish objects from the surrounding context.

In concern with the aspect of cognitive style and psychomotor ability in learning, it is very interesting to examine the relationship between these two important aspects. Determinant aspect analysis for the increase of practicum learning achievement is necessary to be conducted to improve the student learning achievement which is also create an important impact on improving the student’s quality. The study of the relationship between independent variables (cognitive force) and dependent variables (psychomotor ability) is concerned with the scientific truth of the theory justification used to answer research problems. The study of both variables will give an idea of the extent to which the effectiveness of the study process (learning action) can affect the learning outcomes. This study also concerns to comprehensive study of student learning activities based on the learning stages conducted during the study. Therefore, a more in-depth study on the relationship between cognitive style and psychomotor abilities is highly needed.

Based on the problems mentioned above, an analysis related to the student psychomotor ability based on cognitive style is very necessary to be conducted. This is important to examine how strong and effective the relationship between these two variables.

2. Literature Review

2.1 Psychomotor Ability
Psychomotor ability is an ability related to skill or the ability to act after a person receives a particular learning experience. The outcomes of psychomotor learning appears in the form of individual skills and acting abilities [7]. These psychomotor learning outcomes are actually a continuation of cognitive learning outcomes (understanding something) and affective learning outcomes (which are newly apparent in the form of tendencies to behave).

The results of cognitive learning and affective learning results will be the result of psychomotor learning. In this case, the learner has demonstrated certain behaviours or deeds in accordance with the meaning contained in the cognitive realm and affective realm [2]. If the results of cognitive and
affective learning with discipline material according to Islamic teaching as stated previously, then the tangible manifestation of the results of psychomotor learning which is a continuation of the results of cognitive and affective learning is:

- Learners ask Islamic religious education teachers about the examples of discipline that have been shown by the Prophet (s), friends, scholars and others.
- Learners search for and read books, magazines or brochure, newspapers and others that discuss discipline.
- Learners can explain to their classmates at school, or to their younger siblings at home, or to other members of the community, about the importance of discipline applied both at school, at home and in the midst of community life.
- Learners encourage school friends, or their siblings, to be disciplined both at school, at home and in people's lives.
- Learners can provide examples of discipline in school, such as coming to school before the lesson begins, rule in wearing school clothes and discipline in following the school's pre-determined rule.
- Learners practice with a continuation of discipline in learning, discipline in worship, and discipline in obeying traffic regulations, and so on.

2.2 Cognitive Style
Each individual has different characteristics. Therefore, they are different from each other. In addition to differing in problem-solving proficiency, intelligence level, or thinking ability, students can also differ in how they acquire, store and apply knowledge. They can differ the way they approach learning situations by how they receive, organize and connect their experiences, and in the way, they respond to certain teaching methods. The differences between sedentary personal beings in how to compile and process information and experiences are known as cognitive styles [8].

Cognitive style refers to the way a person processes, stores or uses information to respond to a task or respond to different types of environmental situations. It is referred to as a style and not as an ability, because it refers to how a person processes information and solves problems instead of referring to how the settlement process is best.

Cognitive styles are distinguished into two: Field Dependence cognitive styles and Field Independence cognitive styles. Each individual's learning activities can be distinguished into two groups that are global and analytical [9]. Global individuals are individuals who receive something more globally and have difficulty separating themselves from their surroundings or are more influenced by the environment. Individuals of this nature are called Field Dependence cognitive style (FD). While analytical individuals are individuals who tend to express a loose image from the background of the image, and are able to distinguish objects from the surrounding context. They view the surroundings more analytically. Individuals of this nature are called Field Independence cognitive style (FI). The individual characteristics of FD and FI are as follows:

a. In carrying out a task or completing a problem, FI individual will work better if given freedom. Meanwhile, FD individual will work better if given extra guidance.

b. Individuals who are FI have a tendency to not to be easily influenced by the environment, and conversely individuals whose FD have a tendency to be more easily influenced by the environment.

c. In completing a task or solving a problem (problem solving) that requires a skill then FI individual will produce better than the FD individual.

Classing individuals into one cognitive style is done by providing a perceptual test. The Embedded Figures Test (EFT) is a perceptual test that uses images. The reference to the substituted outer frame is an intricate image, which hides a simple image [10].
3. Methodology

3.1 Research Design
The method used in this study was a quasi-experiment method with pre-test post-test research design. All studied classes were given the same learning method in three meetings. The research design shows on Table 1 below.

| Pre-test | Treatment | Post-test |
|----------|-----------|-----------|
| T        | X         | T         |

*Note: T=Test; X=Treatment

3.2 Population and Research Samples
The population of this study was all active students in the Informatics Engineering Education Study Program of Universitas Pendidikan Ganesha. There were 50 students which were used as research samples. These samples were selected using simple random sampling technique. It was started by determining a random group or class of students or by lottery because the average student's ability is already equal. Variables in this research are student cognitive styles and psychomotor abilities. All students were grouped into class and selected as a research sample.

3.3 Data Collection Methods
The data collection in this study was conducted by disseminating questionnaires. The questionnaires were used to determine the cognitive style of the Informatics Engineering Education Study Program of Undiksha students. Furthermore, the data from the questionnaires were compensated with the results of the acquisition of psychomotor abilities through the assessment of practical results in certain courses in the Informatics Engineering Education Study Program of Undiksha. The data obtained were analysed according to the precise statistical analysis.

There were two main instruments used in this study, namely the Group Embedded Figures Test (GEFT) standardized test instrument, and the concept mastery test intrusion. GEFT intrusion used to determine a student's cognitive style, i.e. Field Dependence cognitive style or Field Independence cognitive style. This instrument developed by Witkin, consists of 25 question items. In this test students must find simple images hidden in complicated images. To see the level of achievement of concept mastery, expert validation tests was conducted before being used in the study. The concept mastery test is a multiple-choice test of 16 question items compiled based on Anderson's revised Bloom taxonomic abilities. Concept mastery instruments are limited to levels C1 to C4 with details: five cognitive level problems of remembering (C1), five questions of cognitive level understanding (C2), three cognitive level problems applying (C3), and three cognitive level analysing questions (C4). The increase in student concepts mastery was obtained by calculating the improvement of each student using normalized gain.

\[
g = \frac{T_f - T_i}{S_{max} - T_i}
\]

Notes:
- \(g\) = Normalisation gain
- \(T_f\) = Post-test Score
- \(T_i\) = Pre-test Score
- \(S_{max}\) = Maximum Score

The data analysis techniques used in this study were statistical analysis and descriptive analysis. Statistical analysis refers to ex post facto engineering steps, namely descriptive statistical analysis and inference statistical analysis. Descriptive statistics were used to describe data sample. The descriptive statistics used in this study are calculation mode, median, and mean, data dissemination calculation
through average calculation and standard deviation, and percentage calculation. On the other hand, inference statistics are statistical techniques used to analyse sample data and treated results for populations.

4. Result and Discussion

Based on the data collection which were resulted from 50 respondents in Informatics Engineering Education Study Program Undiksha, it was found that the student input from various secondary schools, as well as the student cognitive style both Field Dependence cognitive style and Field Independence cognitive style were obtained. The respondent’s data from various secondary schools are presented in Table 2 below.

Table 2. Distribution of respondent’s input in Informatics Engineering Education Study Program, Undiksha.

| No  | Respondent       | High School     | Study Multimedia | Multimedia Knowledge |
|-----|------------------|-----------------|------------------|----------------------|
| 1   | Respondent 1     | Senior High School | No              | Yes                  |
| 2   | Respondent 2     | Vocational School | Yes             | Yes                  |
| 3   | Respondent 3     | Vocational School | Yes             | Yes                  |
| 4   | Respondent 4     | Vocational School | Yes             | Yes                  |
| 5   | Respondent 5     | Vocational School | Yes             | Yes                  |
| 6   | Respondent 6     | Vocational School | Yes             | Yes                  |
| 7   | Respondent 7     | Senior High School | No              | No                   |
| 8   | Respondent 8     | Senior High School | No              | Yes                  |
| 9   | Respondent 9     | Vocational School | Yes             | Yes                  |
| 10  | Respondent 10    | Vocational School | Yes             | Yes                  |
| 11  | Respondent 11    | Vocational School | Yes             | Yes                  |
| 12  | Respondent 12    | Vocational School | Yes             | Yes                  |
| 13  | Respondent 13    | Senior High School | No              | Yes                  |
| 14  | Respondent 14    | Senior High School | No              | No                   |
| 15  | Respondent 15    | Senior High School | No              | No                   |
| 16  | Respondent 16    | Vocational School | Yes             | Yes                  |
| 17  | Respondent 17    | Vocational School | Yes             | Yes                  |
| 18  | Respondent 18    | Senior High School | No              | Yes                  |
| 19  | Respondent 19    | Senior High School | No              | Yes                  |
| 20  | Respondent 20    | Vocational School | Yes             | Yes                  |
| 21  | Respondent 21    | Senior High School | No              | Yes                  |
| 22  | Respondent 22    | Vocational School | Yes             | Yes                  |
| 23  | Respondent 23    | Vocational School | Yes             | Yes                  |
| 24  | Respondent 24    | Vocational School | Yes             | Yes                  |
| 25  | Respondent 25    | Vocational School | Yes             | Yes                  |
| 26  | Respondent 26    | Senior High School | No              | Yes                  |
| 27  | Respondent 27    | Vocational School | Yes             | Yes                  |
| 28  | Respondent 28    | Vocational School | Yes             | Yes                  |
| 29  | Respondent 29    | Vocational School | Yes             | Yes                  |
| 30  | Respondent 30    | Vocational School | Yes             | Yes                  |
| 31  | Respondent 31    | Vocational School | Yes             | Yes                  |
| 32  | Respondent 32    | Senior High School | No              | Yes                  |
The data above can be represented in the form of pie charts as shown in Figure 1 below.

![Pie charts](image)

**Figure 1.** Pie charts of descriptive data for respondent’s input.

Figure 1 showed that the student input obtained in Informatics Engineering Education Study Program, Undiksha, was 64% from vocational school (SMK) and 36% from senior high school (SMA). The percentage of respondents who have studied multimedia during high school was 64%, while 36% of them have never received multimedia lessons in school. In concerned with the data obtained for multimedia knowledge, 90% of respondents already know about multimedia, while the remaining 10% of respondents do not really know about multimedia things.

The results of GEFT test were obtained by grouping all the student respondents into three cognitive style groups, namely Field Dependence (FD), Field Independence (FI), and neutral as presented in the following table.
Table 3. Distribution of student cognitive styles

| Respondens | Cognitive Style | FI | FD | Neutral |
|-------------|-----------------|----|----|---------|
| 50          |                 | 23 | 21 | 6       |

It was revealed through Table 3 that 23 students had FI cognitive styles, 21 students had FD cognitive styles, and 6 remaining students had no cognitive style tendencies of FI or FD (neutral). The spread of this cognitive style data was quite balanced especially for the FI and FD that were the main focus in this study. Of these results, the number of respondents taken for the research analysis was 44 students (FI and FD cognitive style groups). The distribution of student cognitive styles in percentage form was presented in Figure 2 below.

![Group Embedded Figure Test](image)

Figure 2. Result of Group Embedded Figure Test.

The achievement of student concept mastery can be seen from the results of the concept mastery test. The concept mastery test was conducted for 44 respondents consisting of 23 respondents with FD cognitive style and 21 respondents with FI cognitive style. In accordance to the data processing results, the average pre-test, post-test, and gain score for the FI and FD cognitive style groups are shown in the following table.

Table 4. The improve of student concept mastery

| No | Group              | Average Pre-test | Average Post-test | Gain Score |
|----|--------------------|------------------|-------------------|------------|
| 1  | Field Dependence   | 7.30             | 7.64              | 0.26       |
| 2  | Field Independence | 7.15             | 7.44              | 0.29       |

Based on Table 4 it can be concluded that the increase score for FD cognitive style group is greater than FI cognitive style group. This can be seen from the normalized gain score (n-gain) of both groups, the n-gain score for the FD cognitive style group was 0.26 while for the FI cognitive style group was 0.29. However, by analysing the pre-test and post-test scores, it appears that the FI cognitive style group is larger than the FD cognitive style group. The improved of student concepts mastery in graph form is presented in Figure 3 below.
Figure 3. The graphic of improved mastery of student concepts

The results showed that there were differences in concept mastery between the FD cognitive group and the FI cognitive group, although the differences were not very large. Interestingly, the results of this study included a comparison of pre-test and post-test scores between the FD and FI groups. Although the increase in FI group was lower than FD group, the achievement of the concept mastery of the FI group was better than the FD group. This is due to the better analytical abilities owned by FI group compared to that of FD group, as revealed by Sobkowicz that students with FI cognitive styles tend to be more analytical in looking at a problem compared to the FD cognitive style [11].

Although theoretically the ability of students with FI cognitive style is better in analysis, the results found that the larger improvement is given by FD cognitive style group. This is because the learning process conducted in the class was dominated by practical activities and group discussions, thus it tends to be more favourable to the FD group. The results of this study also showed that students' learning outcomes (mastery of concepts) were strongly influenced by the suitability of students' cognitive styles with the methods or models of learning performed. This was also revealed by Chen, et al. who concluded that cognitive style had a significant influence on learners' choices in learning strategies [12]. The concept of cognitive style and learning ability has recently assumed a special significance in educational content because it is considered an important dimension of individual differences that is the core basis of effective learning programs [13].

Based on the research conducted, the low learning outcomes that have been complained might be due to the inappropriate selection of learning methods that do not accommodate the differences in student cognitive styles. That one of the problems that causes low student learning outcomes is learning with less attention to the differences in student characteristics [14].

5. Conclusion
The results revealed that the student cognitive style affects significantly on the improvement of student concepts mastery. After gaining an active learning process through practicum activities and group discussions, the concepts mastery of Field Dependence cognitive style group increased greater than the Field Independence cognitive style group.

References
[1] Baeken C et al 2019 The road towards personalized medicine: Increasing the effects of brain stimulation using individual characteristics Encephale. 45 S59
[2] Huang C Y et al 2019 Effects of individual characteristics on insomnia severity trajectory among nurses: A prospective longitudinal study J. Nurs. Manag. 27 1640–7
[3] Enneking K M et al 2019 The Evaluation of a Hybrid General Chemistry Laboratory Curriculum: Impact on Students’ Cognitive, Affective, and Psychomotor Learning J. Chem. Educ. 96 1058–67

[4] Murrihy C, Bailey M, and Roodenburg J 2017 Psychomotor Ability and Short-term Memory, and Reading and Mathematics Achievement in Children Arch. Clin. Neuropsychol. 32 618–30

[5] Rogers M L et al 2019 The Relationship Between Negative Cognitive Styles and Lifetime Suicide Attempts is Indirect Through Lifetime Acute Suicidal Affective Disturbance Symptoms Cognit. Ther. Res. 43 354–64

[6] Ranney R M, Cox C M, and Behar E 2020 Relationships Between Emotion Regulation and Depression in High and Low Worriers J. Psychopathol. Behav. Assess. 42 101–10

[7] Septi B S and Noly S 2020 Psychomotor Skills of Pre-service Teachers of Natural Science on Melde’s Experiment in Guided Inquiry Learning IJORER Int. J. Recent Educ. Res. 1 108–15

[8] Arditte H K A et al 2019 Comparing cognitive styles in social anxiety and major depressive disorders: An examination of rumination, worry, and reappraisal Br. J. Clin. Psychol. 58 231–44

[9] Peng S et al 2019 The affective facial recognition task: The influence of cognitive styles and exposure times J. Vis. Commun. Image Represent. 65 102674

[10] Brown S G, Tenbrink A P, and LaMarre G 2019 Performance while distracted: The effect of cognitive styles and working memory Pers. Individ. Dif. 138 380–4

[11] Sobkowicz P 2017 Opinion dynamics model based on cognitive biases arXiv 2019

[12] Chen X et al 2016 Public authority control strategy for opinion evolution in social networks Chaos 26

[13] Md Yunos J, Sern L C, and Hamdan N H 2017 Changes and challenges in sustainability of technical and vocational education and training-teacher education programme: A case study 2016 IEEE 8th Int. Conf. Eng. Educ. Enhancing Eng. Educ. Through Acad. Collab. ICEED 2016 80–5

[14] Wahyuni D S et al 2020 Analysis on vocational high school teacher competency gaps: Implication for VHS teacher training needs J. Phys. Conf. Ser. 1516