Making Student Experts within a Flipped Mechatronics Class

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Abstract

CONTEXT

The flipped classroom is used to place emphasis on the student, by allowing the students to do their own research which can be applied in the classroom(Amiri, Ahrari et al. 2013). This may be able to be taken to one extreme by allocating each student an area of expertise that all the other students can approach them about. This has be tried in a fourth year Project Orientated, Design Based Learning (PODBL) class.

PURPOSE

Is taking a flipped classroom to the extreme described a good thing? Does it help the student and can the student see its benefits, (if any)? This study is being carried out to determine the benefits or disadvantages of a setting up each student as a topic expert.

APPROACH

In order to get the students perception of the idea, a survey was conducted to determine their views. The survey had both qualitative and quantitative sections to try to best capture the required data. Importantly, the survey will try to capture the differences in the student experience between the class in question and a previous PODBL class in which student experts were not used. The Universities student feedback will also be examined to gather the student's thoughts of the overall class. Finally, the lecturers of the class will supply their thoughts on the process of the class.

OUTCOMES

It was found that the use of the student expert created greater knowledge in the students about their topic of expertise and a greater interaction between the students as they approach each other for information. The students saw the benefit of this approach and especially with regards to preparing for industry. It is hoped that this method will spread to other PODBL classes in the university.

CONCLUSIONS

It was found that there is benefit in the student experience.(Yuan-Chang and Shi-Jer 2013) The use of the student expert adds to the research methods that are available to the students but that it does not become the major method.

KEYWORDS

Flipped classroom, Design Based Learning, Project Based Learning

Introduction

The last decade has seen a great rise in the number of project based learning or flipped classrooms. Many Universities are now using project based learning. (Avotins, Suzdalenko et al. 2013) Traditional teaching was very theory focused which is recognized today as insufficient.(Butala, Vrabic et al. 2013) The flipped classroom consists of the students gathering the theoretical knowledge from videos in their own time and project work in during traditional class time.(Leow Fui and Neo 2013) In the creation of a flipped classroom, the lecturer creates a collection of instructional material in the form of written notes, Internet links and video clips.(Amiri, Ahrari et al. 2013, Bishop and Verleger 2013, Furse 2013, Yuan, Xing et al. 2014) The lecturer can create his own video clips, however with the abundant resources available on the Internet it is often better to source the instructional material from the net. Either way the students are expected to absorb the instructional material outside of, and before class time. In this way the lecturer does not have to repeat the same material for every new group of students. It has been created once and can then be used repeatedly until the unit needs to be updated.

Once the students have absorbed the theory, the classroom can now be used to consolidate the knowledge and skills. Students are given a project that requires that knowledge and

those skills that have been presented to the student. The student is now able to work on these projects during class time which gives the students full access to the lecturer at the time they need it the most. The lecturer in turn, is able to help individual students or, if a common problem arises, the lecturer may address the entire class with either a solution or prompts and clues to the solution. With the acquisition of skills by the student, they become increasingly ready for industry, who in turn need to provide less training.(Duc Man, Tien Vu et al. 2013)

This approach has the benefit of taking learning out of theory and into application. The students “learn by doing”. (Amresh, Carberry et al. 2013) It follows that the students retain more of the knowledge and skills presented and are able to better solve open-ended problems.(Mason, Shuman et al. 2013)

One concern with this approach however is the quality of the project itself. The requirements of the project may be such that it does not need the application of all knowledge and skills that have been presented to the student. Indeed, in the same way that an exam cannot fully cover all knowledge presented to a student, it is very difficult for a project to be able to cover all aspects of the required knowledge and skills. In some cases more than one project may be required. (Cappelleri and Vitoroulis 2013) The requirements also must not be too complex, reducing the students chances of being successful.(Pang Nai and Yap Tat 2014) Further, even in a well-structured project, there may be several solutions that present themselves. While all of the solutions taken together may cover all learning requirements, each individual solution may just use a subset of those requirements. Therefore a student pursuing one solution will not cover all the required ground. This is true even when the students are working in teams. In fact, teamwork often means that those students who are strongest in one aspect of the solution will do the work in that aspect. For the best learning each student should really work in their weakest area. It is however difficult for the lecturer to mandate and enforce students working in the area they need most. To alleviate this problem the idea of the student "expert" was introduced.

Purpose

Each student is given an aspect of the project to become an expert in. The idea is that the student will know more about that aspect then they would of in the normal course of the project. Other students, needing help with a particular aspect, can go to the student expert. The result of this is expected to be twofold; an increase of knowledge and an increase student collaboration.

In regards to the increase of knowledge, whilst the student may not cover every aspect of the project, he will know more about one particular aspect than he would have known by just working on his project solution alone. The idea is that the student expert will study his area of expertise in greater detail. This gives him a greater knowledge of this area and through the sharing of this knowledge, increases the knowledge of the other students.

The collaboration is increased as students are required to approach the student expert on a topic before they approach the lecturer. This applies peer group pressure to the students to learn their area of expertise as well as they can. This collaboration can take the form of direct contact between students or through an online discussion forum.

Method

To test this approach it was applied to a fourth level unit in the Mechatronics discipline. This particular unit, called Mechatronic Design, incorporated a project where each student had to build a sumo robot. This was a small robot could battle other robots and push them out of a circular arena. In building their sumo robot, the students had a number of approaches they could take and a number of solutions they could follow. For example, the students had a choice of motor type. Some would use servomotors, others DC motors, brushed or brushless, and still others would use stepper motors. The students would only learn about the particular motor that they used. There would of course be an "expert" on motor types. That student should become familiar with all motor types so that, when other students approached him, his knowledge could be shared and motor type best suited to that students' design could be selected.

In this project the following topics were randomly assigned to students to become their expert topic: motor type, power supply, software, wheel design, chassis design PCB design, control strategy, sonar, and IR sensors.

In order to evaluate the student's knowledge of their particular area, assessment was tied into their assignments. The assignments consisted of a project progress report, a demonstration of the project during a sumo robot competition day and a final report and reflection. Part of their project progress report was a section where the student had to demonstrate their knowledge of their expert topic. As part of their assessment of their final report, the lecturer would monitor interactions in the classroom and on the student forums to assess the effectiveness of the students' knowledge distribution.

To measure the effectiveness of this approach within the classroom, a survey was used. The survey concentrated on the student experience of what the students gained from this learning style. The questions were a mix of qualitative and quantitative questions. The questions were:

1. Please indicate the knowledge gained in the area assigned to you. (Scale 1 to 5)
2. Please rate the knowledge gained in the other areas. (Scale 1 to 5)
3. How did you gain the knowledge?
4. A. Did the flip classroom approach help? (Scale 1 to 5) B. Why?
5. A. How does this compare against previous experience? (Scale -2 to 2) B. Why?
6. A. Do you believe this is a good approach to prepare students for industry? (Y/N) B. Why?
7. Please rate the knowledge gained in the expert and other areas in weeks 1 to 3. (Scale 1 to 5)
8. Please rate the knowledge gained in the expert and other areas in weeks 1 to 12? (Scale 1 to 5)
9. How did the interaction with your peers help you?
10. How much knowledge was gained from your peers?

Results

The first impression that the lecturer received was one of complete acceptance. This was a surprise to the lecturer as he thought that the students would have fought against this approach. Happy to be proved wrong, the next thing he noticed was that after the first class most of the students started their own expert topic thread on the student online forum. Whilst the lecturer had said that they could use the forum to discuss their topics, he did not expect such a quick and organised uptake. During the first three weeks there was a steady flow of thoughts and ideas in the expert topic threads. This flow slowed after week five and remained at a low level with only one or two thread updates per week.

The survey was given to the 30 students in the class in the final week. Unfortunately only eight students completed the survey. Therefore the survey can only be used as an indication of how the students felt about this approach to learning.

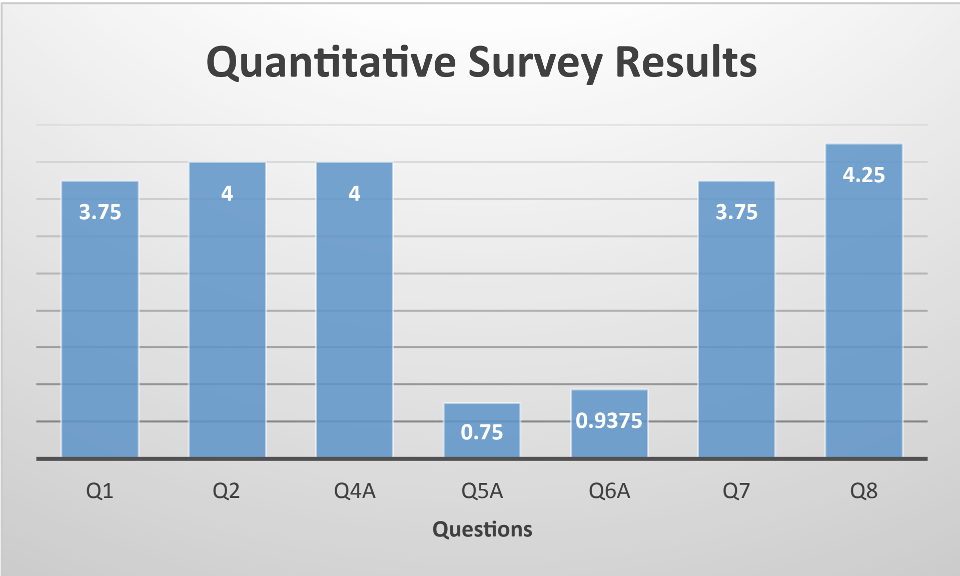

Figure 1 Quantitative Survey Results

Figure 1 shows the quantitative questions. Most of these questions were rated from 1 (being the worst) to 5 (being the best). Note that question 4 was a yes or no answer with "No" being given the value of zero and "Yes" being the value one. Also question 6 was from -2 to 2 and there were no results below 0 for that question.

Question 1.

This question was used to determine the perceived gain that the students received from having an expert topic. The result was 3.75 out of 5. Thus most students believed that they received a reasonable amount of knowledge from their expert topic. To gain the required knowledge in their topic would have meant that most of the students would have had to gain this knowledge by researching books and papers. That is, it was independent self-learning.

Question 2.

This question was used to determine the perceived gain the students received in all other areas apart from their expert topic. Here the result was 4 out of 5. The students then believed that they gained a little more on areas outside of their expert topic. To gain this knowledge the students had a choice of research, self-directed learning or approaching the other students.

Question 4A.

This question was an overall question designed to determine if the students liked the flipped classroom approach. With the result of four out of five, it seems that the students did.

Question 5A.

This question was used to determine if the students preferred this learning approach. This question was scaled from -2 to 2 in order to allow the students to indicate, using negative numbers, that this approach was worse than others. With an average of 0.75 and with no students giving a negative score, we can see that the students were either indifferent to the approach (those giving it a score of zero) or they thought it was a better approach.

Question 6A.

With a possible yes or no answer, this question was used to determine the value that the students saw in this approach to prepare students for industry. To give it a value a “No” was considered a zero and “Yes” was considered a 1. All responses were in the affirmative except for one which gave a "50-50" response. Hence a result of 0.9375 out of 1. This indicates that the students feel that this is a good approach, but the previous questions results indicate that they feel that the approach could possibly be improved.

Question 7.

This question sought to ascertain their perception of knowledge gained during the initial period of the project. The result of 3.75 out of 5 indicates that the students were reasonably happy with the initial phase of the project.

Question 8.

This question sought to ascertain the perception of knowledge gained during overall duration of the project. The result of 4.25 out of five is higher than the previous question. So the students were happier with the knowledge gained overall than in the first three weeks. The first three weeks of the project are mostly spent in analysing the project, analysing the specification for the project, and clarifying the areas of the specification that may seem vague. This could indicate that the students feel they gained more knowledge after they had analysed the project and started working on solutions. It is interesting to tie this with the lecturer's observations of the activity on the student forum. This activity was high during the first five weeks and then dropped away. It would seem that that the students would first analyse the project and determine their solution in the first few weeks. This would be followed by an intense period of gathering information for their particular solution, both from their own research and from the other students. The latter part of the project would be spent on the construction and debugging of their project. During this phase there was less activity on the forum but question eight indicates that they believe they gained more knowledge. It is believed that this is due to the hands-on nature of the project. Students perceive that they are gaining more knowledge whilst they are applying the knowledge gained to a concrete object.

Qualitative Questions

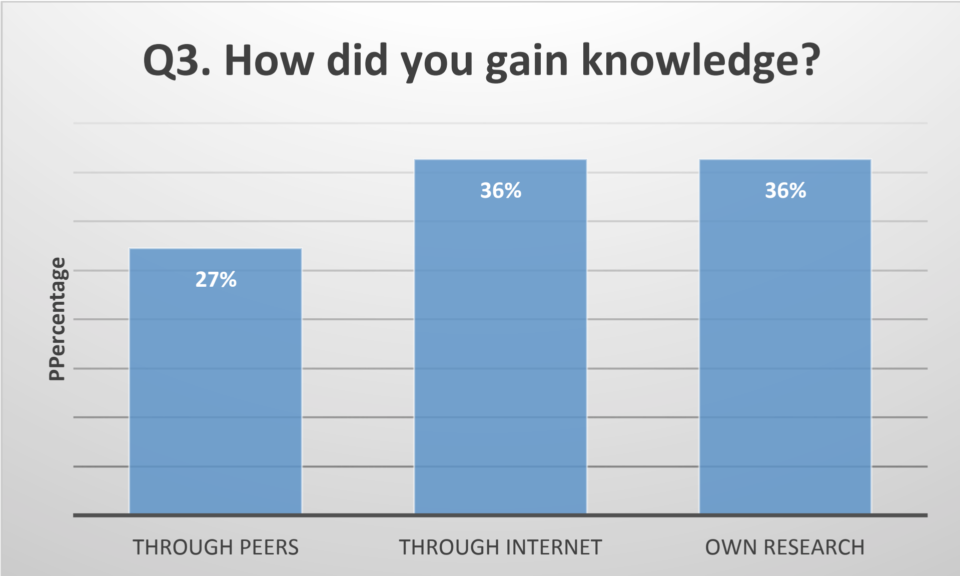

Figure 2 How did you gain knowledge?

Figure 2 examines the ways students perceive they gained knowledge in this unit. The responses could be grouped into three categories. Several respondees wrote descriptions that would fall into more than one category so their response was counted in each of those categories. 27% of the responses showed their knowledge was gained through their peers whilst 36% indicated that the Internet was there knowledge source and another 36% indicated that was due to their own resources. As many students responded in a few different categories it is reasonable to interpret this information as the amount of perceived knowledge gained in these different categories. This would indicate then the students gained their knowledge reasonably equally over all three categories. This is seen as a reasonable and healthy approach to the acquisition of knowledge.

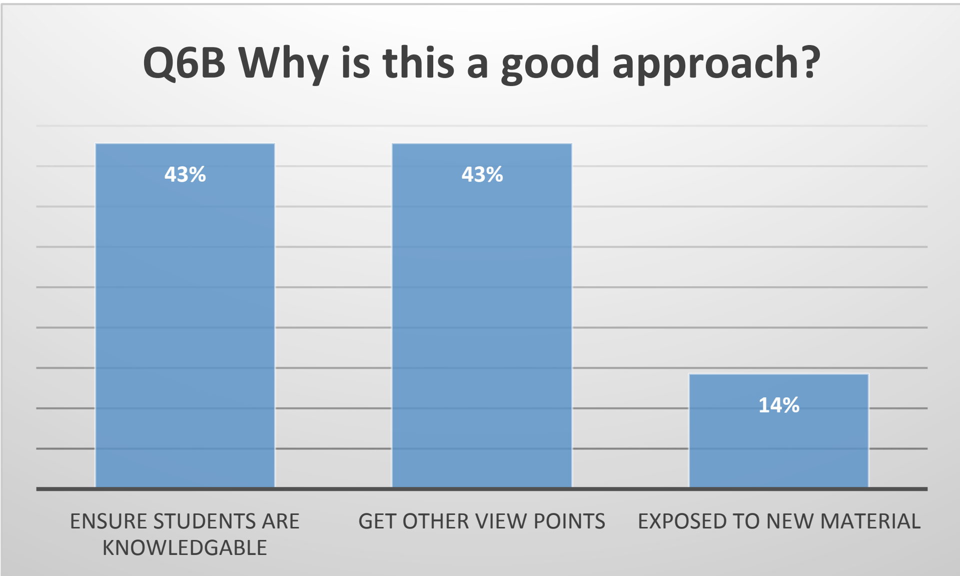

Figure 3 Why is this a good approach?

Figure 3 indicates why the students believe this learning approach was worthwhile. 43% believe that this approach ensures that the students are knowledgeable. This indicates that the students think that this approach has forced them to gain more knowledge than they may otherwise have gathered. Another 43% found that this approach enables one to get other points of view which in turn would have given more options for an optimal project solution. A final 14% stated this exposed them to new material. If by new material they meant that material was presented to them by another student, then this could be tied to the previous category of other viewpoints, bringing it up to 57%. This would indicate that the students find a value in collaboration and sharing viewpoints with others.

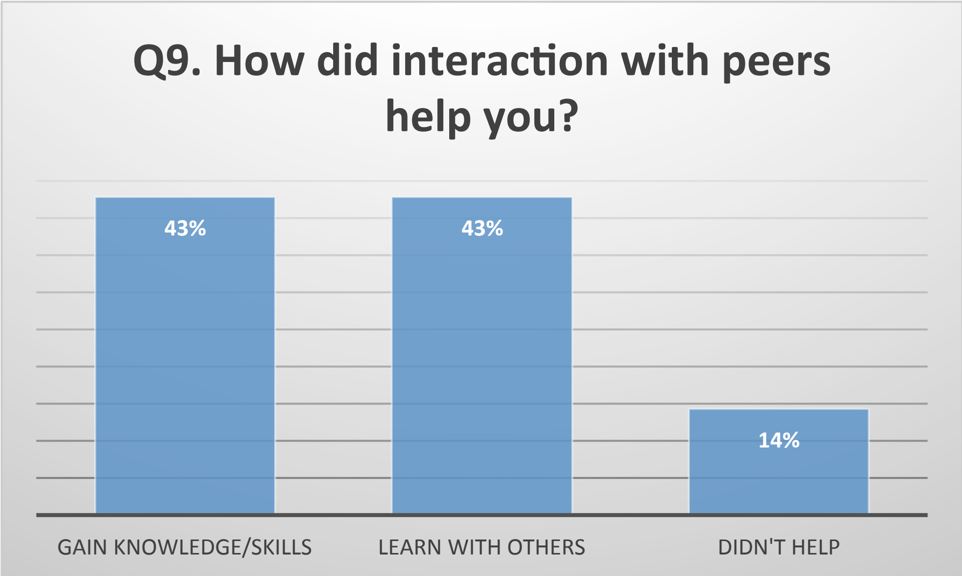

Figure 4 How did interaction with peers help you?

Figure 4 shows what the students thought of their interaction with their peers. 43% indicated that they gained knowledge and skills with the interaction in this learning approach and another 43% found value in learning with others. It is interesting that in the previous question all respondees indicated why they found student experts a good approach yet here, 14% didn't believe they got any help from their peers.

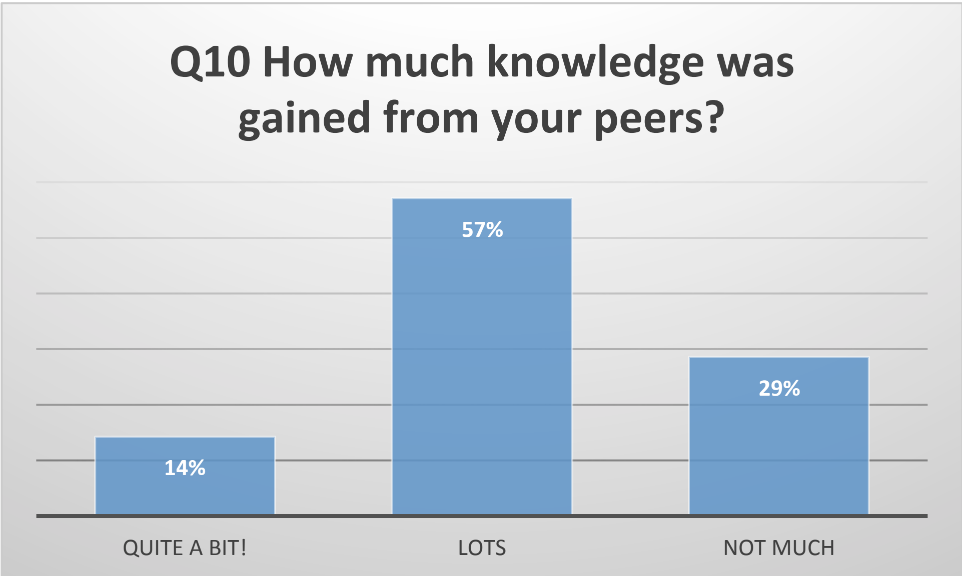

Figure 5 How much knowledge was gained from your peers?

Figure 5 indicates the amount of knowledge the students gained from their peers. 14% indicated that it was "quite a bit!". This is interpreted as indicating that a majority of the knowledge was gained from the topic experts. 57% indicated that they received "lots" of knowledge. This is interpreted that, in line with question three, they received about a third of their knowledge from their peers. 29% however claimed that they did not get much knowledge from their peers at all. At least they got some!

Another indicator of student satisfaction was taken from the university's Student Evaluation of

Teaching and Unit. (SETU). When the unit was run without student experts the overall results of the unit was 4.271 out of 5, whereas when it was run with the student experts the result was 4.158 out of 5. This decrease is not significant due to the low number of students responding and is taken to indicate that the two groups of students had roughly the same impression of the unit. The teacher satisfaction score went from 4.75 to 5 out of five. As the lecturer had less questions to answer due to the student experts does this indicate that the students are happier when they see less of their teacher?!

Student results between the year without student experts and the year with student experts was also examined. It was found that there was no significant change in the student results. Thus the value of this method could only be gauged on the students' feedback.

Conclusion

The results would indicate that the creation of student experts is willingly accepted by the students especially as a good method of preparing them for industry. There is an overall view that more knowledge and skills were gained with the use of the student expert but that this approach does not swamp or override any of the other methods of research for a project solution. Due to the small size of the samples and the number of students there is no information on whether this approach can be scaled up to larger cohorts of students. It is however seen as an effective way to both increase the students' knowledge and to increase the amount of collaboration, especially when projects are done on an individual basis rather than in teams.

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