A STUDY OF THE EFFECTIVENESS OF FLIPPED CLASSROOM OF TEACHING IN BLENDED LEARNING

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ABSTRACT Blended courses (also known as hybrid or mixed-mode courses) are classes where a portion of the traditional face-to-face instruction is replaced by web-based online learning. Blended courses have claimed to be the most popular choices for students at some overseas institutions where they are offered. At first glance, this popularity seems intuitive because blended courses allow students and faculty to take advantage of much of the flexibility and convenience of an online course while retaining the benefits of the face-to-face classroom experience. However, many local institutions appear to be struggling with conceptualising and implementing blended learning.The present study aims to investigate the effectiveness of Flipped Classroom of teaching in blended learning.Feedback survey of two groups of students (Age : 18 – 20 years) studying CAD module at Singapore Polytechnic was carried out: one group studied using the mixed mode (Conventional + Flipped during the 3rd term); another group studied using the pure mode (Flipped from the beginning). Students are asked to rate flipped classroom : Q1(a) in using the in-class time to help them to learn in class/to do homework or tutorial in class; Q1(b) in shaping them to be a more independent and responsible learner.The main findings from t –test for two independent samples are:(a) For Question 1(a) : There is no difference between the two modes (at $\alpha = 0.05$), i.e. flipped classroom did not help students learning in the classroom as compared to traditional 'face-to-face teaching'. In other words, both modes are suitable or effective for teaching CAD module;(b) For Question 1(b) : There is a significant difference between the two modes(at $\alpha = 0.05$), i.e. Pure Mode is effective in shaping students to be more independent and responsible learner. In other words flipped classroom is an effective model to be adopted in blended learning for training students to be more independent and responsible.

Keywords: Flipped Classroom, CAD, Habit, Active Learning

1. INTRODUCTION

"Teach less Learn more", a phrase often misinterprets to mean simply less teaching or fewer hours of teaching. Those who are in the teaching profession will know "Teach less Learn more" does not literally mean less teaching to learning more as advocated in Ministry of Education (MOE) Singapore website [7], is about teaching better, to engage our learners and prepare them for life, rather than teaching more, for tests and examinations.

To accomplish better teaching, active learning strategies are infused into the teaching and learning for better students' engagement and achievement. Active learning supports deep approach to learning, which means that learners intend to understand the concepts instead of simply reproducing the information on an exam. This is discussed in, "Rethinking Engineering Education – The CDIO Approach"[1]. Thus teach less is definitely not a reduction in curriculum hours or content, rather curriculum hours may increase in order to teach better with activities to engage our learners directly in thinking and problem solving. However, in reality, curriculum, hours often do not increase with changing teaching strategies or delivery methods. These better activities need extra class time and may indirectly cause a cut in curriculum hours to deliver content knowledge. The best strategy to overcome this problem is to flip the classroom. Flipped classroom as described in EDUCAUSE [6], a nonprofit membership association created to support those who lead, manage, and use information technology to benefit higher education, is a change in the typical way

of how students learn. It is a pedagogical model in which the lecture and homework components of a module are swapped. In another words, students learn and comprehend independently on the knowledge through video lectures before the lesson time, while tutorials, projects or discussion are carried out in the classroom with the lecturer. This puts more of the responsibility of learning on the students and giving them a more opportunity to inquire about lecture content, experimenting their skills in applying knowledge and interact with their peers in the classroom activities. Lecturers now function as facilitators, bringing students into the higher order of learning in the Bloom's taxonomy as shown in Figure 1 in the classroom. Lecturer now spending time in the class focusing on the higher order thinking skills rather than spending time in the classroom focusing in the basement of the taxonomy on rote and basic teaching. This change will put more of the responsibility of learning on the students and giving them a more opportunity to inquire about lecture content, experimenting their skills in applying knowledge and interact with their peers in the classroom. The better students who can help their peers provide them with an opportunity to see new problems and searching for new solutions encouraged them to reassess their own understandings without a lecturer actually 'telling' them. Lecturers now function as facilitators, bringing students into the higher order of learning in the Bloom's taxonomy by challenging their basic knowledge in CAD tools learned the lesson so as to encourage them to 'reach' for a deeper level of understanding in using the tools on the same or new problem.

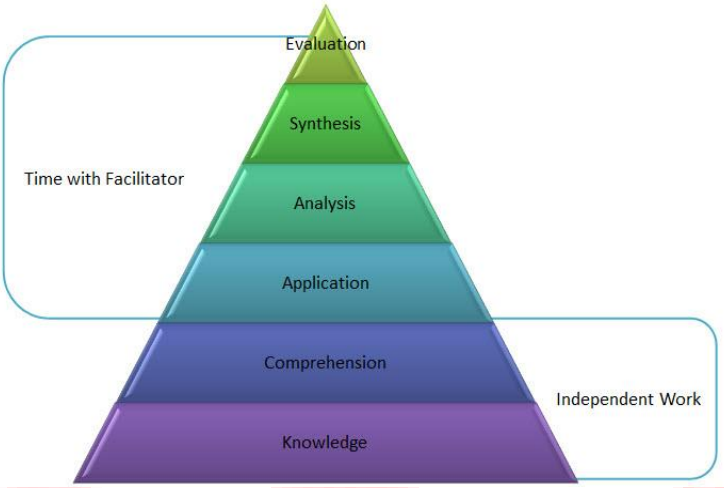

Figure 1. The Flipped Classroom Bloom's (extracted from Leighanne's learning notes)

1.1 The Challenge

The conventional way of teaching CAD comprises a series of step-by-step demonstration of the tool and independent lectures and tutorials on visualisation (i.e. orthographic projections and isometric drawing) and reading of symbols (blueprint reading) and views on a 2-dimensional drawing. Tutorials on orthographic projections and isometric drawings are usually in the form of sketches. Tutorials on reading blueprints are usually in the form of a questionnaire. Assignments and projects are set as homework for students to tell us their integrated application knowledge.

Teaching CAD has becoming more challenging with the new paradigm in the world of CAD – BIM (Building information Model) and the integration of more applied context. The applied context offers to shift the focus of instruction to encouraging strategic and motivated students to sustain students' interest in learning. A quick overview of exhibitions and conferences shows an enormous

advancement in software in the world of CAD. CAD software changes frequently at almost yearly to improve the efficiency of drafting process in the construction industry. To provide graduates to meet the industry needs has thus become even more challenging.

1.2 The Flipped Classroom

One of the ways to meet these challenges is to assimilate (incorporate into one's thinking) the underlying concepts of the tools. Consequently, the emphasis in training is on understanding through concepts, analysis and design rather than concentrating on the operation of the application. Another way is to build a structure such as the high order of learning activities, to connect the knowledge concepts and CAD tool so that students can easily grasp it, also supported by Bruner [2] that such activity and strategies have a significant impact on education and on the understanding of the learning process. Active learning also helps to facilitate the application of knowledge to new problem or task as Crawley et al. [1] make this distinction. However, when the time is allowed for such high order of learning activities, there is less time to deliver the details. Often delivering of the content will be cut to the bare minimum. In order not to compromise the delivering of the content, flipped classroom has just the right structure to replace the step-by-step demonstration delivery method, which is a weak constructivist teaching method as advocated by Geoff Petty [3]. This new way of the learning approach would force students to build up a habit of independent learning in picking up steps in operating the tool and offers time in the classroom for the higher order of learning activities.

1.3 Learning CAD

Figure 2 shows part of the integrated training pyramid for a first-year module in Diploma in Civil Engineering, CAD with BIM, in the School of Architecture and the Built Environment.

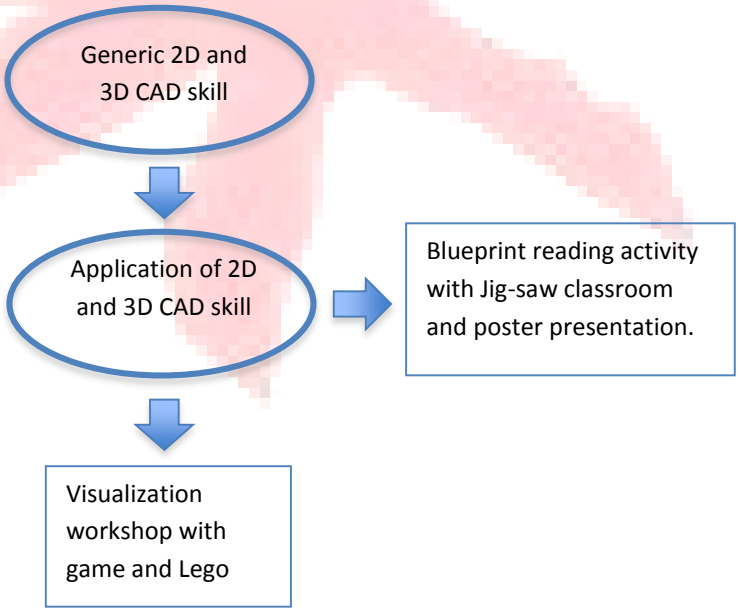

Figure 2. Integrated teaching plan for CAD module

Starting with a two-dimensional (2D) and three-dimensional (3D) base of CAD knowledge upon which the visualisation and blueprint reading and skills build upon.

To engage students in learning visualisation and blueprints reading skills with CAD, a series of active learning strategies were used in the classroom to motivate students. When students are motivated, they need a little push to accomplish a task and learning will become self-directed. This will also help sustain their interest in learning as they advance through the course. Crawley et al. [1] in his book, "Rethinking Engineering Education – The CDIO Approach" make this distinction. The challenging reasoning task of applying the 3D CAD skill to model the blueprint into a 3D digital model which is used to be set as a homework assignment or as a Mini Project is now possible to be set in the classroom with Flipped classroom as shown in Figure 3. In another words, students now spend time to do their homework in the class with lecturer as the facilitator as they learnt the basic concepts at home independently through video lecture.

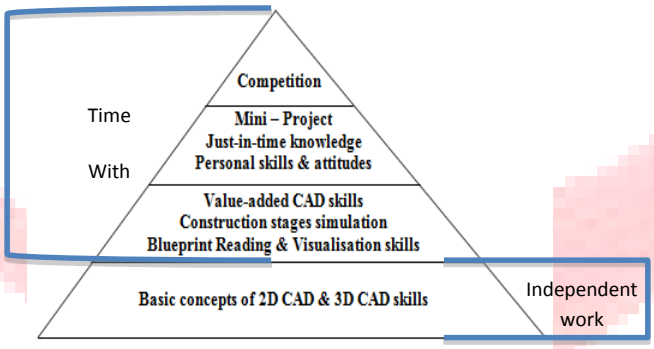

Figure 3. Integrated teaching plan for Blueprints Reading in a Flipped Classroom

The step-by-step demonstration of CAD skills is set as homework for students to go through before the lesson. Thus there is now time in the classroom for application skills learning such as advanced tutorial, assignment or project.

2. FLIPPED CLASSROOM TOOL AND APPROACH

The effects of Flipped Classroom are assessed using Pre-recorded Lecture and Sampling with 1st and 2ndattempts as listed below:

2.1 Pre-recorded lecture & Sampling

Video lectures were sourced and selected from YouTube to match the lecture delivery. A sample group of 39 students (Two Year 1 DCEB lecture and practical session, each class size of about 19-20 students) was used for this research project. Using the flipped classroom pedagogy model, CAD lecture, which consists of a step-by-step demonstration of CAD tools operation, is swapped with project work (usually a completed real-life building). A readiness test was conducted to test if students have watched the video lecture.

1st Attempt Method – Mixed Mode

Flipped classroom was implemented over a period of a term with video lecture uploaded in BB for students to watch and learn the lesson. This was implemented after students have undergone 2 terms of the conventional classroom. This will be called the mixed mode in this paper.

- Pre-Flipped week: students were informed to watch and learn from the video lecture in BB. They were briefed on the purpose of flipping the classroom. It is important that students see why they are learning in this way. Geoff Petty [3] discussed this point in his book as one of the seven principles common to high-quality learning and achievement.

- 1st flipped week: video lecture focus on basic drawing skills. Readiness test was conducted to check on students' skill as a class. The content of the tests was based on the video watched. Students that did not pass the readiness test were to watch and learn from the video again in class while the rest work on their tutorial.
- 2nd flipped week: video lecture still focus on more basic drawing skills. 2nd readiness test was conducted. More students were expected to pass and project work/tutorial were given to a student to work in class.

- The rest of the flipped weeks: once project work has started, video lecture focuses on value-added skill or tricks and tips or applied specific skill related to the project work.

2nd Attempt - Improved Method – Pure Mode

The revised method has flipped classroom for all the terms and has the following changes:

- Flipped classroom was implemented right at the start of the course in year 1 over a period of a term with video lecture uploaded in BB for students to watch and learn the lesson. This revision offers no option for students to choose.

- 1% weight is awarded to those who has watched the video before coming to class. Students were expected to contact lecturer (through email or any social media) when they encountered the problem with the video content.

- Students that did not pass the readiness test were awarded 0% for that week and were expected to pick up the skills from peers during the tutorial session.

- Extended hours of tutorials each week after the readiness test provide students with an opportunity to learn more in the classroom with the lecturer.

3. RESULTS ON FLIPPED CLASSROOM

Students' feedback were collected at the end of the term to gauge relevancy of flipped classroom (Rating questionnaire Q1a, Q1b), the likes and dislikes (open-ended questionnaire Q2 & Q3) from the students who have experienced the flipped classroom.

For rating questionnaire, they were asked to respond to questionnaires with ratings of 1(poor) to 5(excellent). Following two areas were surveyed to rate the flipped classroom in:

Q1a) Using the in-class time to help students' learning in the classroom / do homework or tutorial in the classroom
Q1b) Shaping students to be an independent and responsible learner.

3.1 Data Analysis

Table 1 shows the summary of Output for Q1 (a): Flipped Classroom - in using the in-class time to help them to **learn in class/to do homework or tutorial in class.**

Table 1. Summary of Output for **Q1a** on Flipped Classroom for CAD Module at Singapore Polytechnic

	Sample 1(n= 55) (Mixed Mode)	Sample 2 (n = 52) (Pure Mode)
Q1(a)	n = 55	n = 52
	Mean = 4.0364	Mean = 3.9808
	s = 0.7191	s = 0.8515
Hypotheses	$H_o : \mu_1 = \mu_2$ (Null Hypothesis)	
	$H_1 : \mu_1 \neq \mu_2$ (Alternative Hypothesis)	
	($\alpha = 0.05$)	
Output	Test Statistic, t = 0.3639	
(from **Statdisk**)	Critical t = ± 1.983965	
	P – value : 0.7167	
	Degree of Freedom : 100.0175	
Conclusion	Fail to reject the Null Hypothesis.	
	Sample does not provide enough evidence to reject the claim ($\mu_1 = \mu_2$).	

[t –test for two independent samples; Not eq. vars; No pool.]

From the statistical result in Table 1, the feedback for Q1a) in using the in-class time to help them to **learn in class do homework** or tutorial in class has no significant difference from the mixed or pure mode of sampling.

Table 2 shows the summary of Output for Q1(b) : Flipped Classroom - in shaping them to be a **more independent and responsible learner**.

Table 2. Summary of Output for **Q1b** on Flipped Classroom for CAD Module at Singapore Polytechnic

	Sample 1(n= 55) (Mixed Mode)	Sample 2 (n = 52) (Pure Mode)
Input	n = 55	n = 52
	Mean = 3.8909	Mean = 4.2115
	s = 0.7372	s = 0.7498
Hypotheses	$H_o : \mu_1 = \mu_2$ (Null Hypothesis)	
	$H_1 : \mu_1 \neq \mu_2$ (Alternative Hypothesis)	
	($\alpha = 0.05$)	
Output	Test Statistic, t = - 2.2287	
(from **Statdisk**)	Critical t = ± 1.982928	
	P – value : 0.0280	
	Degree of Freedom : 104.4348	
Conclusion	Reject the Null Hypothesis.	
	Sample provides evidence to reject the claim ($\mu_1 = \mu_2$). In other words sample provides evidence to support the claim (μ_1 not equal to μ_2)	

[t –test for two independent samples ; Not eq. vars; No pool.]

From the statistical result in table 2, the feedback for Q1b) in shaping them to be a **more independent and responsible learners** significant difference from the mixed or pure mode of sampling.

Table 3 presents the responses from the 107 respondents who participated in the survey.Fifty-five (55) responded in the 1st attempt (Sample 1) and fifty-two (52) responded in the 2nd attempt (Sample 2). Responses were also summarised and shown in the bar chart in Figure 4 and Figure 5.

Table 3. Summary of Feedback Survey on Flipped Classroom for CAD Module at Singapore Polytechnic

Sample 1 (Mixed Mode)	Frequency for Rating					Total Frequency
	1	**2**	**3**	**4**	**5**	
Q1(a)	0	1	10	30	14	55
Q1(b)	0	2	12	31	10	55

Sample 2 (Pure Mode)	Frequency for Rating					Total Frequency
	1	**2**	**3**	**4**	**5**	
Q1(a)	0	4	7	27	14	52
Q1(b)	0	1	7	24	20	52

Rating: 1=Very Poor; 2=Poor; 3=Average; 4=Good; 5=Excellent

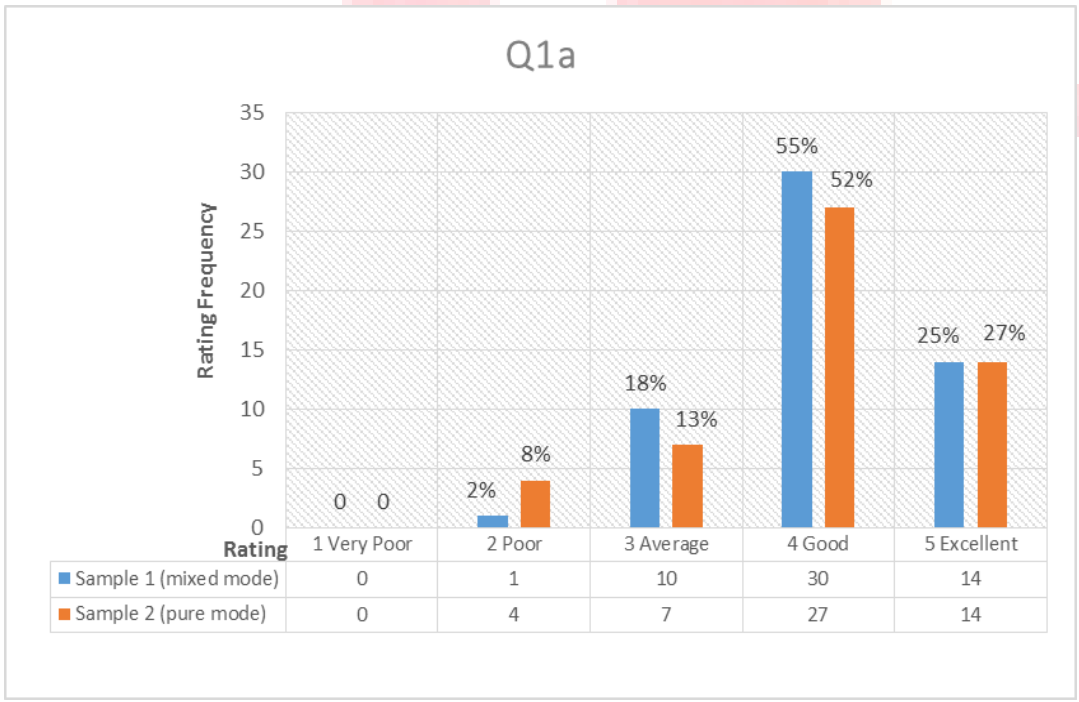

Figure 4. Rating for using in-class time to help student's learning in the classroom

80% (55%+25%) of the students in sample 1 have rated **using the in-class time for their learning in the classroom** as good and above. 79% (52%+27%) of the students in sample 2 rated using the in-class time for their learning in the classroom as good and above.

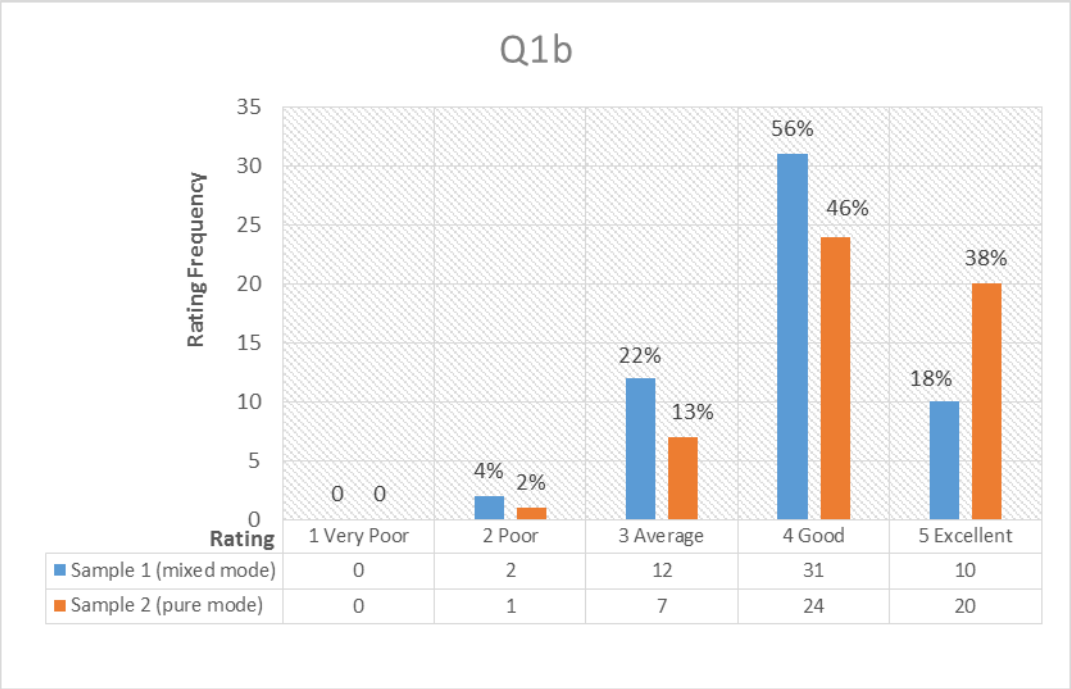

Figure 5. Rating for Shaping Student to be an Independent and Responsible Learner

74% (56%+18%) of the students in sample 1 have rated flipped classroom as a good and above way **in shaping them to be a more independent and responsible learner**. 84% (46%+38%) of the students in sample 2 rated flipped classroom as a good way in shaping them to be a more independent and responsible learner.

3.2 Interpretation and Findings

It is shown statistically above in the data analysis that implementing flipped classroom in the middle of the term does not have significant improvement in helping them to **learn in class/to do homework or tutorial in class** compared to implementing flipped classroom at the beginning the term in-class time.

However, statistics have shown in the data analysis above that there is a significant improvement **in shaping them to be a more independent and responsible learner** if flipped classroom is implemented right at the beginning of the term. Students seem to feel more impactful in becoming an independent and responsible learner when flipped classroom is implemented over a longer period of time.

Sample 1 ratings indicated that students recognised that they have benefited from flipping the classroom in their learning and in nurturing them to be an independent and responsible learner. Sample 2 ratings indicated that more students have recognised the benefits of flipped classroom.

The open-ended questionnaires (Q2, Q3) focus on the likes and dislikes. Students'responses were summarised and listed below:

Students' responeses on one thing that they like most about flipped classroom were:

One thing that they like most about flipped classroom were:

- More 1-1 lecturer's time with them to learn more
- Able to repeat watching of video lecture
- Able to adjust own learning pace and learn more independently
- Opportunity to practice in class and corrected on the spot
- Receiving help in doing real-life project work
- Sense of achievement for learning more
- Able to continue learning at home and clear doubts in class
- More time in class to solve more complicated problem

Students' reponeses on one thing that they don't like about flipped classroom were:

- Video lecture cannot respond to their queries
- Don't like video lecture; prefer traditional class teaching
- Video lecture too long; low video quality
- Difficult to find and download the video lecture
- Have doubts and do not understand the video lecture.

4. DISCUSSIONON FLIPPED CLASSROOM

The greatest challenge in teaching CAD in a flipped classroom is when students came to a classroom without watching the video lecture. These are students who do not like unfamiliar learning styles or learning style that needed effort and responsibilities. Professor Frank Coffield and others [4] conducted a very extensive research on learning styles has advised that it is important to encourage students to use unfamiliar styles, even if they do not like them at first and teach them how to use these.

One strategy, in the 1st attempt, is to make them watch the video lecture at one corner while the others carried on with the high order thinking task with the lecturer. Lecturer has to be firm not to give any teaching to those who did not do their task at home. As a result, the lecturer may get bad feedback for not teaching in the class. Lecturer also has to be cautious in identifying weak students who have done their task at home but still could not grasp the basic content knowledge demonstrated in the video lecture. Giving them a readiness test as described in the flipped classroom method above, would be a good way to identify such students and to give proper help to clear their misconception.

Another strategy, which is implemented in the 2nd attempt, is to award students a small percentage of marks for their learning at home verified by a readiness test in the class. However, there are still some students who just don't bother. For this reason, it is, therefore, good to integrate flipped classroom approach right from the start of the course to build up their habit of independent learning which would lead them to excellent in lifelong learning. This has been found to concur with two of the six principles that foster strong academic growth while focusing on character building in "An Integrated Approach to Character Education", edited by Timothy Rusnak [5].

In both strategies, the readiness test is important. This test offers lecturer to find out what the students already know (learn from the video or other means including students' prior knowledge) and their misconceptions.

5. CONCLUSION

Flipping a CAD classroom depend extensively on the video lectures. This resource preparation task required much time investment from lecturers. CAD video lecture which is easily available on YouTube, usually uploaded free by CAD software vendor, is a good resource centre for lecturers to get started with flipped classroom.
Once they have experienced the benefits of flipped classroom, time can then be invested to improve or add on more applied related video lecture.

Adopting the flipped classroom approach has not only overcome the problem of insufficient time for higher order thinking task in the class but has at the same time become an approach to nurture students to become an independent learner. A quote by Aristotle, "We are what we repeatedly do. Excellence, therefore, is not a skill but a habit". Flipped Classroom is therefore not only a skill but also a good habit to instil in our students that will lead to excellent. It is thus believed that if students are repeatedly trained in this approach will lead them to be an excellent independent learner.

The pedagogy change in a flipped classroom is thus allowing higher order thinking task to be done in the classroom and character building. In summary, besides the known benefit of flipped classroom, it is:

1) A way to provide an excellent environment to nurture independent and responsible learners.
2) A springboard to prepare students and lecturers for home-based learning.
3) A good habit to be repeated in students for excellence in life-long learning. Strategies for managing student loyalty have become increasingly important since the length of student relationship is the main determinant of the educational institutions' success and profitability.

In conclusion, flipped Classroom teaching in blended learning is definitely effective in shaping students to be more independent and responsible learner but it does not necessary has an advantage in helping students learning in the classroom as compared to traditional 'face-to-face teaching'.

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