FLIPPED CLASSROOM PEDAGOGY ENHANCES STUDENT SATISFACTION AND VALIDATED MOTIVATED STRATEGIES IN EVOLUTION BIOLOGY CLASSROOMS

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ABSTRACT

This paper reports the findings of a research inquiry into undergraduate student perceptions of a flipped classroom experience in a 4th-year students in molecular biology major at Dong-eui University, Korea. The purpose of the research was to discuss the impact on promoting student satisfaction and improving their involvement in their own learning when applying a “Flipped classroom” design in evolutionary biology class. The participants involved in this study were lecture evolution biology. Out of the 20 students trained, 20 completed the retro-pre-questionnaires. The increase in scores at ‘Not Confidence’ was statistically significant (mean ± SD, 0.7 ± 5.37; 95% confidence interval, -0.52 to 2.92). The increase in scores at ‘Confidence’ was statistically significant (mean ± SD, 4.31 ± 5.89; 95% confidence interval, 1.36 to 7.26). The differences between the mean scores of pre-test and post-tests for ‘Comprehension’ were also calculated separately to see if there was any difference in the results. There was a statistically significant difference in the scores obtained in the pre-test (M=29.06, SD=7.43) and post-test (M = 32.20, SD = 7.79); $t = 5.18$, $p > 0.001$). The increase in scores was statistically significant (mean ± SD, 3.18 ± 2.53; 95% confidence interval, 1.89 to 4.46). We found that flipped-class pedagogy enhanced the validated motivated strategies for observation, comprehension, comparison, reasoning, application, and experience except organization.

Keywords: Confidence, evolution biology, flipped classroom, validated motivated strategies.

INTRODUCTION

The term *flipped classroom* was popularized by teachers Aaron Sams and Jon Bergman from Woodland Park High School, Colorado in 2007 in response to a realization that class time would be best spent guiding knowledge and providing feedback rather than delivering direct instruction (Sams & Bergmann, 2013). The flipped classroom is often referred to as the inverted classroom or reverse classroom. A flipped classroom is one where students are introduced to content at home, and practice working through it at school. Students watch pre-recorded videos at home, then come to school to do the homework armed with questions and at least some background knowledge (Stone, 2012). Every students can learn at their own pace and at home, you can provide more individual attention and you don't have to worry about make-up classes. This dramatically improved students’ long-term retention of knowledge, motivation, and course completion rates. The key purpose of the flipped classroom is to engage students in active learning where there is a greater focus on students' application of conceptual knowledge rather than factual recall. The flipped classroom has grown in popularity in higher education as a potential model to increase student engagement, leverage technology and provide greater opportunities for active learning in class. Berrett (2012) argues that flipping the classroom can indeed improve the traditional lecture where for the past hundreds of years, teachers put a lot of emphases only on the transfer of information (Karjanto & Lee, 2017). Based on his own experience of teaching Physics in Harvard, the pioneer of peer-instruction also argues in the same line of reasoning (Mazur, 2009). In these studies, there was only one (Papadopoulos & Santiago-Román, 2010) studying the effects of employing a partial flipped classroom using a matched (within the same group of students) pre- and posttest design.

In recent years, biology has been undergoing profound changes that are happening so quickly that biologists have not had the time to integrate these conceptual changes into intellectual and experimental frameworks (Dinger et al., 2009). Along with this increasingly rapid accumulation of data from research, biological education is not keeping pace with either conceptual or factual learning (Depelteau et al., 2010). Evolution is essential to our curriculum and to scientific literacy. Imagine teaching social science without teaching history; students would lack perspective on events going on today. Similarly, to understand the big picture of biology, students need to understand life on Earth in terms of its history and its future - the changing life forms and ecosystems that have arisen and changed over billions of years, as well as the mechanisms that have brought about those changes. For those students who think that they can avoid evolution in biology classes, the number of responses involving evolution suggests otherwise. Four responses were “natural selection” and fifteen involved evolution/genetic drift/adaptation/population genetics. Of course as an evolutionary ecologist, I’m excited to see that many are including evolutionary concepts in their ecology courses. However, it is a challenge that so many find this difficult both to understand (student’s perspective) and to teach. As is true of any subject, to teach evolution successfully, teachers need to be prepared with a conceptual understanding of the topic and with effective curricular strategies. Teachers that develop a depth of knowledge beyond what is actually expected of students will be able to confidently adjust instruction in response to students' needs and inquiries.

It is still difficult to predict whether flipped evolutionary instruction is a temporary fad or paradigm shift in how educators deliver information. The ubiquity of free technological tools has set the stage for interesting innovations in education. At the same time, accrediting agencies and school administrators are looking for creative ways to improve student learning and revamp outdated teaching methods. In this study, we used a pre- and posttest design to investigate the effects of flipped-class pedagogy on learning strategies in university education and study whether the effects of a flipped classroom were persistent. This study showed a gain in student learning in favor of flipped-classroom pedagogy.

METHODOLOGY

Flipped classroom approach

The current study is an action research examining the use of the flipped classroom approach in evolutionary biology. The participants involved in this study were lecture Evolution Biology (textbook: An Introduction to Biological Evolution, Second Edition, Kenneth V. Kardong (ed.), McGrew Hill Higher Education, USA) students (Department of Molecular Biology) from Natural Science College of Dong-eui University in Korea (students are divided into two bands with Band 1 being the traditional teacher-centered model and Band 2 flipped classroom, so two band were selected for analysis because the researcher would like to find out if the flipped classroom pedagogy can benefit the learning of lower achievers).

The researcher explained the participating students for a briefing session (for about an hour) on 2 March 2015 to let them know about the ‘flipped classroom’ pedagogy. Before the briefing session, the researcher enrolled the website of ‘Flipped Classroom: Teachers’ Site’ (http://cyber.deu.ac.kr/main/viewMainIndex.do) to give the participating students an opportunity to experience a flipped classroom before they implemented it in their own classrooms so that they could have a better understanding of this pedagogy. At the end of the flipped classroom activities, students were asked to participate in an online questionnaire. The retrospective survey was used to determine the effectiveness of the instructional module. This type of survey, which requests both retrospective and current assessments of the instruction after completing the module, allows participants to maintain a consistent frame of reference when responding and limits the number of incomplete responses that can occur with pre- and post-tests (Raidl et al., 2004, Shimamoto, 2012).

The difference between the overall scores before and after was found to follow the normal distribution, as confirmed by the Shapiro-Wilk test. The data were analyzed using SPSS ver. 21 (SPSS Inc., Chicago, IL, USA).

Retro Pre-Post Survey

Data from the surveys was loaded into an Excel spreadsheet that captured the difference between the pre-participation and post-participation scores. In this study, a self-assessment instrument, a retro-pre-questionnaire, was used to study the perceived effect of structured evolutionary biology examination skills training (SEBEST) imparted to 4th-year undergraduate students of Department of Molecular Biology at Dong-eui University.

The objective item scores were added to obtain the overall score and the descriptive statistics for before and after the training. A paired t-test was used for evaluating the difference in the overall scores. The homogeneity of variance or mean values to infer whether differences exist among the bands or groups was tested (Zar, 1984).

RESULTS

A total of 25 questionnaires were returned, representing a return rate of 80.0%. Five questionnaires were excluded because they were incomplete. Table 1 shows that students highly regarded the flipped classroom activities. The standard deviations for the six questions asked were very low (all lower than 2.5) and it ranged from 1.0 to 1.41. The standard deviations for all five categories were very different, ranging from 26 to 34. It was very encouraging to know that they rated "I am satisfied that Flip-U meet my learning needs" the highest, followed by "I have improved my academic achievement."

Table 1. Students feeling about flipped classroom experience

Degree of satisfaction	Observation	Comprehension	Comparison	Organization	Reasoning	Application	Experience
I am satisfied that Flip-U meet my learning needs	5	6	7	3	3	6	4
I am satisfied with Flip-U efficiency.	4	3	2	3	5	4	4
I am satisfied with Flip-U effectiveness.	4	4	2	4	5	2	5
I am satisfied with the Flip-U motivation.	5	3	4	5	3	2	4
I have improved my academic achievement	2	4	5	5	6	6	3

The students' responses to the retro-pre-questionnaire before and after the structured evolutionary biology examination skills training were given in Table 2. Out of the 20 students trained, 20 completed the retro-pre-questionnaires. The increase in scores at 'Not Confidence' was statistically significant (mean ± SD, 0.7 ± 5.37; 95% confidence interval, -0.52 to 2.92). The increase in scores at 'Confidence' was statistically significant (mean ± SD, 4.31 ± 5.89; 95% confidence interval, 1.36 to 7.26), which implied that the students perceived that they learned most of the skills after the SEBEST module and that the course was effective. Further, the paired correlation was not very high (r = 0.126), but it was in the positive direction and was statistically significant ($p > 0.05$), implying that the questionnaire before score had a low impact on the questionnaire after score.

Table 2. Student response to the retro-pre-questionnaire before structured evolution examination skills training in Dong-eui University

No.	Chapter	Not confidence		Confidence	
		Before training	After training	Before training	After training
1	Evolution of Evolution	100.0	80.0	63.2	77.2
2	Time	50.5	52.0	45.8	55.4
3	Heredity	100.0	100.0	95.0	94.3
4	Emergence of Life	45.3	55.7	48.6	52.5
5	Diversity of Life	60.4	65.1	77.3	82.4
6	Evidence of Evolution	40.3	45.8	59.6	54.5
7	Selection	70.2	78.6	62.5	67.1
8	Variation: Spice of Life	44.7	52.1	55.7	60.3
9	Speciation	46.0	51.3	42.9	50.2
10	Co- Evolution	22.5	30.4	33.1	40.6
11	Life History Strategies	40.3	49.2	50.7	54.8
12	Life in Groups	100.0	100.0	85.9	100.0
13	Extinction	50.6	50.2	60.0	66.7
14	Human Evolution: The Early Years	63.1	66.9	49.4	53.9
15	Human Evolution: Building Modern Humans	22.5	30.6	27.8	31.8
16	Evolutionary Biology: Today and Beyond	25.8	35.5	30.2	28.6
17	Afterword	45.6	55.6	50.2	56.5
t-test		0.651		4.806	

Lastly, 20 students were to answer whether students will have a significant gain in the knowledge of the 17 lesson topics trailed in this study. With the calculation of the difference between the means of pre-test and post-tests (i.e. before and after the use of flipped classroom pedagogy) in 'Observation' by using a paired sample t-test, it can be found that there was a statistically significant difference in the scores obtained in the pre-test (M = 21.35, SD = 4.37) and post-test (M = 23.24, SD = 4.91); t = 4.92, p >0.001) (Table 3 for details of the results of paired samples t-test). The increase in scores was statistically significant (mean ± SD, 1.88 ± 1.58; 95% confidence interval, 1.08 to 2.68).

The differences between the mean scores of pre-test and post-tests for 'Comprehension' were also calculated separately to see if there was any difference in the results. There was a statistically significant difference in the scores obtained in the pre-test (M=29.06, SD=7.43) and post-test (M = 32.20, SD = 7.79); t = 5.18, p > 0.001). The increase in scores was statistically significant (mean ±

SD, 3.18 ± 2.53; 95% confidence interval, 1.89 to 4.46). The differences between the mean scores of pre-test and post-tests for 'Comparison' were also calculated separately to see if there was any

difference in the results. There was shown a statistically significant difference in the scores obtained in the pre-test (mean ± SD, 30.88 ± 5.36; 95% confidence interval, 1.47 to 3.95). The differences between the mean scores of pre-test and post-tests for 'Organization' were also calculated separately to see if there was any difference in the results. There was not shown a statistically significant difference in the scores obtained in the pre-test (mean ± SD, 1.12 ± 2.23; 95% confidence interval, -0.02 to 2.25).

The differences between the mean scores of pre-test and post-tests for 'Reasoning' were also calculated separately to see if there was any difference in the results. There was a statistically significant difference in the scores obtained in the pre-test (mean ± SD, 3.24 ± 3.68; 95% confidence interval, 1.37 to 5.11). The differences between the mean scores of pre-test and post-tests for 'Application' were also calculated separately to see if there was any difference in the results. There was a statistically significant difference in the scores obtained in the pre-test (mean ± SD, 3.41 ± 2.48; 95% confidence interval, 2.16 to 4.67). The differences between the mean scores of pre-test and post-tests for 'Experience' were also calculated separately to see if there was any difference in the results. There was a statistically significant difference in the scores obtained in the pre-test (mean ± SD, 3.29 ± 2.54; 95% confidence interval, 2.0 to 4.59).

Table 3. Results of t-test and 95% confidence interval of the difference for paired samples (pretest-posttest)

	Mean	SD	SE	Difference		*t*-value	Significance
				Lower	Upper		
Observation	1.882	1.576	0.634	1.082	2.683	4.923	***
Comprehension	3.176	2.531	0.614	1.892	4.461	5.175	***
Comparison	2.706	2.443	0.593	1.466	3.946	4.566	***
Organization	1.118	2.233	0.542	-0.016	2.251	2.064	NS
Reasoning	3.235	3.683	0.893	1.366	5.105	3.622	**
Application	3.412	2.476	0.601	2.155	4.669	5.681	***
Experience	3.294	2.544	0.617	2.003	4.585	5.339	***

NS: Not significance, *: 5%, **: 1%, ***: 0.1%.

DISCUSSION

For a long time ago, the traditional teaching style or specifically, teacher-centered instruction has been dominant in higher education in the world. In a traditional classroom, students become passive learners, or rather just recipients of teachers' knowledge and wisdom (Ahmed, 2013). Flipping the classroom has become something of a buzzword in the last several years, driven in part by high profile publications in The New York Times (Fitzpatrick, 2012).

The flipped classroom approach has been used for years in some disciplines, notably within the humanities. Barbara Walvoord and Virginia Johnson Anderson promoted the use of this approach in their book, Effective Grading. They propose a model in which students gain 'first-exposure learning' prior to class and focus on the 'processing' part of learning (synthesizing, analyzing, problem-solving, etc.) in class.

The most widely used evaluation design is a traditional pre then post-test, where participants are asked a series of questions at both the beginning of a program (pre-test) and then again at the program's completion (post-test). This tool is believed to measure changes in participant knowledge, attitudes, or behaviors regarding whatever the program content is (Colosi & Dunifon, 2006). The theory behind this design is that by testing what participants believe about program content after

program completion, their standard of assessing the changes in knowledge, skills or attitudes is consistent, and thus, not subject to a response shift bias (Davis 2003). However, implementing

program evaluations to measure change using a traditional pretest-posttest model can be difficult to plan and execute (Lynch, 2002). The criticism of the traditional pre/post tool has led to the use of a "retrospective pre-test" tool. In essence, a retrospective pretest is distinguished from the traditional pretest by its relationship to the intervention (or program). That is, a retrospective pretest is a pretest administered post-intervention, asking individuals to recall their behavior prior to an intervention (Allen & Nimon, 2007).

The perceived impact of SEBEST imparted to 4th-year undergraduate molecular major students from the paired t-test showed that the difference between before and after the SEBEST was statistically significant, which implied that the students did learn most of the skills after the implementation of the SEBEST module and that the training was effective. It is important to acknowledge that all self-confidence could be considered somewhat subjective. In addition, we found that flipped-class pedagogy enhanced the validated motivated strategies for observation, comprehension, comparison, reasoning, application, experience, and except organization.

CONCLUSIONS

Flip learning can be used in higher education (universities). Our study on the effects of flipped-class pedagogy on motivation and strategies for evolutionary biology shows that flipped-class session for traditional lecture sessions appeared to be sufficient to achieve changes in learning strategies of students with confidence and toward deep-learning strategies.

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