Development of Technological, Pedagogical, and Content Knowledge Learning Models Based on Massive Open Online Course (MOOC) Geography Teachers in West Sumatera

ABSTRACT

Learning principles in the 2013 Curriculum that is relevant to global developments namely the use of information and communication technology to improve the efficiency and effectiveness of learning and the provision of various learning resources and learning media, especially ICT/Multimedia based media and learning resources. TPACK is a combination of fundamental knowledge types, namely Pedagogical Knowledge (PK), Content Knowledge (CK), and Technological Knowledge (TK). The purpose of this research is to determine the ability of geography teachers to use TPACK and to facilitate teachers in implementing technology-based learning models easily with the guidance of 21st-century education. Mooc is an online learning platform that can be accessed for free by the whole community. The type of research is development research (*Research and Development).* The development model used the ADDIE model. The sample in this research were SMA / MA geography teachers in West Sumatra with trial schools SMA Negeri 1 Pariaman and SMA Negeri 1 Bukittingi. The development of TPACK based MOOC learning model for SMA/MA Geography teachers in West Sumatra is considered feasible and appropriate to use in helping teachers develop and combine three main aspects there are content, pedagogy, and technology in learning at once. The results of the geography teacher TPACK mapping show in the medium category. The implementation of the TPACK-based MOOC learning model implementation shows an increase in learning outcomes at SMA Negeri 1 Pariaman with an N-gain score of 0.71 and SMA Negeri 1 Bukittinggi with an N-gain score of 0.62. Teachers and students assessed that TPACK and MOOC learning helped the asynchronous learning process and by virtual learning.

Keywords: Geography, MOOC, TPACK

INTRODUCTION

The 21st century is marked by extraordinary changes in various aspects of human life. Alvin Toffler calls it the third-wave society and John Naisbitt states the information society [1]. Technology development brings changes in the transformation of digital learning [2]. Such rapid world changes must be accompanied by educational practices that are relevant to the demands of these changes. In 2009, a report entitled "Learning for the 21st Century" published "Framework for 21st Century Learning" which explains the four competencies or fields of study that must be mastered by students which include: 1) core subject and 21st-century themes, 2) learning and innovative skills, 3) information, media and technology skills and 4) life and career skills". The four competencies referred to as the 21st-century learning framework are an attempt to harmonize educational practices with the demands of the times. In this era, the information and knowledge society (IKS) requires professional training in the use of technology for the ability to adapt to new social demands. Learning in the 21st century allows teachers and students to more easily access learning resources, information sources, and the availability of free time [3]. Learning capacity in this century is conditioned by "the active involvement of several hundred to several thousand 'students' who self-regulate their participation according to learning objectives, prior knowledge and skills, and shared interests" [4]. 21st-century learning takes place everywhere because we are in a period where is possible to learn through technological means, learning can also occur through virtual or distance learning [5]. New virtual learning environments generate extensive data about learner behavior, and the field of learning analytics has emerged with the goal of using this data to optimize individual learning and learning contexts [6].

Related to learning based on the 2013 Curriculum, Permendikbud number 22 regarding Process Standards it is explained that there are two relevant learning principles in the 2013 Curriculum relevant to global developments is the use of information and communication technology to improve the efficiency and effectiveness of learning and provision various learning resources and learning media especially ICT/Multimedia based media and learning resources. From the description above, it can be seen that the

regulations for implementing learning in Indonesia have followed developments in the world. In the 2013 curriculum, students are no longer objects of learning but as the main actor (student center). That is, learners exercise a high level of agency for setting forth their ideas [7]. The role of teachers in learning is as a facilitator [8]. Passion for learning of students or as Aristotle termed it curiosity might be a more relevant inner driver of learning persistence in The MOOC context. In the literature, curiosity has been defined as the desire to seek out novelty and functions as a positive emotional motivational system [9]. Some of the problems in the world of education include teacher standards, mastery of materials, and low mastery of media and technology/*media and technology literacy.* Media Indonesia November 17, 2012 edition revealed that there is no difference in the quality of education in Indonesia before and after teacher certification is implemented. In fact, the World Bank asserts that teacher certification does not show a real impact on educational outcomes even though it has spent quite a lot of funds. In addition, the results of the 2012 Teacher Competency Test released by the Ministry of Education and Culture of the Republic of Indonesia show that the average ability of teachers in Indonesia has only reached 44 out of a scale of 100. Quality teachers have professional abilities, including intelligence abilities, attitudes, and work performance [10]. The main role of teachers is to transfer change and learning into the education system and they must deal with all changes actively. Then the competence and expertise of teachers are needed in dealing with changing times that affect processes and changes in the world of education.

The COVID-19 pandemic has changed people's habits, including the world of education. Learning absolutely must utilize technology by not eliminating pedagogic elements and conveying content to students. Education has been profoundly affected, as classes were forced to move online at very short notice and partway through the semester. This worldwide transition had massive practical implications for schools and colleges [11]. This is certainly a formidable challenge for the world of education in Indonesia. The solution provided by the government is in the form of internet-based distance learning. Among these, massive open online courses (MOOCs) have gained prominence in the educational landscape. Some researchers pointed out the assumption of a continuity of interactions in traditional online courses in MOOCs a small group of learners may participate persistently throughout the course, whereas a large number of learners participate intermittently, meaning that they engage and disengage randomly [12]. The use of MOOCs is expected to increase human capital and reduce inequality [13].

The digital educational landscape has changed in many ways in recent years, increasing the challenges and opportunities in educational assessment and validation. Recent advances in educational technology, data science, and artificial intelligence enable practitioners and researchers to assess learners in innovative ways [14]. In addition, a form of teacher competency development pattern has also developed called "TPACK" or Technological, Pedagogical, Content Knowledge which in essence, a teacher must have comprehensive and holistic knowledge and skills in terms of content/material, pedagogy/educational science and technology. TPACK was first coined by Sulman (1987, 1986) and then continued by Mishra and Koehler (2009) and Koehler & Mishra (2008) [15], [16]. TPACK is a combination of 3 types of basic knowledge there are Pedagogical Knowledge (PK), Content Knowledge (CK), and Technological Knowledge (TK) [17]. TK is knowledge of technology as a tool or resource. PK is pedagogic knowledge or a planning, process and evaluation in learning. CK is content knowledge that must be mastered by teachers in teaching a material. With a framework this TPACK, a teacher no longer only teaches a material (CK) using an approach or learning method (PK) but also integrates technology for (TK) combined with a teaching approach to teach a content [18].

So that learning practices in Indonesia, especially in West Sumatra Province can produce graduates who have global competence of course, it must start from the existence of competent teachers in three main aspects, namely Content, Pedagogy and Technology. The teacher is the spearhead of learning. Competent teachers can produce competent graduates. For this reason, a research is needed to determine and analyze the competence of geography teachers in West Sumatra Province is related to mastering the "TPACK" aspects and the development of a TPACK based learning model using MOOC in accordance with technological, pedagogic, and teacher content competencies. Regarding MOOC learning, these courses foster learning dynamics in which motivational variables and students' capacity for self-regulation play a major role, according to Zimmerman self-regulated students are capable of applying cognitive, metacognitive, affective and motivational processes, which allow them to achieve their learning objectives [19].

Previous research has overwhelmingly measured the success of MOOC from the perspective of learner academic performance (e.g., final grades earned), or learner completion.

METHOD

This type of research is research and development *(Research and Development)*. The development model used is the ADDIE model. The ADDIE model is an interactive development design with basic stages that are effective, dynamic and efficient. The ADDIE model of learning design scheme forms a cycle consisting of 5 stages consisting of: Analysis, Design, Development, Implementation and Evaluation of TPACK based MOOC learning model development product.

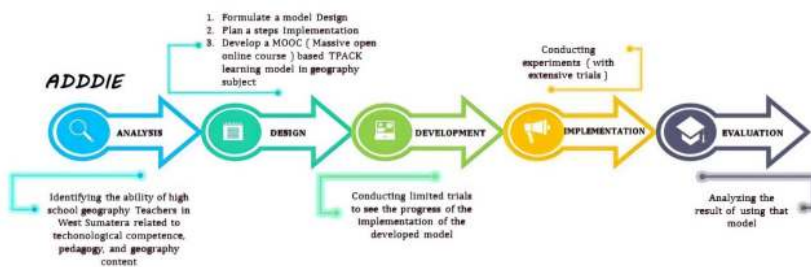The steps for developing a learning model with ADDIE are described in the following figure:

Figure 1. ADDIE development models

The analysis is used to look the virtual learning situation and the urgency of using ICT in geography learning. In addition, this study also looks at the mapping of the Geography Teacher TPACK in West Sumatra. Data were obtained using a questionnaire filled out by geography teachers in West Sumatra. The design of this research is the steps for developing a TPACK based MOOC learning model. MOOC was developed using Google Classroom and Padlet. The learning model that has been designed along with teacher and student books is then validated by material experts and media experts/learning models. The trial implementation of TPACK based MOOC learning model was carried out in two schools there are SMA Negeri 1 Pariaman and SMA Negeri 1 Bukittinggi. The evaluation in this research was seen by a questionnaire about teacher satisfaction and student satisfaction after the implementation of TPACK based MOOC learning model.

RESULTS AND DISCUSSION

Result

Table 1. Virtual Learning Situation

No	Aspects	Precentage
1	Suitability of Teacher Learning Methods with Distance Learning	70,43%
2	The need to update learning methods to be more meaningful during distance learning	84,35%

Virtual learning is a learning system that is carried out to deliver learning materials to students via the web. The system includes grading and student tracking features, as well as collaboration and communication activities. This virtual learning can be accessed inside and outside the school environment. The virtual learning system is considered capable of supporting student learning in 24 hours [20]. Virtual class is the process of implementing learning in a class model carried out without direct meetings between teachers and students.The teacher interacts with students using the help of a device that has internet network connectivity. Before being able to implement this learning system, a teacher is required to conceptualize learning in detail and in detail according to the curriculum used. In addition, the material and introduction to the application used must also be known so that the implementation runs smoothly and according to the purpose. The difference between virtual classes and ordinary classes is the limitation of communication.

Mooc is an online learning platform that can be accessed for free by the whole

community. Teachers have the opportunity to try this new pedagogical approach, the MOOC pedagogical context emphasizes the concept of flexible independent learning based on learning outcomes with a focus on learning outcomes and student achievement. Based on the results of the analysis of the virtual face-to-face learning situation for geography subjects in West Sumatra on the aspect of the suitability of the teacher's learning method using distance learning, it is included in the high category, this can be seen from the availability of teaching materials contained in the MOOC. Where most of the teachers have chosen the appropriate learning method with distance learning. The ideal virtual face-to-face learning includes an equal role between the teacher and the media in carrying out its function to convey material or learning to students properly, completely and completely.

In the aspect of updating learning methods based on the results of the analysis of virtual face-to-face learning situations, geography subjects in West Sumatra are in the very high category, in other words, it is necessary to update learning methods to make distance learning more meaningful. Meaningful learning during the pandemic means that teachers can encourage students to have curiosity about the learning material delivered by the teacher.

Table 2. Urgency of ICT in Geography

No	Aspects	Percentage
1	Teacher using media learning of the ICT based	74,78%
2	Teachers develop ICT based learning media	73,04%
3	The use of ICT based media helps to clarify geographic material	80,87%

According to UNESCO, information and communication technologies (ICT) are media or tools to carry out activities such as processing, manipulating, managing, and transferring/transferring information. ICT includes two aspects namely information technology and communication technology. ICT is indispensable in learning today's era. With the principle of using ICT that is effective and efficient, optimal, attractive, and stimulates creativity, ICT has become one of the learning media that is widely used in various fields study of education because it increases effectiveness and efficiency in the learning process.

Information and communication technology are two aspects there are information technology and communication technology. Information technology includes everything related to the process, use as a tool, manipulation, and management of information. Communication technology is everything related to the use of tools to process and transfer data from one device to another. Information and communication technology is the study or use of electronic equipment, especially computers, to save, analyze and distribute any information including words, numbers and pictures. Based on the analysis of the urgency using Information and Communication Technology (ICT) in geography subjects in West Sumatra it is included in the high category. This is seen from the teachers aspect in using and developing ICT based learning media because it can help clarify geography material and follow the development of education patterns based on 21st century education.

TPACK is a framework for designing new learning models by combining three main aspects there are technology, pedagogy, and content (material knowledge). In addition to the use of technology as teaching material in the TPACK framework, pedagogy is an important aspect that also needs to be considered in learning activities.Technological pedagogical content knowledge (TPACK): Knowledge of the complex interaction between the three components of basic knowledge (CK, PK, TK) that a teacher has when teaching content using appropriate pedagogical methods and technologies. TPACK is the basis of effective teaching with technology [21].

1. Technology indicators are assessments that discuss the teachers ability to use technology. In this indicator the teachers ability is included in the high category. This can be seen from the results of the questionnaire test that has been given.
2. Pedagogic indicators are assessments related to the ability of teachers to manage learning. In this indicator the teachers ability to manage learning is included in the high category.
3. The geography content indicator is an assessment that discusses the teachers ability to master geography material. In this indicator, the ability of teachers is included in the medium category. This result is seen from the questionnaire test that has been given.
4. Pedagogic technology indicators are assessments related to the ability of teachers to use technology in learning. How teachers are able to combine technology adaptation and learning management to students as for this indicator the teachers ability is included in the medium category.

5. Geography content technology indicators are assessments related to the ability of teachers to combine the ability to use technology, the ability to master geography learning materials at one time. The ability of teachers to implement technology, materials and geography simultaneously to students. In this indicator, the teachers ability to combine the three things is included in the high category.

Pedagogic indicators of geography content are assessments that discuss the teachers ability to manage learning and geography learning materials to students properly. In this indicator the teachers ability is included in the medium category.
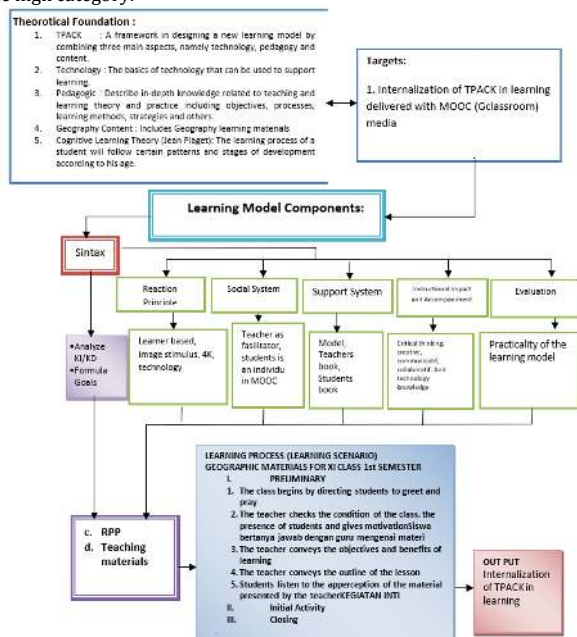

Figure 2. TPACK Model Learning based MOOC

Before the learning media is implemented in the classroom, the media needs to be tested on several indicators of feasibility assessment from the media and material aspects. Several aspects to assess or evaluate learning multimedia, including aspects of subject matter, auxiliary information, affective considerations, interfaces, navigation, pedagogics, and robustness so that the media can be said to be feasible to use. Validity test is the accuracy or accuracy of an instrument in measurement. At the validation stage, lesson plan, learning media, and test instruments that have been designed are validated for feasibility. There are several steps taken at this stage there are material testing by material experts, media testing by media experts and material experts, testing of test instruments by material experts, checking lesson plans (Dian, 2018).

Table 3. Media Expert Validation

No	Aspects	Score
1	Appearance	86,6%
2	Typography	80,0%
3	Programming	86,6%
4	Completeness	80,0%

In the aspect of appearance, product display is very important in attracting students' interest. So the display of learning must also be supportive. TPACK based MOOC learning model is included in the very high category. In this aspect, the background, appearance, and availability of learning materials in MOOC are seen that have completeness. In the typography aspect TPACK based MOOC learning model is included in the high category. The aspects that are seen from the typographical aspect are the ease of understanding the learning contained in the Google classroom, the suitability of the type and variety of letters and the suitability of the

distance. In the programming aspect, the TPACK based MOOC learning model is in the very high category. This aspect is seen from the module, the steps for using Google Classroom and the ease of finding materials.

Table 4. Material Expert Validation

No	Aspects	Score
1	Content Eligibility	73,3%
2	Language	86,6%
3	Presentation	73,3%
4	Graphics	86,6%

In terms of content feasibility TPACK based MOOC learning model is included in the high category. In terms of content feasibility, it can be seen from the suitability of the material with the lesson plans and syllabus, the truth of the material, the coverage of a comprehensive explanation of the material, and in accordance with the initial objectives before making learning media. In the linguistic aspect, TPACK based MOOC learning model is in the very high category. This is seen from the assessment of the accuracy choice of terms, the determination of use language that is in accordance with PUEBI, and the clear language in describing the steps for using Google Classroom. In the presentation aspect, TPACK based MOOC learning model is in the high category. As the aspects seen, there are presentation of clear examples, ease of understanding the model and complete materials related to the Potential of Natural Resources in Google Classroom. In the graphic aspect, TPACK based MOOC learning model is very high category. This is analyze from the aspect of using the typeface, font size and layout of interesting material and content so that it can motivate and encourage students before starting learning.

Table 5. TPACK based MOOC Learning Model Steps

No	Activity	Teacher Activities	Student Activities	Description
1.	Initial activity	The teacher provides motivation to understand the material to be taught regarding Resource Classification, menyiapkan alat dan materials for learning that will be carried out, and prepare learning media in the form of Google Classroom and explain how to implement google classroom media to students.	Students listen carefully regarding the motivation given by the teacher in understanding the material and students implement the google classroom media that has been explained by the teacher	
2.	Crithical thinking	The teacher provides the opportunity to identify as many things as possible that have not been understood through the videos and teaching materials that have been provided in the google classroom media and ask students to provide feedback regarding the videos that have been presented.	Students identify things that have not been understood related to learning materials through videos and teaching materials that have been provided by the teacher in the google classroom media and provide feedback regarding the available videos.	

No		Teacher Activity	Student Activity	
3.	Collaboration	Students are asked to discuss, collect information, re-present, ask each other questions and exchange information about the material *Classification of resources*	Students discuss, gather information, re-present, ask each other questions and exchange information about the material *Classification of resources*	
4.	Communication	The teacher gives an explanation regarding the *Resource Classification material* through a Power Point slide that is displayed using infocus and gives random questions to students about the material displayed on the Power Point slide.	Students understand the explanation regarding the *Resource Classification material* explained by the teacher through Power Point slides and answer questions randomly given by the teacher to students.	
5.	Creativity	The teacher give conclusions about the things that have been learned related to the *classification of resources,* provides opportunities for students to ask questions that have not been understood, and gives a short quiz regarding learning materials before class ends in Google Classroom.	Students make conclusions based on their understanding of the material that has been studied, ask the teacher for things that have not been understood about the learning material, and take a short quiz that has been given by the teacher in google classroom.	

Discussion

Table 6. Results of Pretest, Posttest, and N-gain Learning Using the MOOC-based TPACK Model in Two Schools

No	School	Pretest Mean	Posttest Mean	N-Gain
1	SMA N 1 Bukittinggi	66,35	87,93	0,71
2	SMA N 1 Pariaman	63,87	86,24	0,62

There is conducted a study about the impact of perceived instructional quality on learner control, sense of progress, and perceived effectiveness in MOOCs [22]. From the perspective of student motivation to take MOOCs examined the motivational factors of MOOCs (i.e., intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation), and found that the most significant gap between completers and non-completers is self-efficacy (i.e., the specific beliefs that people have in their capability to complete tasks [23]. Pretest and posttest is a form of formative evaluation that serves to determine the progress or development of student learning. The pretest is a test given before teaching begins and aims to find out to what extent students mastery of the teaching materials (knowledge and skills) will be teach. Pretest is considered very useful because it encourages students to be more active in learning. Posttest is a test conducted at the end of learning activities. The purpose of the posttest is to determine the achievement capacity of students towards teaching materials (knowledge and skills) after participating in learning activities.

If the results of the posttest are compared with the pretest, then both serve to measure the effectiveness of the implementation of the teaching program. Several authors have identifed factors that are important to help

increase student retention in MOOCs [3]. Teachers can find out whether the activity is successful or not, in the sense of whether the learning objectives to students can be conveyed well or not through this test. The average pretest result at SMA N 1 Bukittinggi is 66.35 including the medium category. The average posttest at SMA N 1 Bukittinggi is 87.93 including the high category. For the value of N-Gain, SMA N 1 Bukittinggi is in the high category. This can be seen from the average results of the pretest and posttest given. At SMA N 1 Pariman, the average pretest is 63.87 and is in the medium category. The posttest average is 86.24 and is included in the high category. The N-Gain value for SMA N 1 Pariaman itself is in the medium category.

Table 7. Teacher Satisfaction Analysis of TPACK based MOOC Learning Model

No	Aspects	Score
1	Use	80,0%
2	Time	80,0%
3	Presentation	85,0%
4	Language	80,0%

MOOC can facilitate knowledge sharing between students and teachers without time limit. One line of research proposes that satisfaction is shaped through cognitive comparison between an individual's initial cognition and the new experience. For example, in the marketing literature, Oliver (1980) theorised that customer satisfaction is shaped by initial expectation, product performance and perceived confirmation.[24]. Teacher job satisfaction is a teacher assessment of the aspects contained in a job, there are aspects of supervision, co-workers, working conditions, rewards, responsibilities, the work itself, promotion, security, and rewards [25]. In the aspect of using a questionnaire analysis of teacher satisfaction with TPACK based MOOC learning model, it is included in the high category. Aspects seen are learning models that are easy to use, able to attract students' attention and interest, and are practical to use. In terms of time TPACK based MOOC learning model is in the high category. This can be seen from the time allocation used. In the presentation aspect, time TPACK based MOOC learning model is in the high category. As for the aspects seen from this aspect namely the cover display, a clear description of the material, the availability of videos and pictures according to the learning material clearly and the appropriate illustrations. The high satisfaction scores with this MOOCs and increases in content-based knowledge were similar to what has been reported in the literature [26]. In the language aspect TPACK based MOOC learning model is in the high category. As for the aspects that are seen based on language according to EYD, the sentences used are easy to understand, the type and size of the letters are appropriate and the color combination is right.

Table 8. Students Teacher Satisfaction Analysis of TPACK based MOOC Learning Model

No	Aspects	Score
1	Convenience	85,0%
2	Presentation	85,0%

In research, the most common variables are those related to videos and exercises interactions, and activity in the MOOC platform Boyer [27]. In the aspect of ease of questionnaire analysis of student satisfaction with TPACK based MOOC learning model, it is in the high category. Aspects seen in the form of instructions for using the model, ease of learning teaching materials, there are instructions for solving questions and quizzes in Google Classroom that provide convenience for students. Then TPACK based MOOC learning model is feasible to use. In the aspect of presentation, the questionnaire analysis of student satisfaction with TPACK based MOOC learning model is included in the high category. What is seen is the presentation of teaching materials that can be accessed anytime and anywhere, and the presentation of material presented in the Google classroom media. MOOC research emphasizes the quality of MOOC content which generally argues that the adoption of high quality instructional design will enable students to experience a sense of control, successful learning progress, which in turn leads to a successful learning experience and good results [28] .Given these features of MOOCs, students can apply the acquired knowledge in decision-making and problem-solving activities [29].

CONCLUSION

Online learning may continue to benefit selfregulated learning skills which enable to students to be successful in asynchronous, self-directed formats [30]. The use of MOOCs provides students with ubiquitous access to a diverse range of resources at "anytime anywhere" settings. Also enable students to have enough storage capacities to store their materials. MOOCs are online courses characterized by the absence of formal entrance requirements, free participation, content delivered entirely online, a project designed to support thousands of students [31]. MOOCs require learners to be self-motivated, educators in MOOCs "do not guide individuals' learning or monitor their induction into the attitudes, understandings, mindsets, tools and techniques

that make up a discipline or profession"[32]. For these reasons, MOOCs provide an excellent venue for the study of autonomous learning, particularly through the use of learning analytics.

Academics and other stakeholders in education have utilized MOOCs not only to deliver learning experiences but also help assess student behavior through their online engagement. Among such are trace data, which comprises of counts of activity logs, time spent online, or counts of access to discrete resources [33]. The TPACK mapping of geography teachers in West Sumatra shows the condition of mastery of pedagogic technology and content in moderate conditions. This means that there is a need for habituation in optimizing technology related to content and pedagogics in geography learning. The learning model developed by the research team has been validated by experts with high scores. In the implementation trial, TPACK based MOOC learning model implemented on natural resource materials can improve learning outcomes with normalized N-Gain at high scores. Teachers and students assessed that TPACK and MOOC learning helped the asynchronous learning process and in accordance with virtual face to face learning. Given the amount of data being collected, MOOCs provide ample opportunities to understand human learning and provide a fine-grained assessment of students' learning progress.

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