



Flipped Classroom as a Pedagogical Approach for the Development of Mathematics Instruction for Learning in the 21st Century

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Abstract

Flipped classroom is a pedagogical approach which changes instructional activity from teacher's lecturing to student's self-learning. In flipped classroom, students learn concepts via digital technology and apply understanding about the concepts in classroom activities. In the classroom activities, teachers have the important role in facilitating students to develop better 'conclusions. Flipped classroom approach consists of four stages: (1) experiential engagement, (2) concept exploration, (3) meaning making, and (4) demonstration and application. The learning in flipped classroom approach is relevant to learning in the 21st century where students are able to learn anytime and everywhere via digital technology. Flipped classroom approach is able to be implemented in mathematics classroom instruction in order to prepare students for Thailand 4.0.

Introduction

A goal of education in the 21st century is to prepare students for work and everyday life. A teacher is an important factor who can facilitate students to achieve the goal. Teachers have to be active and creative to conduct high quality instruction that enhances students' knowledge, abilities, and skills necessary for everyday life. (Kiratiganont, 2014; Nopakhun, 2017) Among a number of instructional approaches, flipped classroom is highly recommended. Flipped classroom is an instructional approach that is aligned with the current education. It changes instructional activity from teacher's lecturing to students' self-learning. Students learn content via digital technology, such as website, that teacher prepares. Then, students apply understanding, which they have learned, in classroom activity. The way that students learn in flipped classroom is relevant to learning in the

21st century where students can learn anytime and everywhere via digital technology. Flipped classroom is effective to both students and teacher. Students individually learn content so that they understand the content. In classroom activities, there is no need for teacher to re-teach the content. Instead, teacher can provide students opportunities to do activities to promote students' thinking and other skills. As a result, students will develop better and meaningful understanding about the content and necessary skills.

Background of Flipped Classroom

Flipped classroom is a pedagogical approach that was originally developed by Jonathan Bergmann and Aaron Sams who are chemistry teachers in Woodland Park School, Colorado, USA (Bergmann & Sams, 2017). In their class, there were chemical concepts that were

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complicated so that students need more time to study. In addition, there were some students who were not able to attend classroom activities because of extra-curricular activities in school. To solve the problems, Bergmann and Sams had ideas about instruction that: 1) integrates the use of digital technology, such as computer and mobile phone, to enhance students' learning and 2) includes activities that connect teacher to students such as allowing a teacher to pose a problem and allowing students to ask questions (Na Mahachai, 2013; Panich, 2013). These ideas are included in a flipped classroom approach.

There are several differences between flipped classroom and traditional classroom. The main difference is the roles of teacher and students. In traditional classroom, the teacher has to prepare content prior to class. Then, the teacher lectures students in the classroom. Students have to listen to teacher's talk, take notes on the important issues, and do homework. In contrast, in flipped classroom, teacher has to prepare content and post the content on a digital platform such as website. Students have to study the provided content prior to class. Then, students do in-class activity that focuses on promoting students' higher order thinking rather than teaching the content. In the activity, students have a chance to discuss with teacher and peers so that they have better understanding about the content (Educause, 2012). The summary of differences between traditional classroom and flipped classroom is shown in Figure 1.

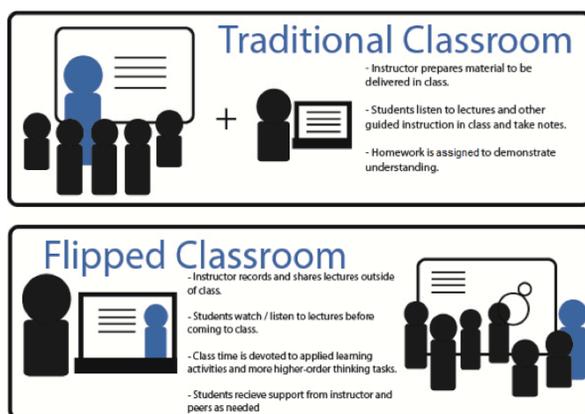


Figure 1 Summary of differences between traditional classroom and flipped classroom

(From <http://www.slu.edu/ctl/resources/teaching-tips-and-resources/flipped-classroom.resources>)

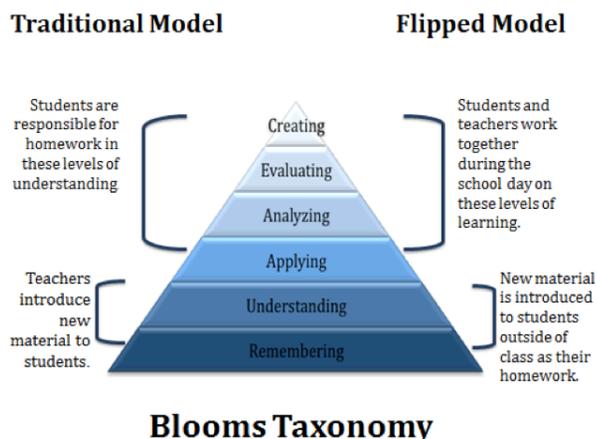
Advantages of Flipped Classroom for Students

Flipped classroom has several advantages to students. First, flipped classroom supports students to use digital technology. This support provides students, who can and cannot attend class, opportunities to learn and understand content prior to class. Also, students can review the content after class. Second, flipped classroom provides students opportunities to revisit the content. For example, students can re-watch the videotape that teacher posts on website as much as they want. Third, flipped classroom supports interactions between teacher and students and between students and students. During in-class activity, students have to apply understanding, which they have gained from learning via digital technology prior to class, to do activity such as solving problems. In the activity, they can discuss their ideas, concerns, or questions with teacher or peers. Last, flipped classroom enhances students to develop higher order thinking. Since students understand content prior to class, teacher does not have to re-teach the content. Thus, in classroom activity, teacher has more time to pose questions and have discussion to promote students' higher order thinking (Pahay, 2013; Ramnarong, 2013).

Roles of Teachers and Students in Flipped Classroom

Flipped classroom changes not only students' role but also teacher's role. Teacher's role is changed from preparing content and teaching the content in the classroom to preparing content and teaching the content by posting the content on a digital platform. Emphasis of classroom activity is changed from teaching content to allowing students to apply knowledge about the content so that they can develop higher order thinking skills.

The changes of teacher's and students' role in flipped classroom are advantage in developing students' learning. Figure 2 shows supports of teacher's and students' role in flipped classroom to develop each learning stage in Bloom's Learning Taxonomy, in comparison with that in traditional classroom.



Blooms Taxonomy

Figure 2 Comparison of instruction in traditional classroom and flipped classroom that support students' learning in each stage of Bloom's learning taxonomy

(From <https://flippedchem.wordpress.com/2015/07/30/theoretical-framework-for-the-flipped-classroom-model-2/>)

From Figure 2, teacher's and students' role in traditional classroom and in flipped classroom can be summarized as shown in Table 1.

Table 1 Teacher's role and students' role in traditional classroom and flipped classroom to support students' learning in each stage of Bloom's Learning Taxonomy

| Learning Stage of Bloom's Learning Taxonomy | Roles of Teachers and Students | |
|---|---|---|
| | Traditional Classroom | Flipped Classroom |
| Remembering | Teachers lecture students on new content in the classroom. | Students learn new content by themselves via technology |
| Understanding | | |
| Applying | Students do homework by themselves. Teachers and students collaboratively work on classroom activities to enhance various levels of learning. | |
| Analyzing | | |
| Evaluating | | |
| Creating | | |

Flipped Classroom in Mathematics Instruction

Mathematics is an important discipline in the 21st century. However, mathematics instruction in Thailand is not successful since a number of teachers teach mathematics only by lecturing. Often, a teacher does not use instructional materials to enhance students' learning and does not provide students opportunities to participate in classroom activities. As a result, students dislike mathematics, develop a bad attitude toward mathematics, and have low achievement in mathematics. Thus, it is very important that a teacher has good understanding in mathematics and abilities to develop activities,

exercises, and instructional media to support students' learning (Chaikhwang, 2011; Khunranartsiri, 2014)

Flipped classroom is one of the solutions to solve the problem about mathematics teaching. With the use of digital technology in flipped classroom, students are motivated. The implementation of flipped classroom approach also provides students opportunities to learn mathematics anytime and everywhere. Lee (2016) specifies five strategies for implementing flipped classroom approach to mathematics instruction as follows:

Strategy 1: Planning. Planning prior to class is effective for teacher. Teachers who plan for teaching prior to class have more time to understand content and design interesting strategies to deliver the content. Also, a teacher has time to develop additional materials to support students' learning such as online test that can be used to evaluate students' understanding.

Strategy 2: Introducing concepts in class. Mathematics is a complex discipline. It is very important for teacher to have students understand objective of lessons before allowing them to learn content via digital technology.

Strategy 3: Using mathematics applications. Use of mathematics applications help students better understand mathematical content. Examples of mathematics applications are the followings.

- Operation Math (<http://www.teacherswithapps.com/operation-math>)
- Power Math Apps (<http://www.powermathapps.com/>)
- DragonBox (<http://dragonbox.com>)
- MathLab (<http://www.mathlab.mtu.edu>)
- Geoboard (<http://www.mathlearningcenter.org/resources/apps/geoboard>)

Students could learn mathematics via these applications with fun anywhere and at any time.

Strategy 4: Video. When teacher plans for delivering content to students by using videotape, a teacher should concern on difficulty of the content included in the videotape. The teacher should classify the content, which will be included in videotape, in various levels such as easy, moderate, and hard. This content classification will be effective in teaching students with various abilities.

Strategy 5: Student teaching. After students learn content via digital technology prior to class, teacher should provide students opportunities to teach peers. With this strategy, teacher will be able to check how well students understand and prepare additional support if

students need more help.

Strategies for Implementing Flipped Classroom Approach in Mathematics Instruction

Schoolwires (2013) describes that stages for implementing flipped classroom approach in classroom instruction consist of four stages as follows:

Stage 1: Experiential Engagement. In this stage, a teacher explains what the instruction and what the content consist of in this course, which is conducted based on flipped classroom approach. In this stage, students will understand their role before the lesson starts.

Stage 2: Concept Exploration. In this stage, a teacher explains to the students about the digital technology used in this course. The digital technology that a teacher introduces to students can consist of what the teacher developed, such as teacher's website, or it could be in the form of what the teacher does not develop, such as Facebook.

Stage 3: Meaning Making. In this stage, students learn content via digital technology that the teacher provides. In their self-learning process, students have to understand the content so that they can bring their understanding to do in-class activity which is in the next stage.

Stage 4: Demonstration and Application. In this stage, students apply the understanding they have gained from the previous stage to do in-class activity. In the activity, students have opportunities to discuss the content they have learned, apply their understanding to solve problems, and make a conclusion about the content with teachers and peers.

Based on these stages to implement flipped classroom approach in classroom instruction, there are five strategies for implementing flipped classroom approach in mathematics instruction as follows:

1. The teacher has to prepare digital technology, which will be used to deliver content to students, before the lesson starts. For example, when a teacher makes a decision to deliver content to students by using a video clip, the teacher has to prepare or select a suitable video clip. Then, the video clip has to be uploaded to a digital platform that the teacher selects such as YouTube (<http://www.youtube.com>), Facebook (<http://www.facebook.com>), or other platforms. The uploaded content will allow students to learn the content anytime and everywhere. Besides the content that teacher uploads, students should be encouraged to explore information from other sources by themselves.

2. During the experiential engagement stage,

teacher has to ensure that students understand the teaching and learning strategies in mathematics flipped classroom. Students have to understand what they have to do when they engage in the lesson. Then, teacher assigns students to learn content from digital platform, which teacher prepares, or from other sources.

3. During the concept exploration stage, the teacher provides students opportunities to study and explore concepts by themselves via digital platform, which teacher prepares, or from other sources. In this stage, the teacher has to encourage students to understand the content as much as possible so that they will be able to do in-class activity.

4. During the meaning making stage, teacher has to encourage students to apply the knowledge and understanding, which they have gained from their self-learning, to do in-class activity. The in-class activity is an activity that both teacher and students participate in. The teacher is responsible for posing a problem, giving suggestion, and leading discussion to enhance students' thinking skills.

5. During the demonstration and application stage, teachers provide students opportunities to demonstrate and present what they have learned from the activities. Then, teachers and students collaboratively make a conclusion about the content learned from the lesson.

Summary

Flipped classroom is an instructional approach which changes instructional activity from teacher's lecturing to students' self-learning via digital technology such as YouTube, Facebook, Blog, or other platforms that a teacher develops. Students' opportunities for self-learning via digital technology allow them to learn content anytime and everywhere. After students self-learn the content, they have to apply their understanding to do in-class activity with teacher and peers. In the activities, teacher facilitates students by giving suggestion or posing questions to motivate students to solve problems, exchange opinion, discuss, and make conclusion. This process enhances students to develop thinking skills. Flipped classroom approach can be implemented in mathematics instruction. The implementation of flipped classroom approach will support teachers to be creative. Teachers have to create the appropriate and interesting delivery of content so that students are motivated to learn and understand the content. In addition, teachers have to appropriately design and conduct in-class activities so

that students better understand the content and develop thinking skills.

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