FLIPPED CLASSROOM PEDAGOGY ENHANCES STUDENT SATISFACTION AND VALIDATED STRATEGIES IN MOLECULAR BIOLOGY

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ABSTRACT

The flipped classroom is a new pedagogical method consisting of online video lectures in their own time prior to attending classes. This paper reports the findings of a research inquiry into undergraduate student perceptions of molecular biology with a flipped classroom experience in sophomores in university and they are majoring in Food Science & Technology at Dong-eui University, Korea. The scores at inquiry courses such as comprehension and comparison were statistically significant, which implied that the students perceived that they learned most of the skills after the flipped classroom module and that the course was effective. The differences between the mean scores of pre-test and post-tests for 'Flipped classroom' 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=33.69, SD=10.870) and post-test (M=71.1, SD=9.517). The increase in scores was statistically significant (mean±SD, 33.1±1.66; 95% confidence interval, 27.43 to 38.67, t=12.138, p>0.001). Across the 29 contents, coefficient alpha for the traditional classroom was 0.387. Coefficient alpha values for flipped classroom was 0.380. Students generally perceived the flipped classroom as a positive experience.

Keywords: Flipped classroom, inquiry courses, molecular biology, pre-test and post-tests.

INTRODUCTION

Flipped classroom (Baker, 2000) or also known inverted classroom (Lage et al., 2000), is one of the student-centered learning approach. Bishop and Verleger (2013) describe flipped learning as 'The flipped classroom is a new pedagogical method, which employs asynchronous video lectures and practice problems as homework, and active, group-based problem solving activities in the classroom'. One of the pioneers and early adopters of this method is Eric Mazur (1993), who searched for a method to activate his students and help them get a deeper understanding of what they are learning. He found that traditional lecturing quickly leads to passive students, while using peer instruction and the flipped classroom model helped students gain a deeper understanding.

The flipped classroom is a new pedagogical method consisting of online video lectures that learners watch in their own time and space so that they are responsible for their own learning prior to attending classes (O'Flaherty & Phillips, 2015). In the classroom they participate in group activities, while the teacher provides support – particularly to those students with additional educational needs (Baepler et al., 2014). This learning strategy is completely opposite to the traditional teaching approach, in which learners are expected to listen to teachers during class hours and complete activities outside of class (Ng, 2016).

There is a number of studies that have reported student success and increased engagement in the flipped classroom (Guy & Marquis, 2016).

Research on the effects of pre-training on learning is a similarly relevant area for the Flipped Learning model. One of the tenets of pre-training is to reduce the cognitive load on learners, to enable them to process information more efficiently. According to Cognitive Load Theory, there is a limit to the amount of information that can be used, processed and stored by the working memory, and overloading that limit undermines the learning process (Cowan et al., 2005). Paas et al. (2003) claim that measures of cognitive load are related to differences in instructional formats in the majority of studies.

Molecular biology is a branch of biology that concerns the molecular basis of biological activity between molecules in the various systems of a cell, including the interactions between DNA, RNA, proteins and their biosynthesis, as well as the regulation of these interactions. Molecular biology is the study of molecular underpinnings of the process of replication, transcription and translation of the genetic material.

The rapid growth and the inter- and multi-disciplinarity of molecular life science place demand on the selection of content. In fact, there is a large gap between what is known by practicing molecular life scientists and what is taught about the domain in secondary schools and universities (Howitt et al., 2008). Furthermore, many difficulties associated with teaching and understanding molecular life science are connected to the abstract nature of concepts, which, in turn, are part of complex systems at several levels of organization. Reasoning difficulties and alternative conceptions are major challenges for learners and teachers. In some cases, these difficulties are connected to the communicative tools of the domain. Both the domain-specific language and visualizations, aimed to facilitate communication, can constitute obstacles or introduce misinterpretations. Thus, research is required to provide further knowledge about factors that hinder or promote effective teaching and learning and to facilitate the development of effective new tools and strategies (Tibell & Rundgren, 2010).

In this study, we used a pre- and post-test de-sign 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 molecular biology. The current study was conducted during the second semester of 2018 at the Dong-eui University. The participants involved in this study were lecture Molecular Biology (textbook: Molecular Biology- Made Simple and Fun, 4/E, David P. Clark, Lonnie D. Russell, ISBN: 1889899097, ISBN-13: 9781889899091) from Department of Food Science & Technology 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) to let them know about the ‘flipped classroom’ pedagogy. Before the briefing session, the researcher enrolled the website of ‘Flipped Classroom: Teachers’ Site’ 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 request 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

To determine the practical significance of measured changes in learning, *d* was calculated as defined by Dunlap et al. (1996):

$$d = t_c[2(1-r)/n]^{1/2}$$

where *tc* is *t* for correlated measures, *r* is the correlation between measures, and *n* is the sample size per group. Descriptive statistics and weighted means (Hedge & Olkin, 1985) were used to compare the standardized mean differences (*d*) across conference sessions.

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 molecular biology examination skills training imparted to second year undergraduate students at a 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 32 students for questionnaires were returned, representing a return rate of 93.80%. Two students' responses for questionnaires were excluded because they were incomplete. Table 1 shows that students highly regarded the flipped classroom activities. It was very encouraging to know that they rated " have improved my academic achievement." the highest, followed by "I am satisfied with the Flip-U motivation" The standard deviations (SD) for the six items asked were ranged from 1.41 to 2.92 with mean of 2.23. The standard deviations for all five categories were very different, ranging from 32 to 48 and SD was 7.37.

The students' responses to the retro-pre-questionnaire before and after the structured molecular biology examination skills training were given in Table 2. 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 (Mean=23.90, SD=10.253) and post-test (Mean=27.47, SD=10.261, Mean of difference=3.567, SD=1.813; t=10.773, p>0.001). The scores at 'Comprehension', 'Comparison', 'Reasoning', 'Application', and 'Experience' were also statistically significant, which implied that the students perceived

that they learned most of the skills after the Flipped classroom module and that the course was effective. Only, the scores at 'Organization' did not show statistically significant.

The differences between the mean scores of pre-test and post-tests for 'Traditional classroom' were 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=35.9, SD=9.649) and post-test (M=66.2, SD=10.31). The increase in scores was statistically significant (mean±SD, 28.9±14.39; 95% confidence interval, 23.33 to 34.37, t=10.794, p>0.001). The differences between the mean scores of pre-test and post-tests for 'Flipped classroom' 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=33.69, SD=10.870) and post-test (M=71.1, SD=9.517). The increase in scores was statistically significant (mean±SD, 33.1±1.66; 95% confidence interval, 27.43 to 38.67, t=12.138, p>0.001). Across the 29 contents, coefficient alpha for the traditional classroom was 0.387 (Table 4). Coefficient alpha values for flipped classroom was 0.380.

Table 1. Students feeling about flipped classroom experience

Category	Inquiry courses						
Degree of satisfaction	Observation	Comprehension	Comparison	Organization	Reasoning	Application	Total
I am satisfied that Flip-U meet my learning needs	8	5	5	6	5	3	32
I am satisfied with Flip-U efficiency.	9	7	4	4	5	4	33
I am satisfied with Flip-U effectiveness.	3	3	4	6	8	5	29
I am satisfied with the Flip-U motivation.	5	6	5	6	4	10	36
I have improved my academic achievement	5	9	10	8	8	8	48

Table 2. Results of *t*-test and 95% confidence interval of the difference for paired samples (pretest-post test)

	Mean	SD	SE	Difference		*t*- value	Significance
				Lower	Upper		
Observation	3.567	1.813	0.331	2.890	4.244	10.773	***
Comprehension	4.067	2.449	0.447	3.152	4.981	9.097	***
Comparison	4.933	2.084	0.563	3.782	6.085	8.761	***
Organization	5.439	2.001	0.993	-0.031	4.031	2.045	NS
Reasoning	6.008	3.800	1.097	1.557	6.043	3.464	*
Application	3.833	1.744	0.318	3.182	4.484	12.042	***
Experience	4.667	2.006	0.366	3.918	5.416	12.744	***

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

Table 3. Students' response to the retro-pre-questionnaire before structured molecular biology examination skills training in university students

No.	Content	Traditional classroom		Flipped classroom	
		Before training	After training	Before training	After training
1	Introduction	-	-	-	-
2	Bacteria:	55	67	55	66
3	Basic Genetics	45	65	47	69
4	Required Reading	25	70	23	75
5	Duplication the DNA	36	68	35	71
6	Getting the Message Out	50	72	52	75
7	Proteins	40	81	44	85
8	Gene Transfer in Bacteria	33	80	32	85
9	Messing About with DNA	25	66	30	66
10	Products from Biotechnology	36	50	35	55
11	Genetic Organization in Higher Organisms	45	70	40	78
12	Mutations	24	55	22	55
13	Inherited Human Disease	25	55	24	65
14	Cancer and Aging	29	45	28	55
15	Down on the Farm	30	65	35	75
16	Techniques of Molecular Biology	36	60	36	67
17	PCR	24	85	22	83
18	Forensic Medicine and Molecular Biology	45	60	55	74
19	Gene Creatures Part I	30	69	33	77
20	Gene Creatures Part II	45	72	47	80
21	Biological Warfare	30	66	26	73
22	The Molecular Defense Initiative	35	70	36	70
23	Sequencing DNA	40	75	40	80
24	Molecular Evolution	33.3	55	35	65
25	Classification	30	42	29	40
26	A Brief History of Molecular Biology	45	65	45	68
27	Molecular Biology	46	83	47	85
28	What Was Said	40	66	38	70
29	DNA Gets Persona	30	65	35	75
30	Brush Up Your Chemistry	35	77	34	79

Table 4. Coefficient alpha reliability measurements and *t*-test for session instrument

Classroom	Tests	Mean	Correlation	*d*	*t*
Traditional classroom	Retrospective learning	35.9	0.250	0.387	10.794***
	Post-session learning	66.2			
Flipped classroom	Retrospective learning	36.6	0.277	0.380	12.138***
	Post-session learning	71.1			

***: Significance at the 0.1%.

DISCUSSION

Mounting pressure from increasing tuition costs and free, online course offerings is opening discussion and catalyzing change in the physical classroom. The flipped classroom is at the center of this discussion (Bishop & Verleger, 2013). Flipping the classroom establishes a framework that ensures students receive a personalized education tailored to their individual needs. The weakness of the traditional approach is that not all students come to class prepared to learn. For the better part of a decade, educators have been told to provide a personalized education for each student, and most educators believe that personalization is a positive goal to reach for each student (Sams & Bergmann, 2013). While the modern method relies on hands-on materials approach.

For a long time ago, the traditional teaching style or specifically, teacher-centered instruction has been dominant in higher education in the world. Traditional method relies mainly on textbooks. In a traditional classroom, students become passive learners, or rather just recipients of teachers' knowledge and wisdom (Ahmed, 2013). teaching method at the traditional teaching style is explanation. Lecturing is teaching, giving a speech, giving much understanding on many important subjects that were opened to the difficult multi-disciplinarity of molecular biology. Teachers are rewarded and recognised for how well their students do in examinations. Although the overall average was lower than flip learning, some students received good grades and had a learning effect (Table 4). Group of flipped classroom was 4.2 points (71.1-36.6=34.5, 66.2–35.9=30.3, 34.5–30.3=4.2) higher than group of traditional classroom. In traditional classroom learning, students did not learn at home. While, teachers should consider the time they invested in flip learning at home. In the traditional model, students would usually come into class confused about some of the homework problems from the previous night. However, some Korean students rarely study at home. They would then see new content at first for 45 or 50 minutes. In the flipped model, the time is completely restructured. Students need to ask warm-up activity (5 min.), Q&A time on video (10 min.), and watch video (30 min.) about the content. Nevertheless, flip learning can not be overemphasized by the fact that it is a good learning method in that it encourages students to study at home and obtain high scores.

Jung et al. (2017) reported flipped-class pedagogy enhanced the validated motivated strategies for observation, comprehension, comparison, reasoning, application, and experience except organization when applying a "Flipped classroom" design in evolutionary biology class. Lee and Huh (2017) reported that on the effects of flipped-class pedagogy on motivation and strategies for genetics shows that flipped-class session for traditional lecture sessions appeared to be sufficient to achieve changes in learning strategies of students toward deep-learning strategies.

In this study I implemented a modified and enhanced model of flipped classrooms for molecular biology classroom with a textbook. Students generally perceived the flipped classroom as a positive experience, and especially appreciated the benefits of viewing lectures on their own time and at their own pace.

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