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A Flipped Classroom Approach for Non-Science Majors

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***Abstract*—**To ensure student success in a non-majors biology course, a flipped classroom pedagogical approach was developed and implemented. All students were assigned online lectures to listen to before they come to class. A three hour lecture was split into one hour of online component, one hour of in class lecture and one hour of worksheets done by students in the classroom. This deviation from a traditional 3 hour in class lecture has resulted in increased student interest in science as well as better understanding of difficult scientific concepts. A pre and post survey was given to measure the interest in the subject and grades were used to measure the success rates. While the overall grade average did not change dramatically, students reported a much better appreciation of biology. Also, students overwhelmingly like the use of worksheets in class to help them understand the concepts. They liked the fact that they could listen to lectures at their own pace on line and even repeat if needed. The flipped classroom approach turned out to work really well our non-science majors and the author is ready to implement this in other classrooms.

***Keywords*—**Flipped classroom, non-science majors, pedagogy, technological pedagogical model.

I. Introduction

FLIPPED classroom approach has been used in classrooms all over the world. It has been dubbed as a buzz word in the last few years due to recent recognition given by main stream media, like articles in The New York Times and The Chronicle of Higher Education [1], [2]. Michael Fitzpatrick thinks that this trend will turn education on its head [1]. However, according to Dan Berrett, who reported that professors are eager to try this new technique in their classrooms later found out that it didn't really work for everyone [2]. That is true for any new pedagogical strategy. It is rare to find something that will work for everyone. The variables are several, subject and content matter, student body, student preparation level all can contribute to the fact that what works for one may not work for the rest.

Cynthia J. Brame in her article, "Flipping the Classroom" reports that before all this hype, the flipped classroom approach has been used and promoted by Barbara Walvoord and Virginia Johnson Anderson [3]. In their book Effective Grading written in 1998, Walyoord and Anderson [4] they propose a model in which the students get their first exposure to the course content before class and the synthesis, analysis and problem solving part happens in class. According to them, this process reduces the written feedback time which traditionally used to be in homework grading from instructor to student. It also increases the interaction in the classroom that is driven by synthesis and analysis of the content in classroom with the instructor in order to understand difficult concepts especially in the STEM fields.

Anderson and Krathwohl (2001) proposed nineteen cognitive process dimensions that represent an extension of Bloom's taxonomy [5]. The Cognitive Process dimensions integrate the knowledge dimensions to put forward a continuum of increasingly complex cognition structures from remembering to creating knowledge. This can be used carefully to make classroom assignments in such a fashion that it increases the student knowledge base by not just the factual memorization but conceptual increase of knowledge followed by increase in Meta-cognitive skills over the course of the semester.

In a study published by Koehler and Mishra (2006, 2009) they propose: The TPCK (Technological pedagogical, content knowledge) Model [6], [7]. According to their study, enhancing the combination of pedagogical content and technical knowledge of teachers in learning situations can make a big difference. The TPCK model separates three specific skills among teachers, linked to pedagogical- (PK), content- (CK) and technical knowledge (TK) in learning situations within given contexts. These three specific skills can be combined in various ways such as pedagogical and content knowledge (PCK), pedagogical and technical knowledge (PTK). These combinations are hard to develop and achieve however once achieved, their implementation can be really fruitful.

Armed with the knowledge gained from personal teaching experiences and these studies the author decided by trial and error to change the pedagogical strategy in her own non science major course, BI-110 - Principles of Biology. The course was taught traditionally when first assigned over five years ago, then, almost three years ago, it was enhanced by making it a partially online course. The author had to make immediate adjustments for students to maintain proper learning standards as our students are non-traditional students who come from diverse and sometimes disadvantageous educational backgrounds. One has to devise a plan that fits the needs of all students in the classroom. For most of them English is not their native language so the best thing about putting lectures online is that it gives a chance for nonnative speakers to listen to lectures slowly at their own pace so that they can understand better.

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The Knowledge Dimension	The Cognitive Process Dimension					
	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	Terminology, definitions & facts	Worksheets	Examples, experiments	Results & Questions		
Conceptual	Diagrams	Seminars offered	Concept Videos	Charts & Graphs	Critique Online Videos	Make Poster for presentation
Metacognitive						• Presentations at Science Day (optional) • Discussion Board (Weekly)

Fig. 1 The tweaked Anderson and Krathwol Taxon [5] used for BI-110 course

II. Pedagogical Strategies Implemented

As a consciences educator one is constantly looking for ways to enhance their classroom. The author over the years tired several proven pedagogical strategies to improve her curriculum delivery techniques. Two of them are discussed below as implemented in BI-110 non science major course.

A. Implementation of Anderson and Krathwol Taxon

Bloom's taxonomy is well known for how the cognitive dimension works in the education world, however, Anderson and Krathwol [5] added the knowledge dimension to it. Both of these concepts were taken into account when designing the course delivery. As Fig. 1 above indicates, the factual knowledge part comes from remembering the new terminology, definitions and facts in the course; however the next step is to help students understand the concepts which were done using weekly worksheets. The second meeting each week, students would be given worksheets developed by the author. These pertain information that goes from basic definitions to understanding the concepts in sequence or how they occur in nature so that the students can make connections.

The application of information learned was done by giving specific examples that impact student's everyday lives from articles they read in newspapers and magazines to news they listen to on television. Examples also included advertisements they listen to in order for them to buy certain products. Later in the semester as the knowledge base increased, students were given examples from the working of pain medication to the cigarette patches. The semester ended by students analyzing data of doing DNA fingerprint analysis of who has committed the crime to the rape suspect and who the father is. These are examples they see on television and material they are exposed to everyday, now it is time for them to understand the science behind that. By giving relevant examples and discussing through worksheets in class, the classroom dynamics changes considerably.

At conceptual level students were able to remember the scientific concepts through diagrams as they were given in worksheets and later asked in exams as well. Students were able to understand what they learned by attending seminars and workshops offered during club hours during the semester. Although some of the information might be higher than their level of understanding, they were happy to understand whatever they could at their level of exposure to scientific concepts. Students were required to watch content related videos and animations each week and post them on discussion board. Then they were required to comment on these videos and what they learned and critique the videos. This discussion board medium exposure leads to a meta cognitive knowledge dimension as well.

Students were also given an option to participate in a service learning project on "I Love Science Day". Students were given a choice to research on a particular animal (Ex. Boa Snakes, Lizards, Python, Turtles etc.) or DNA which were to be brought to the Science Day (with the help of our department technicians). Students were to work in groups of two that taught collaboration skills, they were supposed to demonstrate the information they learnt on a poster that will be on display for local high school and middle school students. This takes learning to a whole new level. Students might forget what they have learned in a classroom right after their finals however, the information they gathered in making a poster and then presenting to a bunch of students a few times is the information they will remember for a long time after they graduate from the course. Some of them were so enthusiastic that they ended up making paper pamphlets for middle and high school students to take home with them.

B. Implementation of Koehler and Mishra's [6], [7] TPCK Model

This model is more for the educator when planning a course delivery mechanism for the class. Most of the educators are PhDs in their field and therefore have mastered the content of the course. Some of them either have the technological savvy already, if not, it can be easily learned these days from several faculty development workshops available. For the author, she has been using the Blackboard Content Management System that City University of New York offers to students and faculty for over a decade. Therefore, it was a natural extension that when the eLearning workshops were offered by Queensborough Office of Academic Computing Center, she took the opportunity to develop online courses that were to be offered as Partially Online (PNET). Then it took a few semesters to try and tweak that so that it works the best for our diverse student body. Once all the mechanics were logistically in place, now comes time to try the pedagogical knowledge gained over the years or learnt through literature from other colleagues that you get to implement some of those strategies into your course.

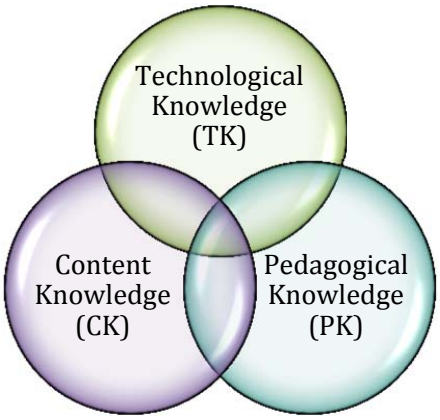

Fig. 2 TPCK Model modified from Koehler and Mishra

For author's BI-110 PNET sections, Content Knowledge (CK) was developed over last five years when the special section of BI-110 PNET was first offered in a traditional classroom setting. A year later, after taking the eLearning workshop, the Technological Knowledge (TK) was developed and implemented. It later took almost two semesters to make sure that they Blackboard site is perfected and all the bells and whistles are added to make the content more attractive to students and to create a so called "web presence". Once all that was in place, now it was time to use the Pedagogical knowledge (PK). For that the author developed a Flipped Classroom approach. Now that the lectures were being listened by the students online and one class period was used to deliver the critical content and concepts in person, it was time to develop the worksheets for each lesson. These worksheets will be used for one class section each week to drive all the important points of each chapter/topic home. This will ensure that students really understand the content and how it relates to the rest of the world that they live in.

Worksheets were designed as fill in the blanks or short answers. Some of them also included problem solving like that in Mendelian Genetics or making predictions of traits being transferred to the next generation. Some of them also included diagrams to label and list the functions or organelles in a cell system while others included DNA fingerprinting analysis to figure out the father of a child or who committed the crime from DNA samples analyzed from a crime scene. This really made the students enthusiastic learners; they never missed that worksheet session because it provided a review of the chapter for some and learning experience for all the students. All of them were given an opportunity to answer the questions so they all participated actively. They were eager to jot down the answers even if they didn't know the answer. Most of time, students were given an opportunity to come on the blackboard and solve the problem. This increased their confidence level. Their classmates were encouraged to help them out if they couldn't figure out how to solve the problem. They were provided tools to solve the problems step by step so that there is no mystery in how the problem is solved.

Flipping the classroom with worksheets is much better approach than assigning homework and just grading and giving a written feedback, this way, you don't know if the weak students actually went over your feedback and understood what they were doing wrong. It is a little easier to provide the feedback when the entire class is trying to solve a problem together in person. Of course, there are no guarantees that all of the students still understood the content being taught.

III. Pre & Post Classroom Survey Results

A. Pre Course Survey Results

Students were given a brief ten question survey on the first day of class. It was a general survey trying to understand what they think of biology and how it relates to everyday life, whether they like a science class or registered just because they had to complete a science course as part of graduation requirement. It also asked if they knew they were registering for a partially online class and if they thought that an online course would be easier than a regular course because they have to spend one less hour in class. The results are from 50 students and two sections of the course. Most of the students didn't have a good science experience in high school before and thought that the course would be hard for them. While most of them had a positive attitude that biology does indeed help and enhance their daily lives and the environment. Nearly 30% of the class didn't even know that they had registered for a partially online class which creates a huge challenge as these students are not prepared or might be technologically savvy to handle the online component of the course. However, most of them did promise that they will make every effort to understand the contents of the course.

B. Post Course Survey Results

Students were given a brief survey at the end of the course. It repeated some of the questions asked earlier from them to see if their attitude towards a science course and biology has changed and indeed it had. It was more positive.

Most of the students answered that they like biology now and understand better how it impacts their lives and helps makes their lives and its surroundings better. They all agreed that indeed scientific progress makes their lives and environment healthier.

Another important result from the survey was the pedagogical and technological component of the course, all students liked the online learning environment and the fact that they can listen to the lectures multiple times and at their own pace. All of them also liked the worksheets done in class and that it help them understand the content of the course better. Most of them didn't think that the class was easy because it was partially online. Rather some of them commented that they really like the fact that the course content was highly organized and it helped them stay disciplined all semester.

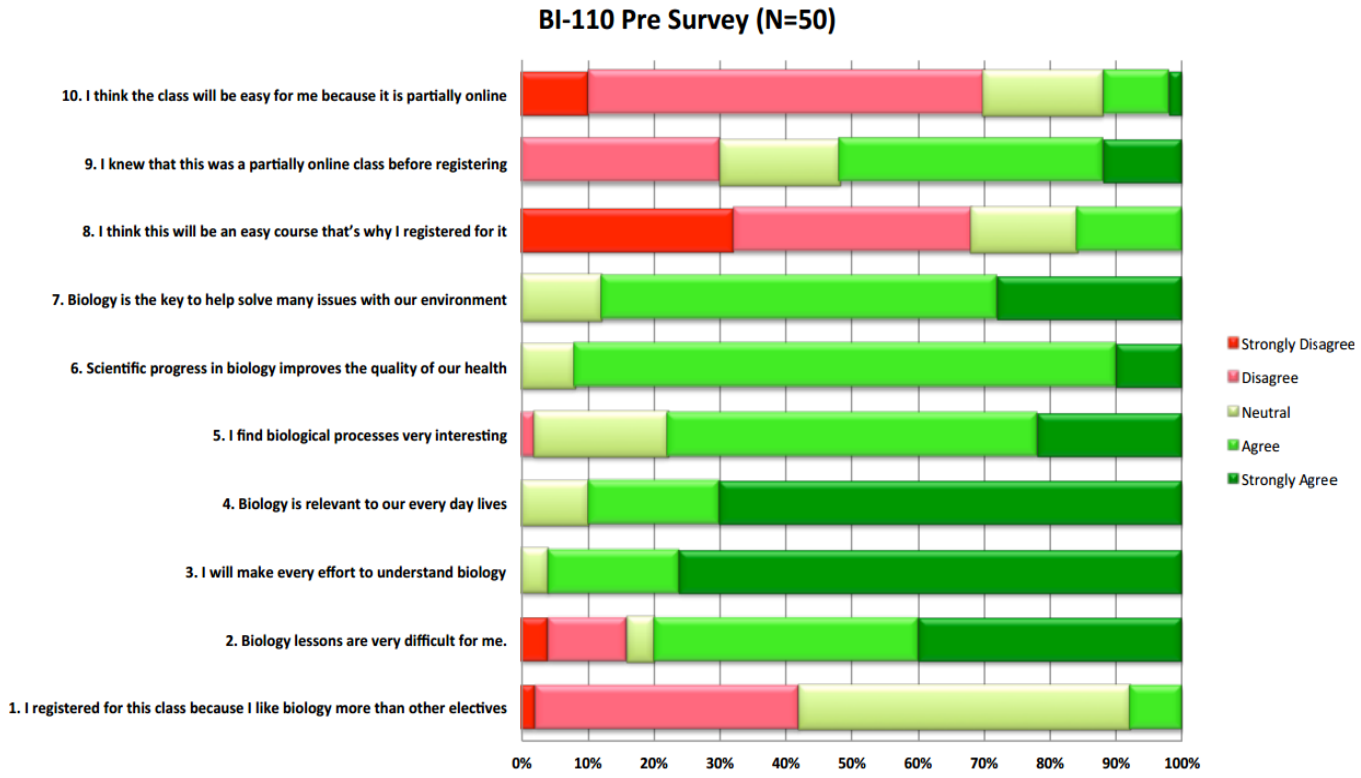

Fig. 3 Anonymous Pre Survey given to BI-110 students first day of class

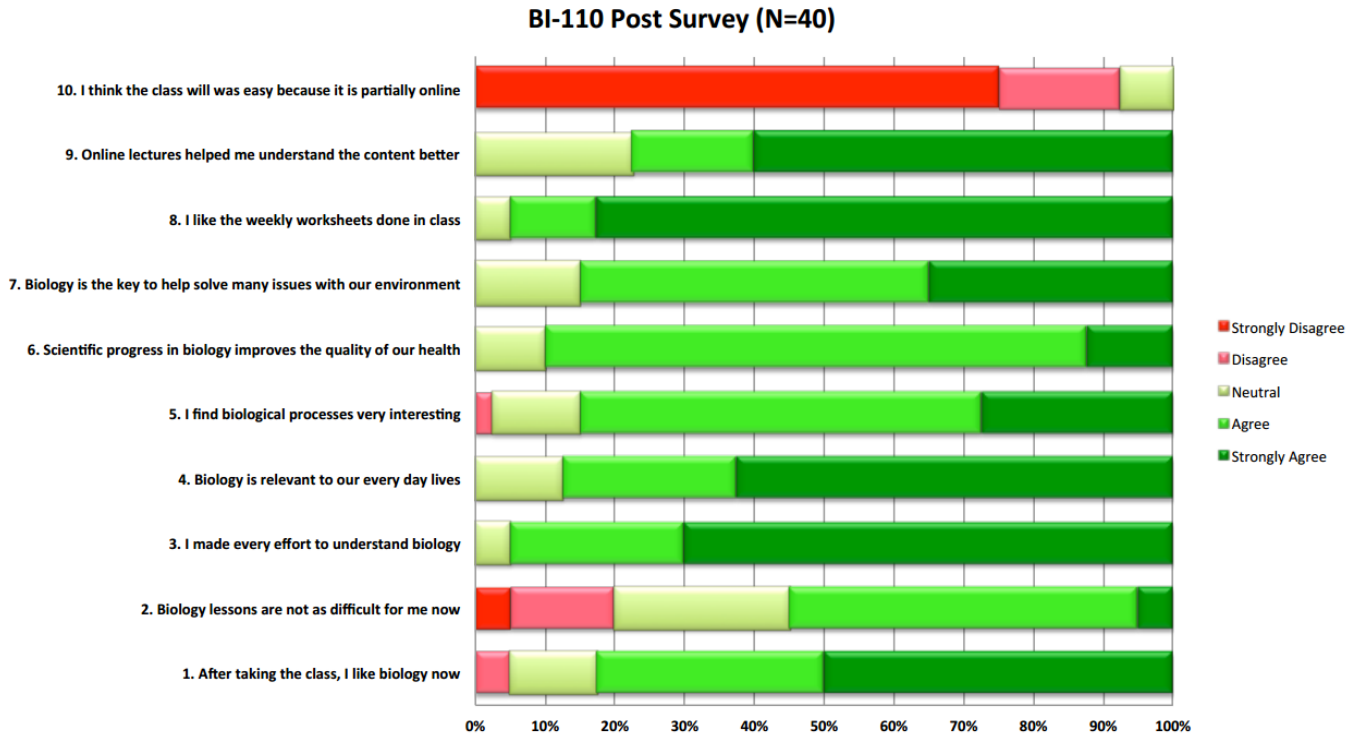

Fig. 4 Anonymous Post Survey given to BI-110 students last day of class

IV. Conclusion

The results gathered from the students clearly indicate that students like the online component. It gives them the freedom of listening to the lectures at their own pace and for non-native English speakers they can do so multiple times in order to understand the concepts better. Most of the students agree or strongly agree that the course helped them not only understand the content of the course better, but it also increased their

appreciation of biology. Some of the feedback received from the students was that negative experiences in the past had left them scared from science courses. However, the interactive nature of the course format broke the barriers of a traditional classroom and increased the interest in science. From a pedagogical perspective, the content knowledge is there already, however mixing the technological knowledge with the online component (Ex. Weekly discussion board etc.) and pedagogical knowledge (Ex. Flipped classroom approach of creating weekly in class worksheets) the classroom dynamics change. Irrespective of whether student grades improve or not, students report self-awareness of remembering the content of the course better and making connections of what they learned in the classroom and how that impacts their daily lives better. This is an ideal outcome of a non-science major biology course. We start the first chapter by saying to the students, you are in this course because you will have a college degree and you should be informed citizens so that you can make better decisions in your daily lives. As an educator, that aspect of teaching is satisfied when you know that what you set out to do has been accomplished, if not for all students, but for most.

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