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A New Model of Students Participation Measurement in e-Learning Systems Based on Meaningful Learning Characteristics: An Initial Investigation

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Abstract— **E-learning systems have been used widely in an education system. A lot of research works have been carried out to improve their features functionalities, such as student's behavior observation, e-learning platform enhancement, and other related factors. This paper presents an initial investigation of a new model to measure student's participation during their activities inside an e-learning system. The measurement of student's participation is piloted by calculating the semantic score of relationships that may exist between e-learning activities and meaningful learning characteristics. The proposed model is expected to provide some benefits on measuring the level of student's engagement with meaningful learning characteristics in order to produce better e-learning systems.**

Keywords–e-learning; meaningful learning; semantic similarity; participation measurement.

I. INTRODUCTION

Conventional learning context has changed rapidly. Teaching and learning process are no longer limited to the conventional classroom [1]. Along with the development of technology and utilization of technology, e-learning has become more popular and widely used in higher education [2]. E-learning is a learning model that can supplement the traditional classroom model and capable of offering a kind of education with less space or tightness schedule [2], [3]. In this regard, e-learning is currently becoming popular learning model, since it is not limited by space, distance, and time. Moreover, it is expected that e-learning will play more significant roles in the development of learning systems in the future.

Measuring the effectiveness of e-learning is important and difficult task, because it involves such five critical success factors as students, teachers, content, technology, and infrastructure [4]. In this context, students become one of important components that must be considered in developing an effective e-learning measurement system.

In the context of meaningful learning, the aim of learning process is to ensure that all students participated inside meaningful learning [5]. According to the theory of meaningful learning, students can achieve meaningful learning if all the following five characteristics of meaningful learning have been achieved: active, constructive, intentional, cooperative, and working on authentic tasks [6]. Therefore, meaningful learning is important because its implications cover learning with meaning, comprehension, retention, and transfer of expertise [7]. Results of the measurements of meaningful learning can be used as useful information for teacher evaluation on students learning activities and learning materials. These results are expected to motivate teachers to be more creative and innovative in providing learning facilities to their students.

Meaningful learning contains the principles and strategies that can be used in a classroom environment where face to face communication occurs [8]. These allow to measure the participation level of students in learning with face-to-face communication directly. However, these could not be applied to e-learning due to an avoidable limitation; i.e., the teacher cannot directly monitor the activities and interactions of their students. Therefore, an additional tool is required in e-learning

environment in order to measure the level of student participation based on meaningful learning concept automatically.

This paper proposes a new model of meaningful learning measurement of students in e-learning systems by calculating the semantic relationships between e-learning activities and meaningful learning characteristics. This paper is organized as follows. In section II, several literatures that are related to e-learning and meaningful learning are discussed. The initial conceptual model from this research is described in section III. Finally the concluding remarks are discussed in section IV.

II. LITERATURE REVIEW

There are several studies on meaningful learning topics in the e-learning environment. In 2012, Yunianta et al. proposed a mapping method between the activities of e-learning in Moodle with the characteristics of meaningful learning [9]. The activities are classified based on the Moodle activities group; i.e., those that support and the others that do not support the characteristics of meaningful learning. The mapping process was conducted by comparing the description of Moodle activities and the characteristics of meaningful learning. Results of the mapping that were produced by a group of selected experts only showed on whether Moodle activities and meaningful learning characteristics have interrelationships or not.

Another research proposed a set of instruments that are intended for measuring the level of meaningful learning for students in higher education institutions in Malaysia. The proposed instruments were implemented in an application called The Meaningful Integrated e-Training (I-MeT) [10]. The research involved 295 respondents consisting of male and female with different variation of ages, area of origin, and courses. Gender bias detection is carried out using the Gender Differential Item Functioning (GDIF) Analysis. The results showed that the proposed instruments are statistically valid and reliable to be used for measuring the level of meaningful learning, except for one that has a gender bias. However, this research has not yet proposed a model for measuring the level of meaningful learning achieved by the students.

Firdausiah and Yusof (2013) constructed a new model for analyzing the behavior of students in social learning network using ontology clustering techniques and characteristics of meaningful learning [11]. The study has given a score of the relationship to a particular Moodle activity considering the meaningful learning characteristics. The scoring process is based on semantic similarity. However, when deal with Moodle activities, it takes all activities in Moodle without considering student's access level. The result of mapping Moodle activities onto the characteristics of meaningful learning are used to classify a student into one of the meaningful learning characteristics. However, it does not measure the level of student's achievement with regard to the meaningful learning.

Yusof et. al. (2013) classifies the use of e-learning by students based on characteristics of meaningful learning in Moodle learning management system. In this paper, students are grouped into three levels: (i) students who are not achieving a certain level of meaningful learning, (ii) students who are reaching an average level of meaningful learning, and (iii) students who are achieving high level of meaningful learning.

TABLE 1. PREVIOUS WORKS ON MEANINGFUL LEARNING IN E-LEARNING ENVIRONMENTS

Author	Research Methods	Research Issues
Yunianta et al., 2012	Require the help of experts to determine whether there is a relationship or not between a Moodle activity with a meaningful learning characteristics.	Only determine the existence of a relationship without specifying the relationship score.
Rosseni et al., 2012	Build an instrument to measure the level of meaningful learning for students and use GDIF to check the gender bias in it.	Only focus on checking the gender bias in the measurement instrument, but the measurement of the student's level of meaningful learning has not been addressed.
Firdausiah and Yusof, 2013	Using the semantic method based on word to determine the relationship score between a Moodle activity and a meaningful learning characteristic and classify students into one of the characteristics of meaningful learning	- Parameter of score calculation focus on keywords from the description of the activities and characteristics of meaningful learning in Moodle. - Does not consider the actions of students on Moodle activity. - Each score of meaningful learning characteristic was used to classify student into one of the meaningful learning characteristics. - Still dosen not measure the student engagement for each meaningful learning characteristic.
Yusof et al., 2013	Classifying the use of e-learning by students based on meaningful learning using K-Means method.	Classify students into three meaningful clusters: the level has not been reached, the average level, and high level. Use students log data, but actions of students on Moodle activity were not considered

K-Means algorithm was used to partition students into those three categories [12]. Table 1 describes the comparison of methods and results of some relevant literatures that were described previously.

As described in Table 1, previous studies have considered meaningful learning in e-learning environments, but the discussion has not already reached the stage of measuring each student's level for all meaningful learning characteristics. Moreover, previous studies used students log data for each Moodle activity without considering the actions of students in

the Moodle activities. Therefore, it is necessary to develop a model that is capable of measuring the level of achievement of each student according to characteristics of meaningful learning based on students' actions log data in Moodle.

III. THE PROPOSED CONCEPTUAL MODEL

As described in the previous section, this paper is concerned with an initial investigation to develop an additional tool that will facilitate the e-learning to automatically measure the level of student participation based on meaningful learning characteristics. The tool will be constructed according to two main stages; i.e., computation of the mapping score between Moodle activities and characteristics of meaningful learning, and measurement of student participation level for each characteristic of meaningful learning.

A. Computation of the mapping score between Moodle activities and characteristics of meaningful learning

The computation of mapping score between Moodle activities and characteristics of meaningful learning will be based on the semantic similarity that may exist between a description of Moodle activity and the description of a characteristic of the meaningful learning. This process consists of several stages: determine the keyword of each meaningful learning characteristic, keyword selection for Moodle activities, and semantic similarity calculation between those keywords. The framework of mapping score between Moodle and meaningful learning characteristics is portrayed in Figure 1.

- First, the selection of sentences from each of Moodle activities description is performed. The keywords selection on moodle activities is commenced by identifying each action that can be done by students. Each student action is taken from the Moodle activities description [13][14]. Each student action will be constructed into an English sentence. For example, if the student action is in the form of activity inside forum where students can discuss each other freely inside Moodle, then this action will be identified by extracting keywords from discussions that may exist among students as well between students and teachers.

- In the second stage, a similar selection process as involved in the first stage will be performed using meaningful learning characteristic descriptions [5] [15]. Some core sentences will be extracted and analyzed, particularly the sentences that most reflect the description in overall. The process of keywords selection is commenced by identifying the meaningful learning characteristics for each five categories of meaningful learning. These indicators will be pulled out from each description of meaningful learning characteristics.

- Finally, the semantic similarity calculation will be executed in this stage. In this context, each sentence in a meaningful learning characteristics will be paired with each sentence on a Moodle activities. A similarity score will be attached to each pair of sentences using the semantic similarity algorithm. A set of pairs of sentences having highest similarity score will be chosen.

In addition to the above measurement mechanism, a subjective evaluation will be conducted using a set of questionnaires that will be distributed to some selected teachers who are specializing in linguistics as well as those teachers who have sufficient experiences in using e-learning systems. This step is performed in order to validate results of the model developed in this research.

B. Measurement of student participation level for each characteristics of meaningful learning

The next stage is calculation of participation level for all five meaningful learning characteristics using students log data. This stage consists of students log data processing according to students' actions according to each Moodle activities, and score calculation of meaningful learning characteristics and decision making for students participation level for each meaningful learning characteristics. The framework of measurement for students participation based on students log data is portrayed in Figure 2.
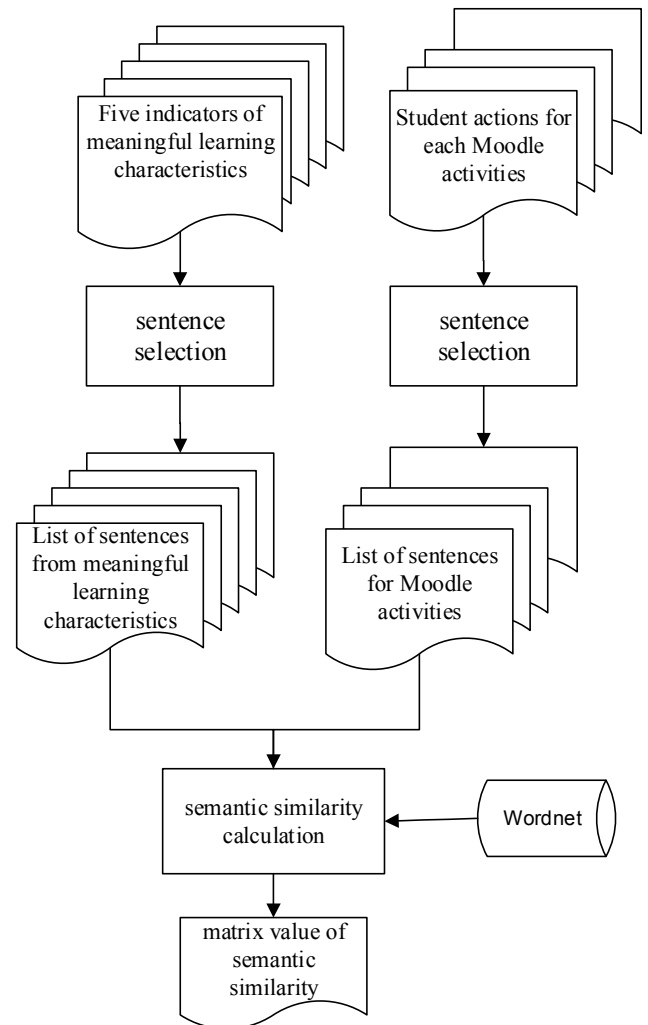

Figure 1. Framework of mapping score calculation between Moodle activities and meaningful learning characteristics

Prior to calculating the score, student log data is pre-processed in order to provide the suitable data format for this study. Student log data is extracted from Moodle and processed according to each student action of Moodle activities. The process of score calculation will be based on mathematical model involving both results of semantic similarity model described in the previous stage and results of students log data processing.

After the score for each meaningful learning characteristic for all students is obtained, it continued by further process to determine whether the student engaged or not in each one of five meaningful learning characteristic.
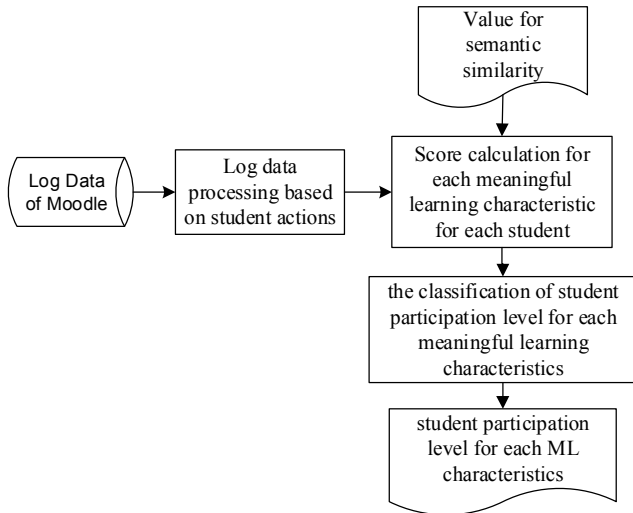

Figure 2. Framework of student participation measurement for five meaningful learning characteristics

IV. CONCLUSIONS

Measuring the effectiveness of e-learning can be regarded as an important and difficult task, since it involves such many components in e-learning as student's engagement and studiousness. This paper proposes a new model to measure the level of student's participation in e-learning environments. The proposed model consists of two main stages: the score calculation between Moodle activities and meaningful learning characteristics and a process of computation to decide the participation level of student. The first stage needs to be conducted once, while the second stage can be repeated accordingly using results of semantic similarity produced in the first stage. The final result of the model is an information of student partici-

pation level inside e-learning according to meaningful learning characteristics.

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