

## Selection of Learning Materials Based on Students' Behaviors in 3DMUVLE

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### Abstract

*Learning in 3-dimensional virtual environments has been widely used as a complement to traditional learning. Multi User Virtual Learning Environment in 3 Dimensions (3DMUVLE) provides many benefits and can support lifelong learning. In its implementation, this learning has not supported personal learning. This study aims to build a 3DMUVLE with personalized materials based on students' models. The system development model uses the Linear Sequence model by integrating MOODLE, SLOODLE and OPENSIM. Student's model in this research is Myer Briggs Type Indicator (MBTI) and determination of type uses fuzzy logic. The results of this study are 16 types of students and each type consists of 3 levels: low, medium and high. Each level has a specific learning material. The implication of this research is the level of MBTI type so that the learning material is more specific.*

**Keywords:** personal learning, fuzzy logic, MBTI, 3DMUVLE

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### 1. Introduction

In the digital era, ICT technology has been widely used in various fields including in education. The effect of this technology in education is a paradigm shift from learning in the classroom into the virtual learning. 3DMUVLE provides many benefits, such as cost-effective, ease of collaboration, and support long life learning. 3DMUVLE built can be social media based [1] and collaborative [2]. Even 3DMUVLE provides entertainment so that learning becomes fun [3]. This learning still provides materials and learning strategies to all students regardless of knowledge level, interest, motivation, and goal [2] even though students have different characters (students' model). Many students' model have been used, such as Learning Style Inventory from Kolb [4], Felder and Silverman [5], Dunn and Dunn [6], Visual, Auditory, Kinesthetic (VAK) [7,8]. MBTI in addition to being a student model is also referred to as a learning style [8-11].

But 3DMUVLE-based learning still rarely adopts personalized learning in which the learning materials in accordance with the type and performance of students. Intelligent Tutoring System (ITS) is a smart application that implements personal learning. In ITS there are 3 main modules related to personal learning, namely: domain, pedagogy and student. Personalization of learning is done on domain and pedagogy based on student module. The learning material is an expert module that explicitly represents the domain of knowledge that is the subject of the learning activity [12,13]. Different types of knowledge require different types of teaching or instructional methods. Commonly used domain of knowledge is rule base and constraint based modeling [12,13]. In practice, personal learning requires attention to capacity, objectives, learning preference, and student history [9].

Information and communication technology (ICT) has been widely used to help learning in the form of software, such as e-learning, serious game, mobile learning, and 3DMUVLE. The development process can use SDLC process models, such as Structured Analysis and Design Model (SADM), Rapid Application Development (RAD), and spiral models [1]. This study aims to design personalized learning software based on 3DMUVLE. The research focus is what module domains are suitable for the student according to the type. The type of student used is MBTI model. Since no student type is absolute, this study attempts to graduate the type of student

with a real value. Fuzzy is used for leveling each type of student. Each type of student is divided into 3 levels, namely: low, medium, high. Each level has a specific learning material.

## 2. Method

### 2.1. Model of Software Development Process

Software is a computer application to solve a specific problem. Software has been widely used to help control tools like cookware [14], control the antenna [15], AC machines [16] or pure system applications such as ITS applications [17] and others. Software development can implement such methods, such as SDLC [14] and spiral [1]. This research uses linear process sequence model. In this model the software development starts from the system level which is followed through the process of analysis, design, coding, testing, and support [18]:

- a. System/information engineering and modeling: System engineering and analysis emphasizes system requirements at the top level while Information engineering emphasizes the need at the business strategy level.
- b. Software requirements analysis: is a stage to determine the needs of the system and software from the customer
- c. Design: is a stage that translates software requirements into software representation. Focus design are: data structure, software architecture, interface representations, and procedural (algorithmic) details
- d. Code generation: is the generation of program code from the design that has been produced in the previous stage
- e. Testing: is the testing phase of the program to be free from errors. Software testing is done on the logic and functional system
- f. Support: is the stage of system maintenance of changes from the customer

### 2.2. Virtual Learning Environment

Learning based on a virtual environment provides intrinsic motivation to students [19,20] created a framework under the name NUCLEO for collaborative learning with multi players. There are three basic components of learning in the virtual environment: the interface for the teacher in creating the learning material, the interface for the student to run the learning, and the interface for the VLE developer to determine the learning material delivery strategy. To integrate the three interfaces required MOODLE, SLOODLE, and Opensim. Research on this integration is done by [21-25] by optimizing the performance of its SLOODLE features, such as presentation, communication, quiz, and assessment. Collaboration learning with SLOODLE is also done by [26]. Assessment in virtual learning environment has been researched by [27] so that feed back for students can be known after the assessment. This gives a good impact because students can formulate strategies to respond to the assessment results. Whereas, [28] have made open libraries in a virtual environment. Other researchers such as [29] put more emphasis on improving communication among game users with some modality. The role of SLOODLE in LMS learning and virtual environment is to bridge the content in the LMS can be accessed from the virtual environment, as well as actions performed by the user can be responded and stored in the LMS, as shown in Figure 1. Figure 1 shows the features present in LMS and VLE. SLOODLE is a middleware between the both.

In this research, the LMS features used are:

- a. User Management: this feature is used to manage the learning participants.
- b. Learning Structure: this feature is used to manage learning, such as making subjects divided into 14 weeks of meetings.
- c. Learning Material Processing: this feature is used to upload learning materials
- d. Quiz Processing: This feature is used to create question banks, and organize quizzes, and view quiz results.

SLOODLE features used are:

- a. Registration Booth registration: this feature is used to register the avatar, so the avatar in VLE is related to the learning participants in the LMS.
- b. Presenter: this feature is used to display learning material in the VLE environment.

OpenSim features used are:

- a. Sloodle Rezer: This component is used as a bridge between LMS and VLE.
- b. Registration Booth: This component is used for the avatar registration interface.

- c. Presenter: This component is used for resource interface, quiz and display of value recapitulation in VLE. In this study all the display on this component is based on web.

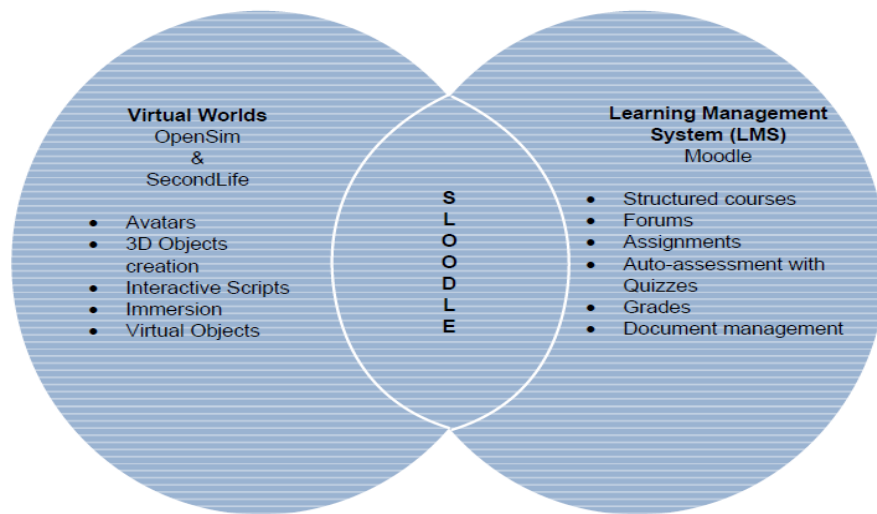


Figure 1. Integrity of LMS and VLE with SLOODLE [23]

**2.3. Logika Fuzzy**

Each type of student has a specific way of learning and learning materials. No student has an absolute type, the determination of the type of student in this study uses fuzzy logic with its fuzzy set using the shoulder model as shown in Figure 2. The fuzzy value is calculated from the questionnaire of the questionnaire question sets from [30]. Each question corresponds to that type. X is the number of answers based on that category.

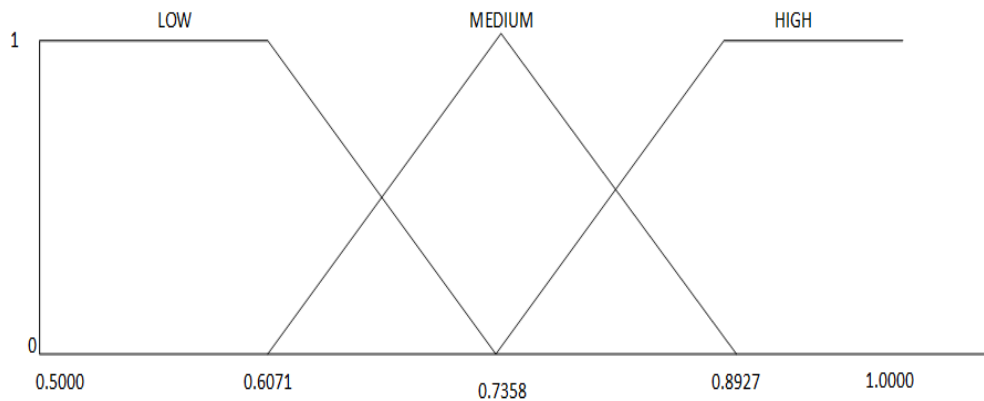


Figure 2. Fuzzy Shoulder Model Set

Membership function as follows:

- a. Membership function LOW:

$$f(x) = \begin{cases} 0 & x \geq 0,7356 \\ (0,7356-x)/(0,7358-0,6071) & 0,6071 \leq x \leq 7356 \\ 1 & x < 0,6071 \end{cases}$$

b. Membership Function MEDIUM

$$f(x) = \begin{cases} 0 & X < 0,7356 \\ (x-0,6071)/(0,7358-0,6071) & 0,6071 \leq x \leq 7356 \\ 1 & X = 0,7356 \\ (x-0,6071)/(0,7358-0,6071) & 0,7356 < x \leq 8927 \\ 0 & X > 0,8927 \end{cases}$$

c. Membership function HIGH

$$f(x) = \begin{cases} 0 & x \leq 0,7356 \\ (x-0,7356)/(0,8927-0,7358) & 0,7356 \leq x \leq 8927 \\ 1 & x > 0,8927 \end{cases}$$

3. Results and Discussion

3.1. MBTI

Students are important element in learning. Generally, they learn by receiving learning materials from teachers. Learning materials and teaching methods undertaken by the teacher must be tailored to the students' characters. In this study the characters of the students were identified using MBTI model. Those characters are divided into four dimensions [31] as shown in Table 1.

Table 1. Personality Dimension [31]

Personality Dimensions	Description
Introvet / Ekstrovet	This dimension shows that the individual concentrates energy into the external or inner world. Introverts (I) focus their energies into the inner world and prefer their own time. Extroverts (E) focus their energies toward the outside world and are often action-oriented
Sense / iNtuitive	This dimension shows the way individuals take information from the world. individuals Intuitive types (N) believe in open minds and new things and prefer to rely on ideas and possibilities. Individual Sensing Type (S) prefers the real world and the things that happen around them.
Feeling / Thinking	This dimension shows how a person makes decisions. Individual Feeling type (F) decisions is taken more dependent on feelings and more subjective. Individual Thinking type (T) decisions is taken by logic and reason and tend to be more objective.
Perceive / Judging	This dimension show way individuals react to outside world and how to adapt. Individual type Judging(J) concern on decision making, planning and organizing. Individual type Perceiving (P) concerns on gathering more information and delaying decision making.

Students' characters of the MBTI model are combination of the four dimensions, so that 16 combinations are formed as shown in Table 2.

Table 2. A Person's Character is based on the MBTI model

ISTJ	ISFJ	INFJ	INTJ
ISTP	ISFP	INFP	INTP
ESTP	ESFP	ENFP	ENTP
ESTJ	ESFJ	ENFJ	ENTJ

The determination of the type of student is done by questionnaire. The questionnaire question consists of 70 questions taken from [30]. Question consists of 10 questions to determine Introvet/Extrovet, 20 questions for determining Sense/iNtuitive, 20 questions for Feeling/Thinking, and 20 questions for determining Perceive/Judging. Each student answers the question quickly. The score is calculated from the average value of each of the highest values of each category.

### 3.2. Model System

Figure 3 shows a system model that has two actors and eight use cases. Both actors are teachers and students, while the eight main use cases are:

- a. Login: this feature is used for user authentication.
- b. Learning Materials Processing: this feature is used for teachers to process learning materials.
- c. Evaluation Processing: This feature is used for teachers to process evaluations such as making problem banks and making quizzes / evaluations for pretest and posttest.
- d. Pretest: this feature is used for students to pretest before learning begins
- e. Questionnaire: This feature is used for students to fill out questionnaires to determine students' character based on MBTI model
- f. Learning: this feature is used for students to learn accordance with her/his character.
- g. Posttest: This feature is used for students doing posttest
- h. Logout: this feature is used to exit the system

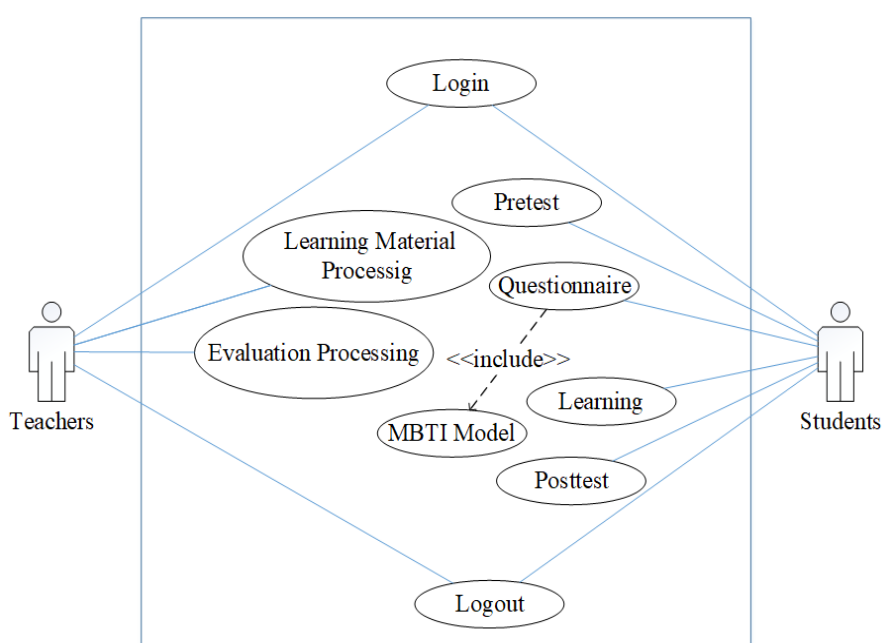


Figure 3. System Model

### 3.3. System Architecture

Figure 4 shows that learning in 3D virtual environments integrate multiple layers, namely: author tools, middleware, and student. The outhor tool layer contains the components used by the author in this case there are teachers to prepare the learning. Preparation of learning includes: 1) preparation of learning materials, 2) preparation of evaluation materials, 3) preparation of students (registration of students to the system). In this study, outhor tool used is MOODLE. With MOODLE, the teacher does not have to master the programming language for the preparation of such learning. This component is web-based so to run it required web service and all data stored in the database that has been provided.

The middleware layer contains a component that serves as a bridge between the author tool and the learning interface. Middleware is a program that is grown in MOODLE so that the learning elements in MOODLE can be accessed through a 3D virtual environment. There is a mechanism to be done so that the learning elements of MOODLE can be displayed in 3DMUVLE and vice versa the learning outcomes in 3DMUVLE recorded in MOODLE. Middleware used in this research is SLOODLE.

The student layer is a learning system interface with students. This interface provides learning materials and evaluation in a 3D virtual environment. This type of 3DMUVLE is the third

person where the student has his own avatar that represents himself. Avatar has fantastic ability like flying, breaking through walls, communicating with other avatars, and so forth.

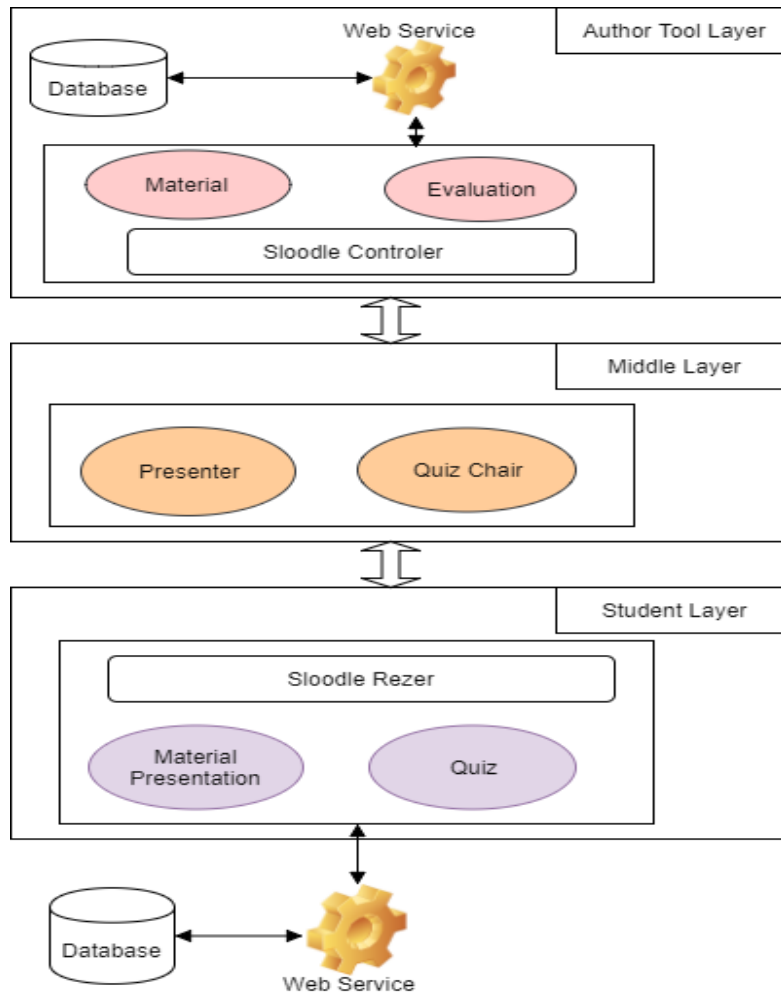


Figure 4. MUVLE Architecture

**3.4. Rule**

In personal learning, learning materials should be appropriate to the type of student. In this study, the determination of the type of students using MBTI model. The type determination algorithm uses fuzzy logic. Each generated type has membership degrees. In this study, the degree of membership is divided into three, namely: low, medium and high. Each degree of membership in each type refers to different learning materials. The rules for selecting the learning materials can be seen in Table 3.

Table 3. Rules of Leveling of Learning Materials

Rule 1	Rule 2
If ISTJ then	Elseif ISFJ then
If HIGH then	If HIGH then
High_learning_material ISTJ	High_learning_material ISFJ
Elseif MEDIUM then	Elseif MEDIUM then
Medium_learning_material ISTJ	Medium_learning_material ISFJ
Else	Else
Low_learning_material ISTJ	Low_learning_material ISFJ
End if	End if

Table 3. Rules of Leveling of Learning Materials

Rule 3	Rule 4
<pre> Elseif INFJ then   If HIGH then     High_learning_material INFJ   Elseif MEDIUM then     Medium_learning_material INFJ   Else     Low_learning_material INFJ   End if </pre>	<pre> Elseif INTJ then   If HIGH then     High_learning_material INTJ   Elseif MEDIUM then     Medium_learning_material INTJ   Else     Low_learning_material INTJ   End if </pre>
<pre> Rule 5 Elseif ISTP then   If HIGH then     High_learning_material ISTP   Elseif MEDIUM then     High_learning_material ISTP   Else     High_learning_material ISTP   End if </pre>	<pre> Rule 6 Elseif ISFP then   If HIGH then     High_learning_material ISFP   Elseif MEDIUM then     Medium_learning_material ISFP   Else     Low_learning_material ISFP   End if </pre>
<pre> Rule 7 Elseif INFP then   If HIGH then     High_learning_material INFP   Elseif MEDIUM then     Medium_learning_material INFP   Else     Low_learning_material INFP   End if </pre>	<pre> Rule 8 Elseif INTP then   If HIGH then     High_learning_material INTP   Elseif MEDIUM then     medium_learning_material INTP   Else     Low_learning_material INTP   End if </pre>
<pre> Rule 9 Elseif ESTJ then   If HIGH then     High_learning_material ESTJ   Elseif MEDIUM then     Medium_learning_material ESTJ   Else     Low_learning_material ESTJ   End if </pre>	<pre> Rule 10 Elseif ESFP then   If HIGH then     High_learning_material ESFP   Elseif MEDIUM then     Medium_learning_material ESFP   Else     Low_learning_material ESFP   End if </pre>
<pre> Rule 11 Elseif ENFP then   If HIGH then     High_learning_material ENFP   Elseif MEDIUM then     Medium_learning_material ENFP   Else     Low_learning_material ENFP   End if </pre>	<pre> Rule 12 Elseif ENTP then   If HIGH then     High_learning_material ENTP   Elseif MEDIUM then     Medium_learning_material ENTP   Else     Low_learning_material ENTP   End if </pre>
<pre> Rule 13 Elseif ESTJ then   If HIGH then     High_learning_material ESTJ   Elseif MEDIUM then     Medium_learning_material ESTJ   Else     Low_learning_material ESTJ   End if </pre>	<pre> Rule 14 Elseif ESFJ then   If HIGH then     High_learning_material ESFJ   Elseif MEDIUM then     Medium_learning_material ESFJ   Else     Low_learning_material ESFJ   End if </pre>
<pre> Rule 15 Elseif ENFJ then   If HIGH then     High_learning_material ENFJ   Elseif MEDIUM then     Medium_learning_material ENFJ   Else     Low_learning_material ENFJ   End if </pre>	<pre> Rule 16 Elseif ENTJ then   If HIGH then     High_learning_material ENTJ   Elseif MEDIUM then     Medium_learning_material ENTJ   Else     Low_learning_material ENTJ   End if </pre>

### 3.5. Flowchart System

The flow of the system starts from the student registration process through the registration booth. The second process is pretest. If the students are in a general student (control class), they go straight into the room to do the learning. Learning in this class is general

(learning material for all students is the same). However, if the students are in the experimental class, they must fill out an MBTI questionnaire to determine their characters. After that, they go into the MBTI classroom to learn. The learning materials presented in the MBTI class are personal according to the degree of their character types. After learning, the next process is the posttest to test the learning achievement. The last process is the announcement of posttest results and ranking based on the amount of posttest value. The complete system flow can be seen in Figure 5.

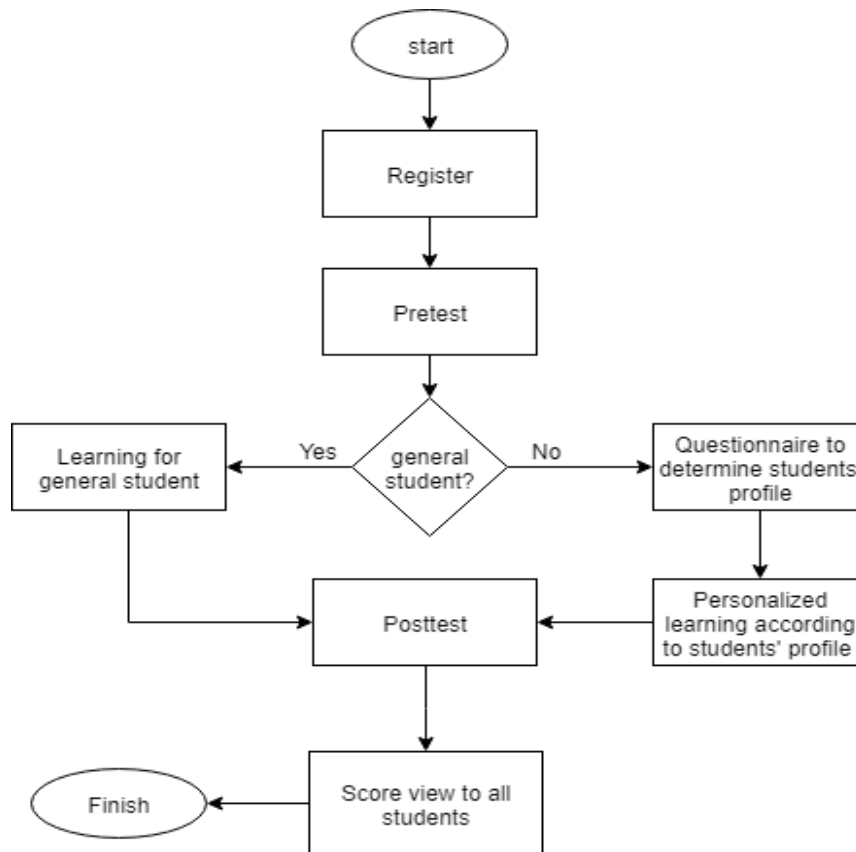


Figure 5. System Flowchart

### 3.6. Learning Interface

Learning interface of students follow the system flowchart. This interface provides learning tools such as: registration interface, test interface, and learning interface. Learning begins with the registration of students at the register booth. Figure 6(a) shows the currently registered avatar. Registration is required for synchronization avatars in 3DMUVLE and learning participants in LMS. Figure 6(b) shows the learner performing a pretest. The pretest interface uses the presenter component and can be displayed in full screen. The student answers a series of questions by clicking on one of the answers and in real time the student score increases if the answer is correct. Click the logout button if you want to quit the pretest.

Figure 7(a) is questionnaire interface. This interface is used to define type of learner. A questionnaire is an instrument used to determine type of learner. There are 70 questions divided into 7 places (each place consists of 10 questions). Figure 7(a) shows the results of the questionnaire that is learner type based on the MBTI model. Figure 7(b) is the post-test interface. This interface is used to test students after learning. Like the pretest interface, the posttest interface consists of a series of questions and the student clicks on one of the answers. The score will automatically increase if the answer is correct and the question moves on to the next question.





Figure 6(a). Registration Interface



Figure 6(b). Pretest Interface

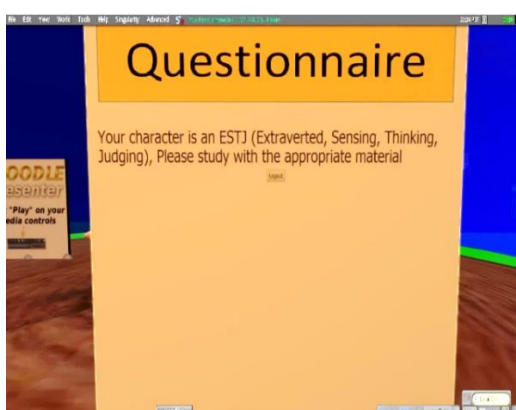


Figure 7(a). Result of Questionnaire

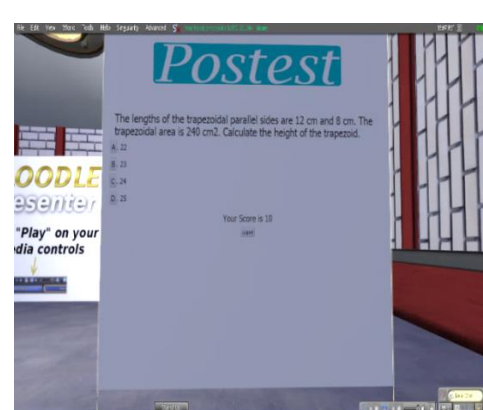


Figure 7(b). Posttest Interface

#### 4. Conclusion

In personal learning, learning materials are displayed according to the type of student. The use of fuzzy logic in the determination of the type of student results in the category of student types with degrees of membership. So the type separation becomes smoother and the given learning material will be closer to the student type. Implementation of learning in 3DMUVLE gives students a sense of fun in learning, and personal learning fosters discipline, responsibility, and honesty in students. The weakness of this research is the generation of learning materials is still done manually. Automation of teaching materials generation has become a trend in e-learning. Advanced research is the generation of adaptive and automated teaching materials to be implemented in virtual environment-based learning.

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