

# Promoting Student-Active Learning

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**ABSTRACT:** This paper discusses measures for promoting student-active learning including flipped classroom and project-based assessment in two petroleum engineering courses. The intention is to coach the students to ask the right questions, instead of asking for the right solutions. The experience from one course (from Spring 2021) using flipped classroom is shared with a discussion of the new course design. Proper design of the activities and assessment form provide better collaboration and feedback opportunities. Flipped classroom and online teaching were used simultaneously in the course. Using this method, it was possible to devote more in-class time to active problem-based learning in groups compared to the traditional teaching methods. To initiate more in-class group activities and discussions, the sessions began with short questions or problems given during the class to be discussed in groups followed by presentation from groups and peer feedback. Group presentations of the exercises were also practiced. Design of the learning outcomes and activities depend on types of the tasks and assessment form. One finding is that active learning in flipped classroom is best achieved if the assessment form is inclusive. Consequently, a new version of the course has been created for next year in which project-based assessment will decide the final grade. This is expected to provide more opportunities for active participation and critical reflection. The design of the projects for next year is ongoing and one of these projects was used this year to get students' feedback. To have a wider scope of study, experience is also shared from another course (from Fall 2020) regarding engaging the students. In the course, the traditional teaching method was mostly used (with only limited flipped material) together with portfolio assessment including final exam and mostly (project-based) group exercises. The new course design is also briefly discussed.

## 1 INTRODUCTION

*Sustainability in education* encompasses more than knowledge transfer. It is not only about what we teach, but also how we teach the material. The knowledge should be solid, but we must also give students a set of skills and character and make sure they are able to transfer them to others in the future. The skills can be anything from working with digital tools (software and programming) to participation in group activities and taking responsibilities. Using techniques for promoting student-active learning in the courses will serve the sustainability.

*Flipped or inverted classroom* is a popular instructional design model in which knowledge acquisition becomes home activity, and knowledge creation (such as problem-solving or project work) becomes class activity. This model has recently gained popularity in the higher education sector worldwide especially during the Covid-19 pandemic when many universities had to close their campuses. In general, the flipped classroom model yields positive academic outcomes. The teacher helps the students instead of merely delivering information, while the students become responsible for their own learning process and must govern their own learning pace (Lai and Hwang, 2016). The teacher can engage with the students by means of the learning activities such as question and answer, discussions, solving problems, project work, hands-on activities, and guidance.

*Student-centered learning* (active learning, peer-assisted learning, collaborative learning) can be better utilized in the flipped classroom model. *Active learning* can be simply defined as “any instructional method that engages students in the learning process” (Prince, 2004). *Peer-assisted learning* is “the acquisition of knowledge and skills through active helping and supporting among status equals or matched companions” (Topping and Ehly, 1998). *Collaborative learning* broadly “is a situation in which learners interact in a collaborative way” (Dillenbourg, 1999).

A more central students' role in shaping their own learning, requires that the *course design provides productive feedback*. Esterhazy et al. (2019) illustrated how *productive feedback* takes distinct forms within two course designs. In both cases, the task organization required students to self-organize their work with the course content. The focus on independent work made it important for the students to plan to have opportunities to obtain guidance and feedback from more experienced peers and teachers along

the way. Good teachers develop productive feedback practices by planning *dialogical* processes and activities which can support and inform the students on the current task, also developing the ability to self-regulate the performance on future tasks (Carless et al., 2011).

Though the importance of *group work* and *engagement* is emphasized, we happen to see not much willingness among all students to participate in discussions. Some students are used to being given the solution from the tutor in the traditional lecture-based approaches. Students should be able to decide the flow of the class and learn to engage in the learning process. Proper design of the course activities and assessments provide opportunities to enhance the learning quality, establish better collaboration, communication, and feedback seeking and to check the progress and preparation of the students.

This paper will discuss promoting student-active learning using flipped classroom and project-based assessment. Some teaching experiences from two courses are shared in addition to analyzing feedback from students. The intention has been to implement measures to engage the students in the learning process and educate autonomous learners. New course designs are also discussed. It is planned to simulate working conditions in some sessions using group work to show the real-world challenges.

## **2 METHOD AND CONTEXT**

The method involves collecting information and feedback from the students as well as the tutor's experience sharing. Both courses investigated in this paper are third year courses in the 5-year petroleum engineering master's program at NTNU (also first year courses in the 2-year international master's program) with around 30 registered students.

### **2.1 Course 1**

The evaluation of course 1 is final exam (100%) and mandatory exercises and in-class problems. Since 2019, we have flipped the classroom to provide more time for class activities. Students watch videos from Whitson academy and come to class for group activities, discussions, summary, and problem solving. The intention is to make students curious and ready for learning. Then, coach them to ask the right questions, instead of asking for the right solutions.

Regarding the students' views, in addition to individual feedback from students in various short chats, a survey (at the end of the semester) and three reference group meetings and discussions were implemented during the semester. The survey was online and anonymous with voluntary participation. It asked the students about the appropriateness of the learning methods and the learning activities. The survey contained nine closed questions using a 5-point scale, plus one last question that was open-ended. The questionnaire that was used in the online survey is presented in the Appendix.

The reference group discussions were guided by a course evaluation template inspired by the quality assurance guidelines of NTNU. The participants (3 students) volunteered to participate in the group, and the meetings lasted about 45 minutes each (3 meetings in total). The course evaluation report (written and submitted by the reference group) comprised two parts including the students' opinions on the quality of the learning activities and proposal of measures that may enhance the learning outcomes. The reference group had an ongoing dialogue with other students throughout the semester to reflect different viewpoints, according to the quality assurance guidelines of NTNU.

### **2.2 Course 2**

This course had two topics (analytical and experimental parts) given by two different lecturers. The author of this paper was the course coordinator and responsible for the analytical part only. In the course, the traditional teaching method (lectures) was mostly used (with only limited flipped material) together with portfolio assessment including final exam (70%), exercises (15%) and lab reports (15%). Mostly, group exercises were given in the course and a software was taught and used.

No student survey was used in this course, but like course 1, a reference group evaluated the course. Both lecturers and the student assistants discussed continuously with the members of the reference group during the semester. We also had individual discussions with some students and revised some of the course activities based on the students' feedback. The assistants and students were also connected through a WhatsApp group for easy information sharing and communication.

### 3 REFLECTIONS AND RESULTS

#### 3.1 Course 1

The results of the last year survey indicated mixed signals (Jahanbani G. and Mavroudi, 2020). Most students felt that the learning methods and activities were helpful in the learning process, but yet half the class preferred the traditional teaching. University educators who observed the teaching method last year suggested initiating more discussions among students during the in-class time. This year, the course was generally improved compared to last year in terms of task organization, with the help of two assistants. We tried to have a balance of theory and problem solving and as reflected in the reference group report, the videos discussed theory, while the class exercises were focused on applications and calculations. The results of this year's student survey are positive and encouraging in terms of students' feedback on quality of both what was implemented this year and the plan for the next year. Before investigating the results of the survey, some remarks about what was tried this year to promote student-active learning are discussed.

The Covid-19 pandemic restrictions required running the course mostly online in addition to a few in-person exercise classes. The reference group report states that if the same activities were done at school, even more people would be satisfied with the learning activities. This is true, online communication and collaboration do not make it easier to participate in group work. The reference group report mentions summary of some issues (and approaches to solve them) discussed in our meetings during the semester. Overall, it is good to read in the report that the students thought the instructor was responsive to their needs based on the meetings with reference group. They were also happy with the assistants and thought they motivated them. The course is redesigned for 2022 with more opportunities for student-active learning through a project-based learning/assessment. Part of the new design was implemented this year to get some feedback which was generally positive.

Learning methods and activities included flipped classroom, summary lectures, guest lectures, group work, problem solving, self-study, oral presentation and use of software. We started the course by introducing some guidelines that would explain to the students what the flipped classroom is about and what they are supposed to do. This was done based on the feedback from last year that in the beginning some students were confused about the expectations. Interaction/communication tools like discussion board on Blackboard were integrated to help the students obtain feedback/help out of class time. Not many students used it though. After some basics were taught and the students had some knowledge, a software was introduced and used for problem solving in a guest lecture. Students liked it very much and seemed engaged.

To know more about the activities, results of the survey are investigated in this section. Almost 70% of the students gave a high score of 4 (on the scale of 1-5) to the course in general when asked how well they thought the course material, applied learning methods, activities, and assessment form helped achieving the learning outcomes. In a special semester (Spring 2021), we had to use flipped classroom and online teaching simultaneously. Close to half of the class gave a high score of 4-5 when asked how effective they found the flipped classroom teaching method. These results are very much similar to last year's survey trend.

In order to initiate more group activities and discussions, we tried to have short questions or problems during the class (or as exercise) to be discussed in groups, sometimes followed by presentations from the groups and peer feedback. For this reason, we had an extra teaching assistant, and also shared ideas with an industry expert. Students evaluated these actions quite effective for active learning since more than 60% gave a high score of 4-5.

One of the challenges of flipped classroom is related to the lack of student preparation prior to the in-class sessions. Students did not evaluate themselves active in preparations before the class, asking questions and getting involved in discussions and problem solving in groups as more than 60% gave low score of 1-2 to their efforts. So, we need to find other ways to activate the students. One way is to not record everything. Another suggestion is to make shorter and interactive videos (10-15 min) with quiz-elements. The project-based assessment in the new course design can also be helpful.

Boud and Molloy (2013) suggested that course designs that support productive feedback should include multiple well-designed and sequenced tasks, which provide opportunities for progressive knowledge construction, repeated use of feedback, and practice how to provide and make use of feedback. The new

course design (2022 version) will introduce a new assessment form (project-based) to create better opportunities for active student participation. Flipped classroom coupled with cumulative assessment and task organization has a good chance to promote active learning and critical reflection. By employing a project-based pedagogy, it is intended to create learning challenges that would introduce the students to skills needed in their future professions. The final project ensures that learning outcomes are met. The sub-projects provide students with useful information to aid learning. Peer feedback builds students' capacity to judge their own learning.

Students will be given the opportunity to progress at their own learning pace and access the videos that are provided before class as needed, which can in turn support self-directed learning. Teachers and the assistants will guide student groups during coaching sessions. Most of the course's workload involves student-driven activities, including managing group work. To encourage student-student communication, we will try different approaches like informal questions either given beforehand or in the classroom, discussion among the students about the topic of the day through their group work (projects) or writing a group one-minute paper (e.g., using Padlet) to test the students' learning and to get an idea of what aspects of teaching practice they are/are not responding to.

The plan for the next version of the course was explained to the students. The assessment will be based on a) final group project composed of sub-projects, b) individual description of the project, c) evaluation of another group's project. Students may for example share their self-recordings so that the other students and teachers can assess and provide feedback. About half the class found it very effective in creating opportunities for active participation. It is also planned to use a software in some tasks next year with guidance and feedback to students who discuss and present their work. This was briefly practiced this year in the form of hands-on activities including a session showing some applications using the software. 70% of the class gave a high score to this activity.

An issue in implementing flipped classroom is students' inability to get immediate help/feedback while they study at home. To get immediate feedback, we proposed using the discussion board. However, we did not observe many students used this function during the semester. To make the course more interactive and to evaluate students' progress, we may include some quiz-elements in the videos or use Kahoot quiz, etc. The students liked the idea. Another measure is arranging guest lectures from industry to better show how the theory is linked to real world applications. We tried this briefly this year and students seemed to like this very much (more than 85% gave high scores).

During the semester, we received feedbacks about the workload in the course. We tried to adjust the workload based on the comments. Half of the class thought the students' workload in this course is more compared to the courses with traditional teaching methods while the other half thought it is the same. Students were also asked to add any comments that can help us to better design the course in the future. Here are some comments:

- Overall, the course is very well presented and has been a great learning experience. The videos are good but may be improved.
- Doing the exercises in groups and making small presentations was a good idea, it should be done more often.
- Flipped classroom works good enough. A more practical approach for solving exercises is preferred such as having the same amount of homework exercises, cut the classroom exercises and add some practical approach (i.e., work with a program) and submit as a project.

Some measures suggested by the reference group to enhance the learning outcomes include:

- The need of synchronizing between video and the in-class teaching with exercises.  
*Comment:* As reflected in the first reference group meeting, some students felt the first exercise was not linked to the material they read and watched for the first week. We tried to explain to them that this was the intention so that they could seek more information and to make them curious about the topic. No specific submission deadline was set for the exercise and students were told to seek feedback to be able to solve the exercise. This is the idea for the project work next year for which the students should deliver the project report at the end of the semester while they must continuously seek feedback during the semester when they are supposed to do group work for solving different tasks of the final project.

- More group projects.  
*Comment:* Obviously, many students liked working in groups for problem solving and presenting their results. This is definitely going to be implemented in the new course design with group project assessment.
- The question-and-answer sessions need to be more effective to fulfil the knowledge of all students.  
*Comment:* After receiving this feedback in the second meeting with the reference group, it was tried to add more summary lectures to the Q&A sessions (though this was already part of the plan). Some students usually ask more questions than the others and sometimes this may turn into a dialogue. We tried to use discussion board and Padlet to give equal opportunity to all students, but not many used it. The new course design will provide better opportunities for this aspect, given work will be done in groups and the class will be more student-driven.

About this year's assessment, only students with approved submission of mandatory exercises could take the exam. The reference group report mentioned the number of exercises was okay for this course. The exercises consisted of a combination of individual and group work (in total 5 exercises and 3 in-class problems). To test the knowledge and fair distribution of workload in the groups, oral presentation of some exercises was requested. This was followed by questions from instructor and students for each group. We also used in-class quiz which was very popular among the students and good participation was received. The final exam (100% of the grade) consisted of a digital home exam. This year, the exam results were better compared with last year. All students except one passed the exam and average grade was C. Five students took the re-sit exam in August and all passed the exam with average grade C.

### 3.2 Course 2

To have a wider scope of study, we also share some experience from another course (from Fall 2020) regarding engaging the students. In this course, traditional teaching method was mostly used together with portfolio assessment including final exam and group exercises (mostly project-based). The Covid-19 pandemic restrictions required running the course in a different way than previous years. Combination of in-person attendance and online communication was very challenging for all parties. Online collaboration between students (international students out of Norway and the students in Norway) was not ideal to motivate them to participate in group work. Generally, the participation in the live lectures was low and students preferred to watch the recordings given the situation they were in. The online collaboration also led to more workload for the assistants. We tried different measures to resolve the issues for online participation and to encourage the students to take part in different activities. Both lecturers and the student assistants discussed continuously with the members of the reference group during the semester. We used a channel of communication (WhatsApp group) between the students and the assistants. Some of the course activities were revised based on the students' feedback. Some experience is shared here (also including some points in the reference group's report):

- After the basics of the analytical part of the course were taught and the students had some knowledge of data analysis, software was introduced for some problem solving (upon the recommendations of students from last year). Students liked it very much and seemed engaged. Tutorial sessions and videos were provided, and students used it partly for problem solving and data analysis.
- This year, new exercises were designed for the course, some of which were solved by the software. A new and comprehensive reference book was used (full of practical examples), some of them were solved in the class or given as exercises. Some students wanted more use of the software, but this was not possible according to the time limit.
- Some students thought the theoretical lectures were hard to follow. But they mentioned when they asked for clarification, they got good and immediate help and guidance. The students liked the group work and learned a lot from the hands-on-experience.
- A combination of individual and group work for submission of mandatory exercises (in total 6) was used for the analytical part of the course. To evaluate the quality and test fair distribution of the workload in the groups, oral presentations of some exercises were requested.
- We used in-class Kahoot quiz which was very engaging and well received by the students.

- Still, more time and more structured lectures are required to enhance the learning outcomes.
- The scope of this course was too wide (analytical and experimental parts) as suggested by the reference group last year and recommended in the action plan of the last year. This was the last round of this course, and two separate courses are now registered to replace this course. With two separate full courses, there will be enough time for various activities such as use of the relevant software and problem solving in the class, and this is something we tried as much as we could this year considering the time limit. The new analytical course (2022 version) will partly use flipped classroom method to provide time for more student-active class activities. The assessment form in the new design will be based on mandatory exercises (mostly in the form of group projects) and final exam (100% of the grade).
- Last year, students thought the lab reports and exercises took a lot of time and they should contribute to the final grade. The course evaluation this year consisted of exercises (15%), lab reports (15%) and a final digital home exam (70%), to reward the efforts needed to fulfill the exam requirements. Exam results were in general slightly weaker than last year which can be due to all the difficulties and restrictions encountered in an unusual semester with combination of physical and digital teaching and attendance. Also, the digital home exam was challenging for some students since it was their first experience. Nevertheless, the average grade was similar to the results obtained in previous years.

#### **4 APPENDIX: THE QUESTIONS OF THE STUDENT SURVEY AND RESULTS**

Introduction: Flipped classroom has recently gained popularity in the higher education sector worldwide especially during the Covid-19 pandemic when many universities had to close their campuses. Flipped classroom is supposed to provide more time for class activities. We want to have a student-driven class and engage students more in class activities. Students will be involved in course planning and implementation. We therefore appreciate your feedback and comments regarding your experience with the flipped classroom this semester (evaluate the following on the scale of 1-5, 5 the highest score).

1. In general, how well do you think the course material, applied learning methods and activities, and assessment (course work) helped achieving the learning outcomes of the course this semester?
2. This semester (Spring 2021) was special, and we used flipped classroom and online teaching simultaneously, given the situation. How effective do you evaluate the flipped classroom teaching method?
3. In order to initiate more group activities and discussions, we tried to have short questions or problems during the class (or as homework) to be discussed in groups sometimes followed by presentations from groups and peer feedback. For this reason, we had an extra teaching assistant this semester, also sharing ideas with an expert from industry. How effective do you evaluate this experience for active learning?
4. One of the challenges of flipped classroom is related to lack of student preparation prior to starting the in-class sessions. How active do you evaluate yourself in preparations before class, asking questions and getting involved in discussions and problem solving in groups?
5. In the new version of the course for 2022, project-based assessment will account for the final grade. The assessment will be based on a) final group project composed of several connected sub-projects, b) individual description of the project, c) evaluation of another group's project. How effective do you evaluate this assessment form in creating opportunities for active student participation?
6. We plan to use a software in project work next year with guidance during the coaching sessions, giving feedback to students who discuss and present their work. How did you like the hands-on activities this semester (including the application session using the software)?
7. An issue in implementing flipped classroom is students' inability to get immediate help/feedback while they study at home. To get immediate feedback, we proposed using the discussion board this semester. However, we didn't see many students used this function during the semester. To make the course more interactive and to evaluate students' progress, we plan to include quiz-elements in the videos. How do you like the idea?

8. Another measure is arranging guest lectures from the industry to better explain how the theory and use of software are linked to real world applications in the industry. How do you like this idea?
9. We received feedbacks from you about the students' workload in the course. We tried to adjust the workload based on your comments. When you look back as a whole, how do you evaluate the students' workload in this course compared to the courses with traditional teaching methods?
  - More
  - Similar
  - Less

Please feel free to write any feedback and comments that can help us to better design the course in the future.

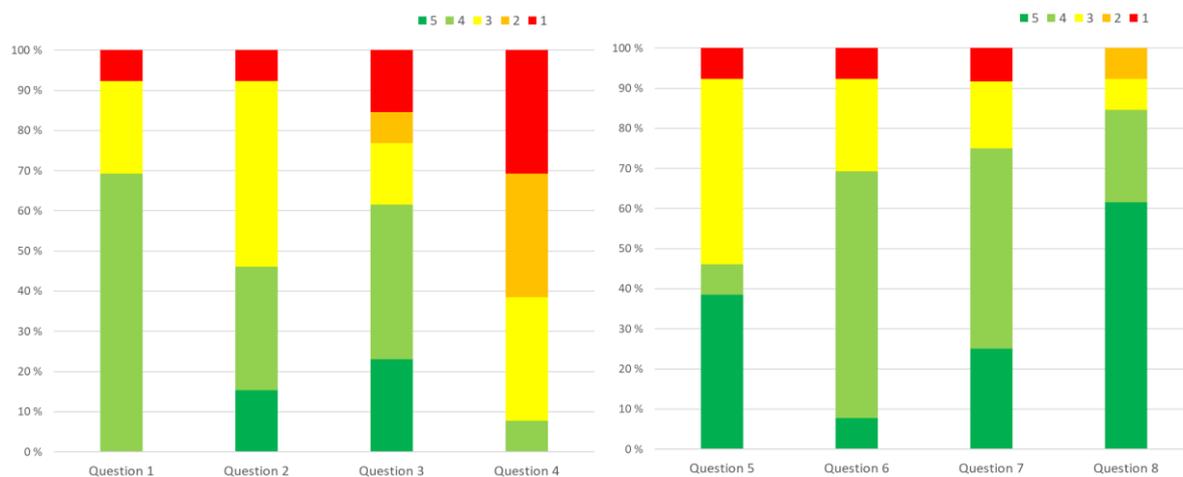


Fig.1 Survey results (colors show the scale of 1: red to 5: green)

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