Development of the analytic geometry flipped classroom teaching model through Google Classroom

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Abstract. The paper clarified the development of the analytic geometry flipped classroom teaching model through Google Classroom. The model of teaching was developed based on the significant definition of flipped classroom that reverses the traditional teaching method. The flipped classroom was known as the active learning that provided lecture before the classroom via video recorded or online and then face-to-face teacher guiding for practicing, doing projects, or problem solving in classroom. The flipped classroom, therefore, probably allow students to learn productively active learning about mathematics (e.g. analytic geometry) with teacher in classroom. And, the open online instructional platform Google Classroom could be used by all teachers to provide the online lecture before practicing, doing projects, or problem solving in classroom. The paper clarified the development of the analytic geometry flipped classroom teaching model through Google Classroom regarding on 5 strategies of effective flipped classroom including plan, introduce concepts in class, use math apps, video, and student teaching. Then, the paper explained more details of the analytic geometry flipped classroom learning activities. The paper may have implications for developing mathematics active learning via the flipped classroom.

Keywords: analytic geometry, flipped classroom, Google Classroom, active learning

1. Introduction

Nowadays, the world has changed in all aspects such as economic, society, environment, science and technology. Especially in science and technology, there has been a variety of new knowledge and innovations changing in a rapid time. As a result, many countries around the world place importance on development of education, Mathematics, Science and Technology, which are important knowledge based for preparing people to those changes. The Partnership for 21st Century Learning published the widely accepted definition of the skills, content knowledge and literacies that students would need to be successful in their future endeavors. The definition was provided as the framework for 21st century learning. This included frameworks of (a) life and career skills; (b) learning and innovation skills; (c) information, media, and technology skills; and (d) key subjects [1]. The part (a), (b), and (c) of framework clarified literacies students should develop and can be integrated and developed in any academic lesson. Part (d) of framework suggested what contents or themes that should be learned (Partnership for 21st Century Learning, 2016). Regarding on the framework for 21st century learning, the learning and innovation skills should be considered as key features for preparing Thai citizens. The learning and innovation skills consist of critical thinking, problem-solving, communication, collaboration, creativity and innovation. These skills would support students to become citizens who develop knowledge construction, real world problem solving, skill communication, and collaboration.
These citizens would push the country to become the developed country. All these abilities must be trained together with technology skill appropriately [1].

The Institute for the Promotion of Teaching Science and Technology (IPST), as an the institution responsible for the development of curriculum and learning in Mathematics, Science and Technology in Thailand, has developed the curriculum for those subjects to be modern and appropriate for the changes by considering from the draft of the 20-year National Strategic Framework (2017-2036) which sets the goals and characteristics of Thai people in the next 20 years. The 12th National Economic and Social Development Plan (2017-2021) is also integrated in the plan [2].

The goal of the development focuses on education and learning to meet international quality standards. It is aimed to develop Thai people to have creative thinking skill, information skill, life and career skills and especially technology competency. Furthermore, Thai people should be able to synthesize and create innovations continuously with a lifelong learning. They would be trained in accordance to Basic Education Curriculum 2008, focusing on developing learners to be good, intelligent, happy, and have a full potential to continue their further studies and careers. The IPST, therefore, set the target of the Mathematics Learning Curriculum (revised version, 2017) accordingly to the Basic Education Curriculum 2008 [3]. Thai students should be able to have knowledge and understanding of essential mathematics concepts, principles and theories as well as being able to apply that knowledge for further using. Thai students could acquire ability to solve communicative problems and mathematics symbols, connect the knowledge, give reasons and be creative. Thai students would obtain positive attitude towards mathematics, appreciate and recognize the importance of it. They should be able to use mathematical knowledge as a learning tool for their higher education and future careers. And, Thai students should hold the ability to choose the right media, equipment, technology, and data source as a tool in learning, communicating, working and problem solving correctly and efficiently.

According to the goal of Mathematics Learning Curriculum (revised version, 2017) founded in the core curriculum of Thailand Basic Education 2008, it can be aware that students must have knowledge in a core subject together with learning skill and necessary skills for the 21st century, including information technology knowledge, thinking and problem-solving skill, communication and life skills. Therefore, teachers have to design the teaching and learning in the 21st century to suit learners' environment accordingly to the rapid changes of social and technological context. Thus, technology is employed to use as a tool for Mathematics teaching in the upper secondary students, both inside and outside in which IPST has been motivating teachers to use technology to be integrated in learning management. Learning design should focus on Mathematic process skills in 3 ways. Firstly, it should be provided through the process of using technology to reduce time consuming and unnecessary steps in order to increase the time for learners to achieve learning goals and to apply the knowledge in their real life using. Secondly, the learning design should provide students chance to apply technology as learning resources for studying and research and to utilize information through rational analytical processes. Thirdly, it is about employing technology in communication process such as using it in a data presentation, sending assignments, submitting homework or creating informal teaching channels outside the classroom [4].

For this reason, to design mathematics teaching and learning to develop learners to achieve the goals set in the curriculum together with having the necessary skills in the 21st century; teachers must "change" both the roles and methods of teaching. It is to change the transfer of knowledge in front of the classroom with the traditional lecture-based learning method to be an active learning activity, which is a process that the teaching focuses on learning in various techniques by paying attention to the learners, allowing them to participate in the process, and to enable interaction between teachers and learners. The emphasis is placed on practical learning through media or learning activities. The dialogues and learners’ discussion are created for them to gradually instruct the knowledge and they would be able to adjust the knowledge using in other circumstances. The teachers have a role as facilitators who spark interest for students’ curiosity by creating inspiration and are also the planners for organizing activities both inside and outside of the classroom. The teaching and learning style that is effective and is appropriate to support the proactive teaching and learning activities is the flipped classroom [5].
2. Definition of the flipped classroom instructional approach

The flipped classroom was initially made by Jonathan Bergmann and Aaron Sams in 2007. Bergmann and Sams are chemistry teachers from Woodland Park, Colorado, USA. They were inspired by the do-it-yourself video production tools. Then, they argued that it possible to engage all students to learn less content when students are asked to view videos of lectures prior to coming to class and then spending the time in class discussing assignments, rather than receiving a lecture. Then, Bergmann and Sams provided pre-recording all their chemistry lectures from 2007 to 2008 and assigning videos of lectures and note taking as homework. So, they could motivate students in problem-solving and laboratory experiments during class time. It means that they were flipping the classroom [6].

Currently, the flipped classroom was clearly explained. It is an instructional approach that reverses the traditional teaching method. In traditional teaching, teachers usually lecture all students together in the classroom and then ask students to do assignments or homework outside of classroom. For flipped classroom approach, students study the instructional videos outside of classroom at home and then do assignments in the classroom. In other word, a flipped classroom approach, teachers provided their lectures before the class as pre-recorded videos, and then provide the class by engaging students in learning activities that involve collaboration and interaction [6], [7].

The flipped classroom is not only the approach for mathematics learning but also should be provided for other disciplines and student level. It could provide students the process readings and other learning materials prior to class and then engage in discussions and problem-solving that advance understanding of content and help develop critical perspectives on the topic during class time. And, to provide reading and other materials prior to class, the video lectures and practice problems could be employed as homework. Then, organize active, group-based problem-solving activities in the classroom [5], [8]. Regarding on view of the revised Bloom’s taxonomy on educational objectives in cognitive domain [9], the flipped classroom approach could be explained that students learned instructional videos and supporting materials before class and then provide interactive learning activities that foster students to understand, apply, analyze, evaluate, and create during class [5].

However, the other educational models such as blended learning or hybrid learning could make confusing to teachers who will develop the flipped classroom. The blended learning or hybrid learning is about combining face-to-face instruction with computer as media of instruction [10]. Staker and Horn [11] clarified the blended learning as a taxonomy consisting of four models including rotation model, flex model, self-blend model, and enriched-virtual model. Based on this view, the flipped classroom is only a subset of the rotation model of blended learning. In flipped classroom approach, it is rotation between lecture online and face-to-face teacher guiding for practicing or doing projects in classroom [5].

Significance of flipped classroom is an active learning approach. The flipped classroom allow students to problem solving, brainstorming, hands-on activities, practicing, and peer-review, feedback exchange in the classroom but it provides the prior lecture on theories or knowledge via online or videos. The flipped classroom approach, therefore, fosters students to learn actively because it supports students to construct their own understanding and knowledge [12], [13], [14], [15].

The flipped classroom is a form of teaching and learning that has been used in teaching development for solving different problems in the era of various sources and ICT technology. It is because teaching and learning styles in the classroom are inverted, focusing on creating knowledge of the learners according to skills, knowledge and ability of each learner. This approach also gives learners freedom in terms of ideas and styles of seeking knowledge from sources outside of the classroom by supporting analytical and creative thinking, problem-solving skill, and bringing students’ interaction. The model allows learners to search on information that focuses on learners centered which this form of teaching is appropriate with the changes especially in educational nowadays trends. [16]. The approach moreover promotes students' Mathematics processes and problem-solving skill, creative thinking which these abilities are able use in applying knowledge for their daily lives efficiently. To develop the flipped classroom, the open online instructional videos (such as Google classroom, Khan Academy, Open Course Ware, Massive Open Online Courses (MOOCs), and so on) supported teachers to practice and research about it [17], [18]. For, this study, we developed the flipped classroom through Google classroom.
3. Google classroom as a tool for flipped classroom

According to the flipped classroom, it suggested forms of learning activities consisting of two parts including the outside classroom and the inside classroom. The learning will start from outside the classroom, in which students have to study various forms of learning materials that teachers have prepared on the internet by themselves in order to learn the basic knowledge necessary for participating in learning activities inside the classroom. After that, there will be the learning within the actual classroom, learners will organize learning activities to build on the content, do exercises and ask questions from what they have learned through the media with an instructor as a coach or tutor to guide, advice or provide assistance.

The flipped classroom is an integrated learning by using modern technology to manage learning, to solve the problems, or to develop effective learning that meets the curriculum's goals which will help classroom learning and teaching more effective. Students are able to learn faster, save time, more efficiently, and more motivated to study with this innovation. Currently, there is an application for effective classroom management for the flipped classroom which is the Google Classroom system. It is used as an educational aid tool designing to give teachers more time to communicate with students, while students have more time to search for information as well. The use of Google Classroom helps to create and store learning information in one place using Google Docs, Drive and Gmail. Teachers can continually check studying information and can continuously provide advices to students.

The Google Classroom application is a free web-based service for schools, charity organization and everyone with a personal Google Account which is a part of Google Apps for Education. It is a tool that helps facilitate education, increase work efficiency so that teachers have more time to communicate with students. At the same time, students have more time to search for information for learning as well as it is a set of devices that integrate various Google applications such as Google Doc, Google drive, Google slide and Gmail together. Teachers can create and collect assignments without wasting paper and it can be used in various classes, whether in groups or individuals. It further increases communication channels between teachers and students while the instructors can keep track of which students have already finished the tasks or not. Moreover, teachers can comment and suggest each student at all times, even when they are not in the classroom or school. In the same way, learners can see a list of tasks that are being done or which are already completed. They can also comment, adjust the tasks and work together as a team. From that activity, students’ leadership and following skill can be observed by the teacher. Most importantly, teachers can measure, evaluate actual assignments, see all holistic grades for every task while students can also see their own scores from the completed assignments. As a result, in 2011, 16 million students from 146 countries used Google Apps for Education while in Thailand, Khon Kaen University is the first university to use this Google Apps for Education.

IPST [19] clarified the benefits of Google Classroom using that could be summarized as following.

1. It is an easy-to-use application which the teachers can create an online classroom in different subjects. Both teachers and students can use it through different types of devices such as computers, tablets or smart phones.
2. It can be used by students easily. The teachers can add names of learners from their Google accounts while the students’ class codes can also be used to register.
3. It helps facilitate the teaching and learning management. Students can check all of their works on the assignment page while the teachers can set up homework, worksheets or handouts for students to study and research by providing attachments, links, clips, or websites. Plus, the submitting date can also be set.
4. All information is managed properly since all content is stored on Google drive automatically. Students can get access the classroom to do their homework on Google Docs and send it to the Google drive to the instructors.
5. Google classroom allows more communication between teachers and learners. Teachers can easily announce various information to the students online and start talking immediately while learners can announce news, share data, source and they can answer questions in the stream.
6. It can be used to measure and assess learners in different channels. The instructors can check the number of students who have submitted the assignments within the specified time and not yet
submitted. They are able to check the tasks of each student, give scores and feedback in real time and announce the exams or exercises through Google forms.

7. It is economical and safe as it integrates existing Google services such as Drive, Docs, Gmail Forms or Sheets into one. It can be presented as a single, integrated system to prevent infringement. It can be allowed or not allowed students or other people to modify or use the information.

From the overall benefits of Google Classroom, this is an easy-to-use system via the internet. It can connect to work easily between teachers, students and parents, whether outside or inside the school. Students can check the tasks and submit assignments online at Google Classroom any time, with teachers and students having a role in organizing learning activities through the Google Classroom system as shown in Figure 1.

**Figure 1: Roles and responsibilities of teachers and students in the work process of the Google Classroom system [19]**

In summary, the Google Classroom application is a tool for teachers that helps manage tasks, create assignments, and mark grades. Students can check whether the work is completed as scheduled or not, and can express comments, including view score grading. Furthermore, students can view the content of the class, track assignments and check assignment deadline by logging into the classroom. They can automatically search for one's own which will be stored in the file within Drive.

**4. Overview of designing the analytic geometry in flipped classroom through Google Classroom**

The integration of the flipped classroom and the Google Classroom in mathematics teaching about analytic geometry, it is aimed to develop skills and processes for solving mathematical problems. By using these approaches, students are more interested in learning content and receive higher achievement in Mathematics because of the use of technology to teach, allowing students to learn anywhere, anytime, according to the potential of the learners. They can study the lessons in advance and the program helps learners to have more time working and practicing learning activities to solve Mathematics problems in actual classrooms. Teaches works as mentors and experts in organizing learning activities.

The analytic geometry in flipped classroom through Google Classroom was designed regarding on Lee W C suggestion on 5 strategies for a successful flipped math class [16], [22]. The effective flipped classroom of 5 strategies included plan, introduce concepts in class, use math apps, video, and student teaching. Firstly, plan refers to provided lesson plan considering with what resources will be employed for engaging students to comprehend. The plan should provide also online quizzes after each section. The quizzes could not examine students’ understanding on concepts but also suggest reshaping further plans. Secondly, introduce concepts in class, it should be provided to recheck what and how students on the provided concepts. Because the mathematics is complex concepts, the introducing concept in class is important part that will foster students to be successful application of mathematics concepts outside of the classroom. Thirdly, use math apps, there are many of math apps such as Operation...
Math, Power Math Apps, DragonBox, MathLab, Geoboard, GeoGebra, and so on [20], [21]. These apps usually provide students scenarios related to mathematics that would scaffold students to see concepts of mathematics. Fourthly, video should be produced for showing several ways how to construct meaning of a concept and solve problems. The video should be provided concerning on different abilities of students – simple, intermediate, and advanced. Finally, student teaching will be provided in order to see what students have understood when they return to the classroom. The learning activity will be organized by dividing students into groups based on what videos they watched. And then, a group will teach a part of lesson to others. Next, the section will provide example of designing the analytic geometry in flipped classroom through Google Classroom regarding on the five steps.

4.1 Plan:
Lesson plan was designed to utilize the resources for engaging students to comprehend. The process of lesson plan was designed through two components. First component was analysis of the teaching and learning context. The content of analysis included the goals of the curriculum and content, the current state of teaching and learning, and the technology resources available in the school and for the learners. Second component was designing of outside classroom learning activities on the Google Classroom system. The designing focuses on 1) the system of creating class and bringing students into class, and 2) classroom management system of the analytic geometry flipped classroom through the Google Classroom. Each component will be clarified as following.

4.1.1 Component 1: analysis of the teaching and learning context
Analysis of the teaching and learning context was organized by the following steps.

1) Study and analyze the goals of the mathematics curriculum in Thailand content standard of analytic geometry for Grade 10 students. And, review literatures about teaching and learning about analytic geometry.

It is found that the goals of the curriculum require students to have a good attitude towards Mathematics. Plus, they must have knowledge and understanding of concepts, theoretical principles needed in Mathematics to be used as a learning tool for higher education. They should also attain the ability to solve problems, communicate with Mathematics symbols, relate and give reasons. Furthermore, they are required to be creative and have the ability to choose media, equipment, technology, and data sources to use as learning tools for communication, and to find out problem solving solutions correctly and efficiently. Regarding on mathematics curriculum, the lesson plan was designed for teaching for two topics including analytic geometry and conic sections.

2) Current conditions regarded mathematics teaching and learning. The teacher has studied and analyzed the situation, problems, student and teacher’s needs toward learning. Based on the second semester teaching schedule and Thailand office calendar, it was found that a number of mathematics classes have been missed because there are many public holidays together with many of school extracurricular activities. Additionally, some of the male students are required to participate in military training for 1 week and some student athletes must prepare themselves to compete in Satit Sport Games. As a result, school term was divided into 2 sections; with each one contains a teaching period of about 7 weeks.

3) Existing technology resources of schools and learners; it was found that the school could provide equipment and technology for supporting the use of modern digital media in teaching and learning. For example, there are computers, smart TVs and wireless internet network services in each classroom. And, all students have online learning tools, such as computers, smart phones or tablets and Google accounts, etc.

Regarding on information of analysis of the teaching and learning context, the flipped classroom through Google Classroom was developed based on above 3 basic conditions. The teaching and learning activities were designed into three units including unit 1 basic knowledge on analytical geometry, unit 2 the slope of the straight line, and unit 3 relations with straight-line graphs. The details are shown in Table 1.
Table 1: content, objectives, subtopics, and media types in the design of teaching and learning activities on Google Classroom

| Units | Objectives | Subtopics | Media Types on Google classroom |
|-------|------------|-----------|---------------------------------|
| Unit 1: Basic Knowledge on Analytical Geometry | Students are able: 1. Find the projection of the set point. 2. Find the distance between two points and find the center of the segment line. 3. Find the area of the given polygon. 4. Apply knowledge about the midpoint and the dividing point to solve problems. 5. Find the intersection of the median. | 1.1 The coordinate of the projection plane | - Teaching materials that are similar to those used in actual classrooms - 2 episodes of video content lecture from other sources - 4 multiple choice exam papers for Google forms |
| | | 1.2 The distance between two points in the coordinate plane | - 4 episodes of video content lecture from other sources - 4 multiple choice exam papers for Google forms |
| | | 1.3 To find the area of a polygon. | - A video teaches the content recorded in actual classrooms produced by the researcher and a video content lecture from 2 other sources - Descriptive worksheets through Google forms |
| | | 1.4 The dividing point of the segment line | - A video content lecture divided into 3 parts produced by the researcher and the 3 video from other resources divided into 6 parts |
| | | 1.5 The intersection of the median | - 1 section of a video content lecture produced by the researcher and 1 video content lecture from other resources - Template and Cornell Note conclusion for unit 1: Knowledge of Analytical Geometry |
| Unit 2: A slope of the straight line | Students are able to: 1. Find the slope of a straight line that passes through the two points set. 2. Apply knowledge about the slope to solve problems. 3. Check whether all three points are on the same straight line or not. 4. Able to use the slope to describe parallel and perpendicular lines | 2.1 The slope of the straight line | - A video content lecture produced by the researcher and 1 video content lecture divided into 4 sections from other resources - 4 multiple choice exam papers for Google forms |
| | | 2.2 Check whether all three points are on the same straight line or not. | - A video content lecture produced by the researcher and 1 video lecture content from other resources |
| | | 2.3 Parallel lines | - A video content lecture produced by the researcher and 1 video content lecture divided into 4 sections from other resources - Learning materials for a video recording from other resources |
| | | 2.4 Straight lines that are perpendicular | - A video content lecture divided into 2 sections produced by the researcher and a video content lecture divided into 6 sections from other resources - Template and Cornell Note conclusion for unit 2: A slope of the straight line |
| Unit 3: Relations with straight-line | Students are able to: 1. Plot graph and find the equation of a | 3.1 Relations with straight-line graphs | - A video content lecture divided into 9 sections produced by the researcher |
According to Table 1, the teacher designed the content of the lesson into 3 learning units. Each unit consisted of only 4 - 5 subtopics, divided by the relations and purposes of the content. For each sub-topic of the content, a teacher would post various media on the Google Classroom for all students to study and work as assigned. The features of analytic geometry flipped classroom through Google Classroom could be seen as the figure 2. The instructor used the classwork menu in the Google Classroom to organize teaching activities outside of the classroom. Regarding on 3 units, learners learn basic knowledge from video lectures with content. After watching the video, the teacher assigned the students to do a self-assessment activity by completing a worksheet. The activities for recording, summarizing and synthesizing knowledge were recorded in Cornell Note when they finished studying each unit. These activities supported a Flipped Classroom learning effectively and efficiently. It consists of 3 sub-activities.

Figure 2: features of analytic geometry flipped classroom through Google Classroom

Sub-Activity 1: Studying the knowledge from different media and resources which are 1) the teaching material as a medium for students to use the data in the form of Google Docs that could be written, edited and saved the information as instructed by the teacher. 2) The descriptive videos that described the content by the researcher and from other sources. Each video should not last more than 10-15 minutes of lecture. If the content was overwhelmed, the teacher should divide the content to 1 example in 1 video so that, students would not feel bored and some students could specifically choose only the videos that they had not been understood.

Sub-Activity 2: Evaluation of student learning for each objective. Evaluation was provided in order to examine what and how students achieve on the learning objectives. There were two online evaluation tasks. These included multiple choices exam through Google forms and descriptive worksheets through Google forms. The Google forms multiple choices exam was provided to examine students’ understanding on analytic geometry which students would immediately know the results of scores. The Google forms descriptive worksheets allow students to submit their assignment which teachers could check the number of students who had submitted assignments within the specified time.
or who not yet submitted. And, teachers could also check student’s Google forms descriptive worksheets assignment while giving scores and feedback in real time.

Sub-Activity 3: Assessing students’ learning outcomes in each unit. It was aimed to assess whether students were able to summarize and linked knowledge of each unit accordingly to the objectives of each unit by using the Template and Cornell Note for summarizing and asking questions at the end of each unit for 3 times. The information would be beneficial for a teacher in further planning and organizing learning activities to knowledge process summarization of each unit.

4.1.2 Component 2: designing of outside classroom learning activities on the Google Classroom system

The teacher must prepare for the students to study outside the classroom which consisted of 2 operations as follows:

1) Classroom creation system and bringing students into class

Google Classroom allows teachers to create the online courses which could add students name and ID via Google accounts. Students, then, could use their ID to register for the analytic geometry online course. The course was created as multiple online classes and difference class level as showed in the figure 3. The multiple online classes were provided for Grade 10 student class 2, 3 and 4; totally 110 Grade 10 students. The figure 3 showed the feature of the analytic geometry online course that provided screen in Google Classroom system displays a menu of 4 sections including Stream, Classwork, People and Grades.

2) Classroom management system;

The teachers can organize teaching and learning activities on the Google Classroom in different ways as well as in the actual classroom. Two main menus of classroom management system were used for organizing the analytic geometry Google Classroom. These included Stream and Classwork menu. The details of designing through these 2 main menus would be clarified as following.

2.1) Stream menu was used to design activities for creating announcements or public relations. It is efficient for promoting the communication between teachers and learners. The teacher can easily announce the news to the students online and start talking in an immediate response. In the same way, learners can also announce news, share data source or answer questions on this channel as in Figure 4. The teacher will share a variety of learning resources in addition to announcements, suggestions and agreements in the orientation session. Those announcements are beneficial to encourage students to be alert in studying and searching for knowledge by themselves from various sources. The teacher also used the Stream to share learning sources in a video format (YouTube), online lessons of the content (Khan Academy), how to make a note of the Cornell Note, so that students were able to learn basic knowledge before studying in the classroom. This system could be used as a communication channel between the teacher and the learners, such as the teacher announcing the test scores. By expressing opinions of learners per 1 class, it is found that 1 student had written a website for his friends to easily find content, assignments and content that the teacher shared in the classroom through https://tankoon1579.wixsite.com.
2.2) Classwork menu was used to design assignments or assigning tasks to students. The teacher can attach files, videos, documents, tests, and worksheets which will be allocated the specific date and time for the student to submit the tasks. Students will receive an email notification for inviting student viewing the tasks in the class stream when the teacher has created the tasks and posted them. If the students have delayed work submission, the system will notify teacher. The teacher created assignments and assigns students to work in each unit. Each unit was assigned to be divided into 3 sub-activities which are 1) an activity for learning from the media posted by the instructor 2) an activity for checking students’ understanding by using the 4 multiple choice exam papers and descriptive questions through Google forms and 3) learning evaluation activities in each unit by using the Cornell Note form. There were 4 main parts divided in the form which were Heading, Note, Summary and Main Ideas. These features could be viewed as the figure 5.

The teacher creates and assigns the students’ tasks into 3 sub-activities which are; Sub-Activity 1, study the basic knowledge content about Analytic Geometry in 3 units in the video content lecture from both other sources and self-made teacher. The sub-topic is shown in Table 1. The teacher recorded the explanations together with the answers on the Mathematics teaching book that created by the teacher. Sub-activity 2, it is learners’ self-assessment before learning in the actual class through online worksheets to assess learning outcomes for each learning objective. Sub-Activity 3, summarizing and synthesis of learners’ knowledge by using the Cornell Note form at the end of each unit, it is used in 3 times to evaluate the learning outcomes for each lesson. This process is very beneficial for organizing instructional activities in the real classroom because the teacher knows how much the students understand. As a result, the finding information will be used to design and form the teaching and learning activities to be interesting, easy to understand. By doing this, the teacher can also organize activities that promote more advanced knowledge.

4.2 Introducing concepts in class
Mathematics is a complex subject. The teacher must explain the purposes of learning objectives to students before assigning them to study the content by themselves outside the classroom. Therefore, the teacher provides the orientation for students to study in the analytic geometry flipped classroom with Google Classroom. Then, the orientation was provided for two sections including section 1 (learning activities outside of the classroom on the Google Classroom system, and section 2 (learning activities within a real classroom).

Section 1, Learning activities outside of the classroom on the Google Classroom system, requires students who have to study and learn from various media and resources by themselves. They have to complete worksheets and quizzes to check for understanding and work on the Cornell Note form at the end of each unit.

Section 2, Learning activities within a real classroom (Normal classroom), allows teacher and learners to interaction in the classroom for 3 steps of activities including preparation, problem solving skill development practice, and discussion and reflection step

1) Preparation step; It is a step where the teacher asks questions and discuss issues about questions, reviews, and summarize content learned from worksheets/quizzes that the students did on online systems. The teacher will ask questions from the video and afterward will present the problems to connect the content learning from videos with the content set in the classroom. From this process, students are able to apply the knowledge gained from watching videos to use in teaching and learning activities in class. The teacher may ask the students to join online quiz games which is a Kahoot program to create a more fun learning atmosphere.

2) Problem-solving skill development practice step; The teacher asks the student To practice Mathematics problem-solving skill by working in groups of 2-3 people so that the students can analyze, plan, find solutions for the given problems. Presentation in front of the class is also required.

3) Discussion and reflection step; It is a step where the teacher allows the whole class to join in a discussion about the answers whether each group agrees or disagrees with reasoning to find conclusions of knowledge. The teacher has students reflect on what they have learned and connect the relationship of the knowledge gained from both external and internal teaching and learning activities.

4.3 The Use of Math Apps
It is aimed to enable the teaching and learning of Mathematics on Analytical Geometry more effectively. The teacher has applied software that helps in teaching Mathematics to make the students easier to understand the content, namely GeoGebra program. It is a program that users can create tasks with points, straight line, vector, polygon, conic and graphing from the given equation. It can be found at http://www.quickmath.com. These applications will help learners enjoy and be able to use them anytime and anywhere.

4.4 Videos
Videos were used for students who study by themselves through the video posted on Google Classroom. The video would facilitate students’ understanding and theirs content would also suitable with their level. Videos contained lectures content created by the teacher and chosen from other sources. Each chapter should not take more than 10-15 minutes of lecture. If content is overwhelmed, the instructor should create the content showing 1 example only. The videos contain different levels for teaching which are easy, medium and difficult, so students will not be bored and can choose to study only videos that are not yet understood.

4.5 Student Teaching
It is aimed to check learners’ understanding of the content and what teachers should teach more in class. The teaching and learning activities will be self-evaluated by the students 2 times. First, the evaluation was provided to assess learning on Google Classroom in which students’ complete worksheets, tests and notes before conducting other activities in a real classroom.

Second, the evaluation was provided to evaluate students in the preparation step by playing Q&A games through the Kahoot application. Students can be assigned to take turn teaching their friends about the content, so that they also have a chance to develop their communication skills.
From the previous steps; the teaching model of Analytic Geometry Flipped Classroom approach with Google Classroom could be summarized and divided into 2 parts as shown in figure 6.

**Preparation step**

Component 1: analysis of the teaching and learning context
1. Goals of curriculum and content
2. Situation, problems and needs of learners and teachers towards the learning process
3. Existing technology resources of schools and learners

Component 2: designing of outside classroom learning activities on the Google Classroom system
1. The design of lesson content, media, and teaching materials based on the Flipped Classroom together with Google Classroom
2. Creating and developing learning activities outside of the classroom on Google Classroom
   2.1 The system for creating class and bringing students into class
   2.2 The 4 menu class management system; Stream, Classwork, People, Grades

**Learning Management**

Process before organizing learning activities
1. Orientation to clarify and understand the learning process
2. Bringing students into class

Learning activities
1. Learning activities outside the classroom on Google Classroom
   1.1 Study of knowledge from various media and learning resources
   1.2 Evaluate learners in each objective
   1.3 Assess students’ learning in each unit
2. Learning activities in a real classroom
   2.1 Preparation step
   2.2 Problem-solving skill development practice step
   2.3 Discussion and reflection step

**Mathematics skills and processes of Analytic Geometry**

Figure 6: the teaching model of Analytic Geometry Flipped Classroom approach with Google Classroom

5. Conclusion
It could be mentioned that mathematics learning could be provided as active learning through online learning as the flipped classroom via the open online instructional platform Google Classroom. Regarding on 5 strategies of effective flipped classroom, teachers could develop the ideas of online teaching. The analysis of technology for teaching also suggested what the other online platforms could be utilized on Google Classroom in order to develop the mathematics flipped classroom.

The Google Classroom management system provided menus of classroom management system were used for organizing the analytic geometry Google Classroom. Stream menu is productive for providing prior VDO. It supports designing activities for creating announcements or public relations. Math apps (e.g. Operation Math, Power Math Apps, DragonBox, MathLab, Geoboard, GeoGebra, and so on), Khan Academy, YouTube and others suggested teachers’ ideas to develop pre-video online via Google Classroom. Based on Google Classroom analytic geometry online, it provided student chance to develop some knowledge and skills before participating into the classroom where teachers assignment to do problem solving about analytic geometry on face to face classroom. The students’ assessment on mathematics learning also could be provided via Classwork menu. The development of
the analytic geometry flipped classroom teaching model through Google Classroom, therefore, provided active learning environment.

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