Enhancing the Use of Digital Model with Team-Based Learning Approach in Science Teaching

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Abstract. This study describes the introduction of digital models and team-based learning (TBL) for teaching science; in this case, the teaching of the magnetic induction portion of a physics class. This new approach required students' active construction of knowledge as both an individual and team. Students were asked to begin their studies through the viewing of digital models in videos through an online learning portal. *Camtasia Studio* was utilized in creating video contains class material and experiments along with the teacher's audio explanation. The TBL approach was implemented as the instructional strategy during in-class sessions. A portion of the classroom time was spent ensuring that students master the class material and a vast majority of class time was used for team assignments that focused on problem-based learning and simulating complex questions that the student would face as the course developed. The utilization of digital models and TBL improved the students' ability to learn independently and to present their ideas coherently, transforming them into more engaged, independent learners, not just in science learning but also in their overall academic experience.

Keywords: Team-Based Learning, TBL, digital model, science teaching.

1 Introduction

The latest data indicates that the development of secondary education, especially in the science and mathematics, in Indonesia experienced a declining trend, in comparison with other countries. The TIMSS (Trends International in Mathematics and Science Study) report showed that in 2007, Indonesian was ranked 35 (out of 49 countries) in eighth grade science. However, four years later, its rank went down to 40 (from 42 countries). Realizing that science (and technology) plays significant role in shaping the future of the country, the Indonesian government is putting efforts to improve the quality of education through National Education Standard (NES). One of the issues that impede the government's endeavor is the practice of learning and teaching, especially in science.

Currently, the teaching of science-related courses at primary as well as secondary school level in Indonesia is based on a relatively traditional teaching method; the

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instructor imparts knowledge to students in the classroom, explaining various concepts, facts, and other learning contents [1]. As teaching time is limited, the students listens to, absorbs, and memorizes what the teacher has said while activities, such as homework and material review would then complement the teaching activities. This renders the students to be more of a group of passive participants in the learning process. Furthermore, students rely on textbooks as a primary information source; they are urged to read the text but in reality, many do not do so. As a result, the teacher spends more time organizing and clarifying the text's information for the students. In this more traditional method of teaching, students are not maximally engaged in the learning process and do not reach their maximum potential in mastering the content material. (The Content Standard of the NES is the minimum criteria in the Indonesian educational system; thus, mastering the material is essential). Furthermore, in the traditional teaching method, there is a lack of opportunity for students to develop the attitudes necessary for scientific inquiry [2]. In the traditional curriculum, the science is taught as proven facts and absolute truth, which is treated as a static body of knowledge [3]. Thus, we believe that an effective teaching method should involve the students' active participation in the learning process. The focus of instruction would be learning how to apply the concepts and ideas substantially instead of merely learning about them theoretically. Marx et al. (2004) argue that learning science should be active and constructive [4]. In this student-centered teaching method, a different kind of instructional strategies to teach science is employed. It includes using digital models as well as putting students in groups for them to collaborate as an effective team.

The use of models and analogies in the pedagogy of science teaching was directed to assist students to gain understanding of the subject [5]. However, the advances in Information and Communication Technology (ICT) within the past three decades which positively impact on the teaching and learning in science [6] have provided the opportunities for some educators to employ the digital models in the teaching and learning activities, especially for science-related subjects. Many digital models and applications have been developed to address students' difficulties in understanding the concept. However, the students' grasping of a concept does not depend solely on the model; there should be a learning process that ensures the model can help students optimally in their learning activities. This problem is often exacerbated by the fact that the students are not accustomed to working in groups. Coll, France and Taylor (2005) suggest that the collaborative work and peer discussion are important factors to enhance students' cognitive thinking skills, which are crucial in the understanding of science-related subjects [5]. Thus, the aim of the paper is to present a method of science teaching with digital models that requires students to actively construct knowledge in both an independent and group setting.

This method is currently employed in the Grade 9 in one of public junior high schools in Jakarta, Indonesia. The students learnt about magnetic induction in their physics class in. Students were asked to examine digital models in the form of instructional videos through an online learning portal. The video content consisted of class materials and experiments, along with the teacher's narration, which was created using *Camtasia Studio*.

In learning science-related subjects, it is not enough just to study the concepts; the Indonesian Ministry of National Education in its science curriculum policy expect that students to develop their domain knowledge as well as cognitive process [7].

As students learn from cognitive processes of their peers [8], during classroom activities, the Team-Based Learning (TBL) would be employed as the instructional strategy. In this method, the students would learn about magnetic induction concepts and its applications through individual and group activities.

1.1 Models in Science Teaching and Learning

Learning is defined as any relatively permanent change in behavior that occurs as a result of practice or experience [9]. This definition consists of two important concepts, “change in behavior” and “a result of practice or experience”. Thus, a teaching method should aim to achieve these two ideas in learning. For science, models can be one of the tools for shaping the students’ learning experience.

Models are defined as intended physical, computational, or mental representations of a more concrete entity, set of concepts, or phenomena [10]. There are three different types of model in science education [11]: conceptual, mental, and physical models.

Conceptual models are external representations. They are precise, complete, and consistent with the shared scientific knowledge specifically created to facilitate the comprehension or the teaching of systems in the world [12]. Mental models are internal and cognitive representations of familiar objects and concepts [10, 13]. They are psychological representations of real or imaginary situations [11]. Lastly, physical models are considered by the science-education community as a simplified and/or idealized version of a more complex physical system or phenomenon [11].

The conceptual models consists of mathematical, computer, and physical models. Ornek (2008) states that the definitions of each conceptual model are as follows [11]:

- A mathematical model is the use of mathematical language to describe the behavior of a system.
- A computer model has a program that attempts to simulate the behavior of a particular system. The program was created through the use of a mathematical model to find analytical solutions to problems, enabling the prediction of a complex system’s behavior via a set of parameters and initial conditions.
- Physical models in the science-education community are considered to be tangible representations that can be carried, touched, or held.

1.2 ICT for Science Teaching and Learning

With computer technology’s rapid advancement as well as widespread use of the Internet, teaching and learning with communication/information processing technologies have become a current, popular interest among researchers and educators [14]. The implementation of Information and Communication Technology (ICT) influenced the teaching methodology and teaching material. For the science teaching and learning, ICT could provide digital contents and a deliver mechanism to the students. Due to difference with a traditional class, the students must “adjust” their concept cognition to reap the benefits of conceptual change learning [14].

1.3 Digital Model

A digital model is created and delivered via ICT, with the ability to incorporate not only a computer model, but also a mathematical or physical model. The resulting digital data can range from videos to interactive games to virtual simulation.

This research addressed the use of digital video presentations. The instructor/teacher created the video with *Camtasia*, a computer software that captures both the computer's screen and teacher's voice. With this software, the teacher recorded his power point presentation then added with his own explanation in synch with the presentation's progress.

1.4 Webblog

A web blog (blog) was used to deliver the digital model. From an educational point of view, weblogs are the development of traditional learning logs for students and teachers, whether as a complement to traditional lectures or as an e-learning tool [15].

1.5 Team-Based Learning (TBL)

The primary learning objective in TBL is to go beyond simply covering content, shifting more focus to ensuring that students have the opportunity to practice course concepts via problem solving. Thus, TBL is designed to provide students with both conceptual and procedural knowledge [16]. Although a portion of the classroom time is still spent ensuring that students master the course content, the vast majority of class time is used for team assignments that focus on problem-based learning, simulating complex questions that the student will face as the course develops.

Figure 1 outlines a general scheme of how a TBL course is organized. Students are strategically organized into permanent groups for the term, and the course content is organized into major units— typically five to seven. Before any in-class content work, students must study assigned materials since each unit begins with the readiness assurance process (RAP), which consists of a short test on the key ideas from the readings that students complete as individuals. Subsequently, the students would work on the test as a team, coming to consensus on team answers. Immediate feedback is given on the team test, allowing the opportunity to write evidence-based appeals and valid arguments for incorrect responses. The final step in the RAP is short and specific lecture to clarify any common misunderstandings found within the team test and appeals. Upon the completion of the RAP, the majority remainder of learning unit is spent on in-class activities and assignments that require students to practice using the course content.

1.6 TBL Structure

Shifting from simply familiarizing students with course concepts to requiring that students use those concepts to solve problems is no small task [16]. The realization of this shift requires changes in the roles of both instructor and students. The instructor's primary role shifts from dispensing information to designing and managing the overall instructional process. On the other hand, the students' role shifts from being passive recipients of information to actively responding to initial exposure to the course content during the process of preparing for in-class teamwork. Changes of this magnitude do not happen automatically and may even seem improbable. They are, however, achievable when the four essential elements of TBL are implemented successfully [16]:

- Teams: groups of students must be properly formed and managed
- Accountability: students must be accountable for the quality of their individual and group work
- Feedback: instructors must provide frequent and timely feedback to students
- Assignment design: group questions must promote both learning and team development

When these four elements are implemented in a course, the stage is set for student groups to evolve into cohesive learning teams [16].

1.7 Advantages of TBL

Forming student teams for group work, even in a casual manner, produces benefits that cannot be achieved with students's being in a strictly passive learning role. While even the casual use of teams is beneficial, it must be stressed that team-based learning allows the achievement and maintenance of important outcomes only through consistent utilization of the method. Some of these benefits include [16]: 1) developing students' higher level cognitive skills in large classes, 2) providing social support for "at-risk" students, 3) promoting the development of interpersonal and team skills, and 4) building and maintaining faculty members' enthusiasm for their teaching role.

2 Methods

This study was conducted to implement digital models and Team Based Learning (TBL) approach in the magnetic induction portion of a physics class. This research was done in a group consisting of 36 Grade 9 students at a public junior high school in Jakarta, Indonesia.

Magnetic induction is a part of Indonesia's physics curriculum for the junior high school level. This material is chosen because of students' difficulty in grasping the concept of induction with prior utilization of direct classroom demonstration. Some animations or digital models had been created but garnered no significant result, presumably because of the passive role that the students still assumed. Thus, TBL was applied as an attempt to make students construct knowledge actively.

This research conducted a blended learning model; that is, the course taught magnetic induction with part traditional (in-person) lectures and part modern ICT over internet [17]. This course consisted of three stages: online learning, first in-person, and second in-person sessions. Fig. 1 shows the research design's stages.

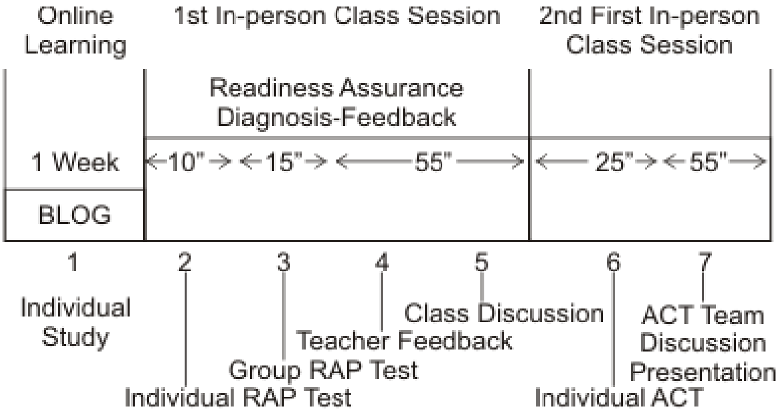

Fig. 1. Research Design [16]

During the online learning stage, students learned the material by watching digital models that were uploaded onto the teacher's blog. The 'video presentation' materials consisted of presentation slides on Magnetic Induction along with the teacher's audio explanation, generated with *Camtasia Studio*. Every student could to study this video's contents independently, one week prior to the implementation of the next learning stage. They could access video presentation multiple times until they achieved good understanding on the topic.

At in-person stages, students completed a test and collaborated in a small group. The first in-person meeting had the students perform an RAP (Readiness Assurance Process) test individually for 10 minutes. The RAP gauged a student's comprehension of the concept through 10 multiple-choice questions, each of which had four answer choices. Students must distribute a total of 4 points to each question. This way, the students could receive partial credit based on their point distributions on the questions. An RAP test has a maximum possible score of 40. After the individual RAP testing, students split into nine groups (four students per group) with systematic grouping to ensure uniform distribution of genders and comprehension levels. Teachers checked the individual students' RAP tests while the students discussed the questions within their groups. The groups RAP's worksheet was a scratched paper. The students could scratch their group answer for every question. If they got a star in the first scratch, they would get 4 point for one question. For the second scratch, they got 2 point and 1 point for third scratch. From the individual and group RAP answers, the teacher compiled the wrong answers as basis for reviewing the RAP worksheet. At the end of the review, students could ask for a more in-depth explanation if confusion still remained. This first in-person meeting would last for approximately 80 minutes.

In the second in-person meeting, the students completed the Application Concept Test (ACT), which consisted of two essay questions. The student wrote out explanations to their answers individually then discussed those explanations with their team. This session also lasted for 80 minutes. The discourse among the team members is the key characteristic feature of students' engagement in their learning.

3 Discussions

The most important preparation for this research was to the creation of the video presentation and their subsequent uploading to the teacher's blog. The magnetic induction presentation consisted of fifteen power point slides. The details of each slide's content are shown in Table 1. All slides were synched with the recorded explanations with *Camtasia Recorder* version 3.0. The video's duration was 12:38.

The video presentation was saved in mpeg format with 720-pixel frame width and 576-pixel frame height. This screen resolution size produced a video that was difficult to see. However, higher resolutions led to data size that was too large. The total data size of the final video was 300 MB, which was too large for internet uploads in Indonesia. Thus, the file was split into three parts for easier uploads and downloads. Fig. 2 shows a screen capture of video presentation.

Table 1. Power Point Presentation's Description

Slide Number	Description
Slide 1	Introduction and definition of magnetic induction
Slide 2	Animation about galvanometer when a wire was moved between magnetic poles
Slide 3-5	Animation about how to create electromagnetic induction in AC and DC powers
Slide 6-8	Animation about the direction of Induced Electromotive Force (EMF)
Slide 9-11	Animation about factors affecting EMF
Slide 12-15	Animation about tools that uses the working principle of electromagnetic induction

The RAP test consisted of ten conceptual questions, all of which were based on the video presentation. The questions covered definitions, examples, and tools for creating magnetic induction. This test also covered how magnetic induction could be created as well as factors that influenced EMF.

The entire study was completed within two weeks; the first week was spent on Stage 1 while the second week was split between Stages 2 and 3. The following details the results from each step:

Stage 1: Online Learning

Students had the opportunity to learn independently during in Stage 1 at their own convenience since virtually, the blog can be accessed anytime after school for the number of times the students needed until adequate comprehension was achieved. Half of the research participants repeated the video more than three times. By doing this repetition, students have well understanding about the topics.

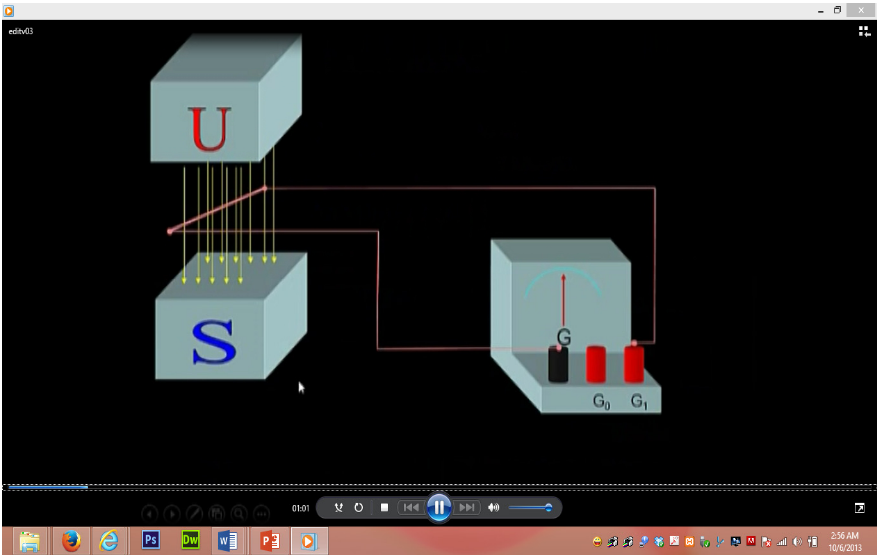

Fig. 2. Screen Capture of Video Presentation

Stage 2: First In-person Class Session
For the first ten minutes of class, students took the RAP test individually. Students can earn partial credit through point allocations for each question. For example, if a student is confident that the correct choice is "A", all 4 points would be assigned to "A". However, if a student is fairly certain of the answer "A", but is hesitant to rule out "C", they could allot 3 points to "A" and 1 to "C". After students had completed the RAP test individually, the teacher collected the worksheets and had the students discuss and decide on their group answers. They seemed happy to work in groups. They can evaluate their own answers. If they do not find "star" in the first scratch, they discuss their answers again to find the correct answer.

Based on the individual and group RAP worksheets, most of mistakes came from the question on factors that influenced EMF. After the individual and group RAP test were completed, the teacher gave explanations on common mistakes. The teacher also replayed parts of the video presentation that covered concepts that most of the students missed. This session concluded with a question and answer session.

Stage 3: Second In-person Class Session
This session begins with individual ACT that lasted for twenty minutes. After this test, the students returned to their groups to discuss and prepare a presentation on their ACT answers. Students were allowed to present with a flip chart or power point. During the presentation, the class was allowed to ask questions to the presenters.

4 Conclusion

TBL can be a solution to improve the use of digital media in teaching and learning processes. TBL helps students to self-evaluate their learning outcomes through small groups. The use of digital models without strict control can lead to misconceptions about student comprehension of course materials. Additionally, TBL can help teachers provide a quick feedback mechanism to student learning outcomes. Moreover, TBL improves students' ability to learn independently and to present their ideas coherently. This ability is important to transform students into independent learners, one of key features for engaging students in not just science learning but in their overall academic experience.

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