Exploring Flipped Learning in Elementary Linear Algebra Class

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Abstract. This preliminary study is conducted to observe how flipped learning could be used in teaching the subject of elementary linear algebra in campus. The study is descriptive explorative using video and direct observations as the main data collection techniques. Forty students and a lecturer attending a blended-based elementary linear algebra class set in flipped learning mode were involved as the subjects. The data were analysed to gain insights on how it would be best to conduct the flipped learning, and to see how it helps the students and the lecturer during the class sessions. The results showed that the flipped learning made the class very dynamic. The online session is also helpful in students' learning accelerations in procedural contents and on providing more opportunity for lecturer to simulate students' higher order thinking during the offline sessions.

1. Introduction

Flipped learning is introduced by Jonathan Bregmann and Aaron Sams who video recorded their teaching uploaded it to web to deal with the very large number of students they had in class, and the high rate of students' absences. Having a significantly positive effect, educational practitioners started to adopt the approach. As a result, Flipped Learning Network (FLN) is established and become home for multidisciplinary educators who conducted the flipped learning in their class [1].

Flipped learning and other blended based approaches are seen as answers to the challenge of the so-called industrial revolution 4.0 to present a more futuristic approach in teaching mathematics [2]. Activities in the flipped learning classes are IT based making it possible to culture the IT in teaching [3]. They are set in a way that students would be able to access the learning materials the way they wanted, regardless time and space constraints. So, the classroom activities would focus more on providing students with learning experiences, problem solving activities, and further investigations of concepts they learned before they attended the class session [4]. Thus, it is really suitable to apply in courses that require innovations, accelerated learning, curriculum bounded-topics, frequent practices, investigations to advanced topics, or dealing with limited times for learning [5].

While flipped learning has been well recognized by educational researchers worldwide, there is still limited number of studies conducted in Indonesia. Therefore, we initiate this study to observe how flipped learning would be applicable in the country.

2. Theoretical framework

In order to prevent misconception and over-simplification of what is meant by flipped learning, FLN provided a formal definition of flipped learning, as follows:

> "Flipped learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter" [6]

The formal definition puts emphases on four main characteristics of flipped learning, such as, 1) independent direct learning, 2) dynamic and interactive classroom sessions, 3) roles of lecturers or teachers in supervising students' learning, and 4) students active and creative engagement in applying concepts they learned.

2.1. Implementation of flipped learning

The formal definition highlights if flipped learning should be more than just video recording the class teaching. Thus, in order to help educators prepare for their flipped learning class, FLN [6] released the so-called four pillars of flipped learning, such as:

- Flexible environment (F)
  A flipped based class should accommodate students' needs in learning, as such, they can freely choose how, where, and when they want to learn. This urges variations in the teaching materials, methods, and accesses to be provided.
- Learning culture (L)
  Flipped learning must provide students with more learning experiences that cover individual investigations in their first exposure to the topic and deeper learning during the class sessions. The class must be student-centered where students construct their own knowledge as they involved in the learning activities.
- Intentional content (I)
  Learning materials provided in the flipped learning class must be well structured to let students develop their own understanding of conceptual and procedural knowledge.
- Professional educator (P)
  Teacher holds a vital role in a flipped class especially in facilitating the conceptual investigations, posting guiding questions, providing feedback and scaffolding, leading the class discussions, and evaluating the learning. Collaboration with other educators to improve the learning is highly suggested to ensure the professionality of the teacher in managing the flipped classes.

2.2. Previous studies on flipped learning

Several studies on flipped learning have been performed either to investigate the effectiveness of flipped learning classrooms [7] [8], design alternatives for the implementation of flipped learning [9], observe the effects it has to students [10]-[13], investigate factors contributing to success in flipped learning classes [14], and analyze perceptions of students and teachers of the flipped learning itself [15]-[17].

All the studies showed positive trends toward the implementation of flipped learning approach, especially in students' motivations, active participations, and self-regulations during the class sessions. While the academic performances of high achievers are not really affected, they still found it helpful and enjoyable to study with the flipped learning platform. Meanwhile, the performances of moderate and low achiever students experienced significant increases as they involved in the flipped learning activities [7] [9].

3. Methods

This study is preliminary to a larger study on designing flipped class setting and materials in college. It is a descriptive explorative study with the focus on gaining insights on the flipped learning in its real

practice including the benefits it may offer for both students and lecturer, and how to conduct it in class.

To address the concern, we managed to present a flipped learning based class in our teaching of elementary linear algebra. Forty students enrolling in the course and a lecturer are involved as the subjects of our observations. The class is conducted in two settings namely online session using Google Classroom platform and offline session in class. Learning materials are regularly uploaded into the class account a week before the offline session to ensure if the students would have enough time to access the learning materials before the offline session starts.

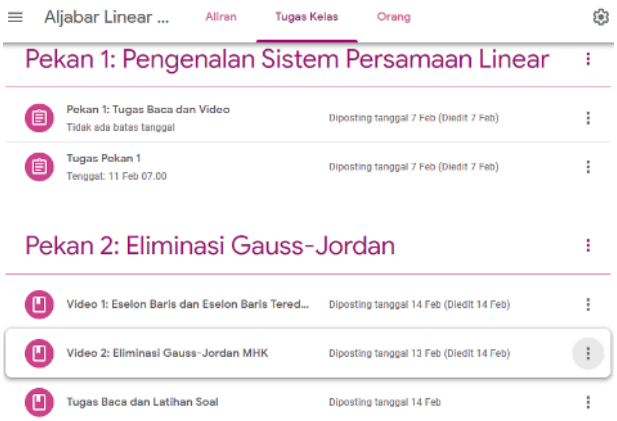

Figure 1 Timeline of the class account in google classroom

Figure 2 Example of weekly tasks display in the google class account

Activities during the class sessions are video recorded to gain data on classroom activities. In addition, field notes are also provided by two observers in each meeting. Data from the recording and the field notes are pivot in describing the classroom situations given the implemented flipped learning. Reflections take place directly after each offline session to help us figure out the best practice.

Other data collection techniques are also employed such as pre- and post-test, students' daily reports, assignments, and also questionnaire. The data gathered are used to support the observations and the overall conclusions.

4. Result and Discussion

This study is a work in progress and the designed flipped learning might still not reach its best practice yet. Therefore, beginning this part is a brief description of how we set the flipped learning class to this point; followed by areas on which the impacts of the flipped learning setting is observable, such as, classroom dynamics, students' performances, and lecturer's activities.

4.1. Flipped learning class setting

The class starts with an online session when all the learning materials are uploaded into the course account via google classroom. The learning materials include videos, readings, exercises, and assignments, as you can see in figure 1 and figure 2. Variations are intended to provide a flexible environment in terms of learning styles, times, and places (F).

The materials are uploaded one week prior to the offline session to ensure that the students will have adequate time to study all the materials independently. So, the students would have had their first exposure to the materials before they really learn it in class; this will help the lecturer later in applying student-centered models in class (L). Meanwhile, the assignments must be submitted two days beforehand. Thus, the lecturer and the researchers will have enough time to adjust the content and the focus of the offline class session. Reflections on students' assignments will be used to organize the offline session. Here, we tried to design problems as well as guiding questions that will help students construct their own comprehension of the intended topic (I).

The offline session is mainly conducted by a lecturer in collaboration with other two lecturers as facilitators. In order to ensure the professionality of the lecturer in handling the class, reflections are done after class or directly in class, when needed (P). Quizzes and supplementary exercises and materials during the class session are also sometimes provided.

Overall, the scheme of flipped learning class we implemented is shown in figure 3.

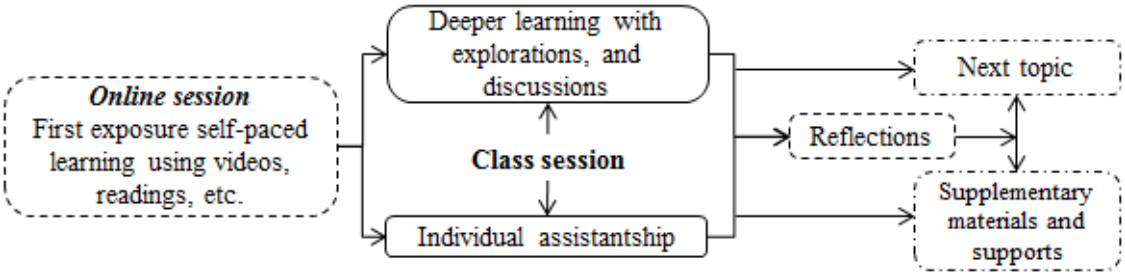

Figure 3 Scheme of the implemented flipped learning

4.2. Classroom dynamics

Activities during the class sessions vary depending on the topics and the results of the students' preliminary assignments. However, students-centered activities in the form of discussions, explorations, and investigations related to the mathematical concept clearly dominate the overall sessions.

The field notes and video observations showed how the offline sessions went very dynamically. Most of the students are actively engaged in the class discussions, expressing their ideas and opinions in response to problems or questions posted by the lecturer or their fellow students. Prior knowledge that the students have built from their initial learning seems to have successfully motivated them to critically apply what they have to solve problems. This strengthens the finding of other studies on how the learning approach could encourage students' motivations [7], efficacy [9], and self-regulations [12] to be actively involved in learning activities [11].

4.3. Students' performances in the flipped learning class

Flipped learning is also helpful for our students to improve their learning achievement. Acceleration in learning is evidently observable, especially in teaching procedures. In a moment in our session, we presented an unplanned quiz to check students' comprehensions of row reduced echelon form and Gaussian elimination before we discussed it in class. The results showed 90% of our students can perform the operation well; 15 students completed the task perfectly and 17 others made a small tolerable error in their calculation. Four students did not complete the task due to time limit but have performed correct steps in their temporary answers, meanwhile, the other four students still missed to answer the task in the correct ways. This confirmed the finding of Bruss [5] of the potential areas in which the flipped learning would work effectively.

Prior knowledge the students have as they accessed the materials in the online session made the teaching of terminologies more efficient, especially in distinguishing between examples and non-examples of a certain concept. However, there is still a big struggle for students when they need to deal with notations, for example, when the students were asked to provide proof of some arithmetic properties of matrix operations. Here, the class discussions, as also recorded in the filed note, revealed five different notations that confused students of their uses, such as $[a_{ij}], a_{ij}, (A)_{ij}, A_{ij}$, and $[A_{ij}]$. Fortunately, brainstorming among students in class has overcome the problem.

4.4. Lecturer's activities during the class sessions

Reflections and analysis of field notes and video observations showed if the lecturer seems to have more opportunities to conduct deeper exploration to students' conceptual understanding in class. This

is because the lecturer did not have to spend more time to explain procedures and terminologies to students any longer, given the aforementioned explanation.

The following are of the remarkable activities or actions of the lecturer during the class sessions, as recorded in the field note:

- Start the class by identifying parts that students have or have not understood from their initial learning, and then, posting some questions to stimulate students' critical thinking toward the concept.
- Leave not to confirm students' answers, and let the students justify the answer themselves or facilitate them with a peer discussion. Here, scaffoldings took part to help students figure out the correct answer.
- In reaction to misconceptions or incorrect answers, the lecturer will provide critical questions for students to think and realize the mistakes themselves.
- In teaching procedures, the lecturer provides various exercises for students to practice on their own. At the time, the lecturer himself will go around the class observing and providing individual assistantship.
- In teaching concepts, the lecturer posts some questions that require students to think deeply to come into conclusion. To manage this task, the lecturer facilitates the students with small group and class discussions. True-or-false questions are also sometimes provided to check the students' understandings.

5. Conclusion

The implemented flipped learning has successfully contributed positive atmosphere in our teaching and learning of elementary linear algebra. The online sessions has perfectly assisted our students in comprehending procedural contents, and leaves more time to discuss the conceptual materials for the offline sessions. Patterns to deal with students' necessities in the class sessions are also revealed and would be helpful in redesigning or organizing another flipped learning class in the future.

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References

[1] Bergman J and Sams A, *Flip Your Classroom: Reach Every Student in Every Class Every Day,* Washington DC: International Society for Technology in Education, 2012.
[2] Ahmad I, *Proses pembelajaran digital dalam era revolusi industri 4.0 – Digital learning processes in the era of industrial revolution 4.0.* Directorate General of Higher Education of the Ministry of Research, Technology, and Higher Education, 2018.
[3] Hamidi F, Meshkat M, Rezaee M, and Jafari M, "Information technology in education," *Procedia Computer Science,* vol. 3, pp. 369-373, Dec.2011.
[4] Bergmann J and Sams A, *Flipped Learning: Gateway to Student Engagement.* Washington DC: International Society for Technology in Education, 2014.
[5] Bruss K, *Flipped Learning at PAREXEL*, Parexel International Corporation, 2014.
[6] Flipped Learning Network – FLN, "The four pillars of F-L-I-P," accessible on www.flippedlearning.org/definition, 2014.
[7] Bhagat, KK, Chang, CN, and Chang CY, "The impact of the flipped classroom on mathematics concept learning in high school," *Educational Technology and Society,* vol.19(3), pp. 134-142, 2016.
[8] Hibbard L, Sung S, and Wells B, "Examining the effectiveness of a semi-self-paced flipped learning format in a college general chemistry sequence," *Journal of Chemical Education,* vol. 93, pp. 24-30, 2016.

[9] Hwang GJ and Lai CL, "Facilitating and bridging out-of-class and in-class learning: an interactive e-book-based flipped learning approach for math courses," *Educational Technology and Society,* vol. 20(1), pp. 184-197, 2017.
[10] Kong SC. "An Experience of a three-year study on the development of critical thinking skills in flipped secondary classrooms with pedagogical and technological support," *Computers and Education,* vol.89, pp.16-31, 2015.
[11] Al-Zahrani AM, "From passive to active: The Impact of the flipped classroom through social learning platforms on higher education students' creative thinking," *British Journal of Educational Technology,* vol.46(6), pp.1133-1148, 2015.
[12] Lai CL and Hwang GJ, "A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course," *Computers and Education,* vol.100, pp.126-140, 2016.
[13] Talley CP and Scherer S, "The enhanced flipped classroom: increasing academic performance with student-recorded lectures and practice testing in a "flipped" STEM course," *The Journal of Negro Education,* vol.82(3), pp.339-347, 2013.
[14] Sun Z, Xie K, and Anderman LH, "The role of self-regulated learning in students' success in flipped undergraduate math courses." *The Internet and Higher Education,* vol.36, pp.41-53, 2018.
[15] Evangelia T and Timcenko O, "Student perceptions on learning with online resources in a flipped mathematics classroom," *Proceedings of the Ninth Congress of the European Society for Research in Mathematics Education*, pp.2573-2579, Feb.2015.
[16] Love B, Hodge A, Grandgenett N, and Swift AW, "Student learning and perceptions in a flipped linear algebra course," *International Journal of Mathematical Education in Science and Technology,* vol.45(3), pp.317-324, 2014.
[17] Muir T and Geiger V, "The affordances of using a flipped classroom approach in the teaching of mathematics: a case study of a grade 10 mathematics class," *Mathematics Education Research Journal*, vol.28, pp.149-171, 2016.