

The Role of The Flipped Classroom to Enhance User Experience in Cells and Molecules Course Junior-Levelled Students At The American University Of Science and Technology–Achraiyeh Campus

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Abstract – Flipped classroom was performed on 133 students in “Cells and Molecules” course on junior leveled students at the American University of Science and Technology (AUST) – Achrafiyeh Campus. This study is one of the pioneering quantitative studies assessing the impact of flipping classroom on students in Lebanon. The aim of this study is to test if the flipped classroom was to challenge, motivate, engage students in their learning process, and use class time in a more effective way. The data collected in the pre and post questionnaires was the basis for evaluating students’ reaction towards their traditional class verses the newly introduced flipped module. The results of the study are encouraging; comprehension, enthusiasm reflected through participation and collaboration and class time effectiveness for both instructor and student. The impact of the flipping on students’ performance was evaluated through a post exam in which their average increased by 13 points, and students were able to elaborate their answers. The outcomes of this study are encouraging and pave the road for future researchers on education on the Lebanese educational system.

Keywords – Flipped Classroom, 21st Century Skills, Students-Centered, Blending Learning, ICT, Educational Technology.

I. INTRODUCTION

Technology is advancing at a very fast pace it is now a primary tool in our social and professional lives. The majority of people spends most of their time using some kind of technology and has proved its crucial effects on our lives. Even though education was the least sector affected by technology, the technology impact came out to be positive [1]. Yet some teaching facilities have started using technology based tools in their classrooms to decrease the gap between students’ life style and apply the 21st century skills - creativity, innovation, communication, collaboration, critical thinking, problem solving, and decision making [2] - in their learning-teaching process. Technology has improved education on many levels one of which is making knowledge available and easily accessed online anytime and anywhere. This revolutionary action of using new technology based tools simulates real life experiences, makes the students the center of the learning process, involves the students by personalizing their learning experience, and motivates them by making the learning process and material more enjoyable, thus the material is more comprehensible [3].

A) Statement of the Problem

The situation in Lebanon is similar to that in some Arab countries; the use of technology in the educational sector is still limited. Mary Burns reported “Lebanon’s overall educational technology or ‘Information Communication Technology (ICT) in education’ efforts may best be categorized within the emerging category of nations in terms of the overall educational technology efforts” [4]. Moreover, the plan for implementing ICT in the Lebanese educational process is not properly controlled, yet still some facilities are keen on improving their system and have started using ICT according to their personal vision and efforts [5].

The Faculty of Health Sciences at the American University of Science and Technology (AUST) became aware of the existing gap between students’ lifestyle and educational approach as well as the importance of using technology in classrooms. In the recent years, AUST started using multimedia presentations in the form of “PowerPoint” and videos in all of its classes. This study aims to add more technology in the classrooms to facilitate students learning in the faculty of Sciences. An interview was done with the doctor of the “Cell and Molecule” course to collect some data about the course; content and learning methods, and to check the difficulties she faces with her students in this course. After collecting the information an observation was performed during sixteen hours in the classroom. The observation aims to detect students’ attitude towards the learning environment, determine if the class is instructor or student centered, and evaluate the interaction between students amongst each other and their instructor.

Upon analyzing the behaviors and circumstances surrounding the observation done, the drawbacks of the teaching method in use were defined as well as its impact on students’ behaviors, engagement and attitude towards their learning process. The aim of this analysis is to determine a substitute method to remedy the weaknesses and improve the quality of learning inside and outside the classroom. In the following sections, the problems are stated, analyzed and a solution will be proposed.

The summary of the interview and observation were the following. Students were not involved with the instructor because the general atmosphere of the class was dull and passive. The instructor was the only active person in class; explaining, asking questions and answering them. This deprived students of numerous educational experiences and skills. Students didn’t prepare at home and this wastes instructor’s time and consequently slows the learning

process. They showed no collaboration or interaction with the material presented and they were distracted with their cellular phones and side talks.

Then a pre-questionnaire was distributed to the students under study (Table I). The purpose of it was to pull together students' perception of the class environment and their opinion on the level of technology used. The pre questionnaire showed that despite the minimal use of interactive multimedia presentations during explaining the lessons, students were not motivated nor engaged with it and the instructor was still the center of the learning-teaching process. Lectures are dominant in the classroom thus there is no interactivity inside the classroom. Students consider the course as a difficult one, and they are not able to answering correctly and accurately in the exams. Lastly, they affirmed the need to add more technology and are keen to try new methods.

Table I: Pre questionnaire results

| | Strongly Agree | Agree | Neither-Nor | Disagree | Strongly Disagree |
|---|----------------|-------|-------------|----------|-------------------|
| | % | % | % | % | % |
| Do you find the course interesting? | 48.5 | 45.5 | 3.0 | 3.0 | 0 |
| Do you find the course difficult? | 3.0 | 51.5 | 27.3 | 12.1 | 6.1 |
| Do you find the class is active? | 18.2 | 48.5 | 21.2 | 12.1 | 0 |
| Do you participate in class discussion? | 18.2 | 42.4 | 21.2 | 15.2 | 3.0 |
| Do you have interactive presentation in class? | 15.2 | 36.4 | 15.2 | 30.3 | 3.0 |
| Does the instructor use lectures to explain the content most of the time? | 72.7 | 18.2 | 6.1 | 3.0 | 0 |

After studying data collected through the interview, observation and post questionnaire, the flipped classroom might be a potential for a suitable alternative teaching method to solve the observed problems. Flipped classroom is based on blending of digital and class based learning which stresses on the importance of acquired fundamental concepts prior to class. It is a new pedagogical approach which allows students to study according to his/her pace, and creates an active class environment where the students is the center of the class while the educators guides and facilitates the knowledge exchange. Also, flipped classroom method stresses on the importance of acquired fundamental concepts prior to class. It also creates opportunities for students to share newly learned concepts with their colleagues in class discussions. This helps evaluate and improve students understanding and instill in them the desire to learn more (Table II).

Table II: Students perception on adding technology

| | Yes | No |
|--|------|------|
| | % | % |
| Do you think adding more technology in class will make it better place to learn? | 78.8 | 21.2 |
| Do you prefer having digital format for the material you are studying? | 72.7 | 27.3 |
| Do you like to interact more with the material given in the course? | 90.9 | 9.1 |
| Do you prefer if you study at your own pace? | 57.6 | 42.4 |
| Do you know what a flipped classroom is? | 9.4 | 90.6 |
| Do you like to experience it? | 85.7 | 14.3 |

B) Research Question

This study will assess the impact of implementing a flipped classroom model in “Cell and Molecules” course. The following are the leading questions for this study:

- 1- Does the Flipped classroom model engage and motivate students?
- 2- Does the Flipped classroom model in Cells and Molecules course make the learning process (understanding) easier?
- 3- What are the students' feelings towards the integration of technology in Cells and Molecules course? How will this class model affect the instructor's efficiency during class and his time management?

C) Hypotheses

- H1. Flipped classroom engages and motivates students in class.
- H2. If flipped classroom is used in Cells and Molecules Class, then students will prepare prior to class time and thus increase their achievements.
- H3. Students have positive attitude towards the integration of flipped classroom model at class.
- H4. The instructor teaches more effectively during class and has more time to focus on her new roles as a director and facilitator of information exchange rather than as a information provider.

II. LITERATURE REVIEW

The “Flipped classroom where it is also known as the reverse, inverse, or backwards classroom where students gain first exposure to new material outside of class, usually via reading or lecture videos, and then class time is used to do the harder work of assimilating that knowledge through strategies such as problem-solving, discussion or debates” [6]. Flipped classroom is based on blending of digital and class based learning which stresses on the importance of acquired fundamental concepts prior to

class. It is a new pedagogical approach which allows students to study according to his/her pace, and creates an active class environment where the students is the center of the class while the educators guides and facilitates the knowledge exchange. Also, flipped classroom method stresses on the importance of acquired fundamental concepts prior to class. It also creates opportunities for students to share newly learned concepts with their colleagues in class discussions. This helps evaluate and improve students understanding and instill in them the desire to learn more [7].

This method is flexible when student study the prepared material at home, they have the chance to pause, repeat and check it again several times, and consequently fast and slow learners will have the opportunity to excel the material [8]. This way class time is dedicated to encouraging student-center activities such as collaboration and problem solving learning experience. The flipped classroom gives the instructor the time to engage a wide range of learning styles and implement pedagogies that encourage higher learning activities [9]. By using the flipped classroom method, the students will have a new class experience different than the one currently implemented. Unlike the flipped classroom, the traditional pedagogic method in use depends on “lecturing, note taking and memorizing information for later recognition or reproduction” [10].

Several Studies were done on the effect of using the flipped classroom method, the outcome of the studies included a listing of the advantages of using this method, below is a description of the main advantages backed up with case studies done by different researchers.

A) *Flexible Studying Pace*

The limited cognitive varies from student to another, yet traditional classes do not take that into consideration, the teacher in a traditional class has a limited time to deliver a specified amount of information to students regardless of their response or engagement to the content. On the other hand, a flipped class method allows the students to take all the time they need to understand the material. The lecture is available online and each student can study and control the pace of information flow based on his comprehension. Fast learners might finish the material in minutes while slow learners can take hours to establish the same level of comprehension. The main advantage of this is keeping students interested in material unlike traditional classes where fast learners might get bored and slow students might not be capable to follow up. This is effective because it gives students more control on their time; they are capable now of putting their own studying schedule in accordance with their social and academic needs. Moreover even if students miss a class the material is present online and they can follow up with their colleagues at any time [11].

B) *Customized Content*

The three learning styles, the auditory, the visual, and the Kinesthetic Learners targeted by the flipped classroom. The material uploaded online can be in the form of PowerPoint slides, video, podcast or interactive material. The teacher decides on the type of material prepared

according to the objectives and requirements of the content. For example scientific subjects favor the use of simulated visual tools rather than auditory due to the nature of the material which is better comprehended and absorbed when seen and practiced. On the other hand history teachers prefer podcasts since this enables students to follow the sequence of events [11], [12]. Moreover, educators can make use of this online application by updating it constantly without the need to inform or stop the students learning process.

C) *Familiarity with the Material*

When using a flipped class method the student sees the material for the first time at home, he/she is free to take as much time as he/she needs to understand and absorb the new information; when students are involved in the active learning. Active learning is when “learning occurs when people engage in appropriate cognitive processing during learning, such as attending to relevant material, organizing the material into a coherent structure and integrating it with what they already know”[13]. During class time both slow and fast learners are familiar with the material and can participate in class discussions without compromising one another’s pace. The time spent at studying becomes more effective and not limited to the interval spent at the educational institution only. Students can now study anytime and anywhere making their learning a life style that they can benefit from in their future. Consequently, class time is dedicated for activities and discussions. This aids students to build social as well as educational skills. The collaboration, rising competition and need to present ones ideas clearly are utilized in making students motivated to learn more to prove and defend their ideas. Students are more actively involved in the learning process. Moreover this teaches students how to team up to reach a certain goal and allows the rise of critical questions due to the increased engagement and understanding of material. All these procedures the flipped class method introduces, helps shape the 21st century essential skills. This not only enhances the students’ performance but also the teacher becomes more efficient and can spend more time focusing on detecting weaknesses of his/her students and addressing these weak points more efficiently, “Students normally perform better when teachers can explain clearly and keep their interest with the class. Multimedia is a powerful tool that can assist teachers in attaining this goal” [14]. As a result, class time is more effective and a good environment that invokes creative ideas and creative learning [11], [12], [15].

D) *Pitfalls of the Flipped Classroom*

The flipped classroom method if not implemented properly will induce negative outcomes. The possible pitfalls of flipped class were gathered based on some previous researches and observations performed. The flipped classroom method is a new and not widely spread in the Middle East area, and thus there exists a risk that students may resist it. To avoid this problem the instructor should be aware of this issue and stay keen on making students watch the prepared videos. There exists multiple ways to make students watch the material one of which is

giving homework at the end of each video, slide, or content available online thus students will have to watch the video in order to solve the homework. Another way is doing class quizzes on the material studied at home; the quiz should be performed at the beginning of the class time. Consequently, students will get used to the online tools and will adapt to the requirements of the flipped class [11].

Instructors should also be aware that not all the material can be flipped, and should be able to choose which material to flip and which not. If flipped teaching was used on inadequate material the outcome will not be appreciated. The teacher should be capable of preparing student oriented slides based on the material requirement [11].

Davies, Dean and Ball (2013) stated that the process of changing from a traditional classroom to a flipped classroom could be challenging because of a lack of facilities, Internet accessibility and effective models. It is important to help students learn and develop their learning skills using innovative methods of instruction [16].

As shown in the literature section, many experiments were conducted to prove the positive effect of using the flipped classroom on the students' achievements and its conformity with the concepts of main learning theories and have proven to be successful if implemented properly. The new trend in education is the flipped class based on blending of digital and class base learning.

E) *Flipped Classroom Case studies*

Despite the fact that the first flipped class method was used by a chemistry teacher [17], the flipped classroom module has long been used in non-science courses, but the recent expansion of video and Internet capabilities has led to a renewed interest in this flipped format in science, technology, engineering, and mathematics courses [18]. Many studies have been conducted to evaluate the educational impact of flipped classroom model and stated that if flipped classroom was implemented properly, it has the potential to revolutionize the students learning [19] Flipped Learning is being used in higher education as shown in some research and seems to be resulting in improved performance and better student-instructor interaction.

Papadopoulos and Roman 2010 did a research on students in an electrical engineering class. They implemented the flipped classroom by making lectures available online for students to watch and prepare at home then they worked on discussing the material and solving more exercises class time. The implementation of the flipped classroom divided into 3 stages. Stage I was uploading a 10 to 15 pages power point presentation at least 48 hours prior to the class. The preparation time for this slide was approximately 15- 20 min. These slides were designed to promote critical and active thinking and contain exercises for students to test their knowledge.

The exercises that accompany the modules were designed to be interactive, provide feedback, and require about 5-10 minutes each.

Stage II was during class time, the instructor highlighted the main parts of the power point presentation and posed

on questions that were asked in the PowerPoint exercise. The instructor then asked questions and gave the students time to solve these questions. The instructor then moved between students to check if someone needed help and made sure every student attempted to solve the asked question.

Stage III was the problem-solving session; this was an optional session, where students had the chance to solve the homework with the instructor. They could work alone or within a group.

The results of the implementation showed that students were able to finish the content faster and with deeper understanding of the material covered. Students said they helped their colleagues while learning. Moreover, test scores showed improvements over traditional learning environment [20].

(Chippis, 2012) and (Redmond, 2014), executed their own experiments to assess the impact of flipped class module on students' comprehension and academic performance. They also stated similar results to what Redmond 2014. The researched focused on students' feedback on the flipped class experiment and did interviews with many students who took part of this tryout. Students appreciated this new method; they stated that in flipped classroom they were able to better understand hard concepts when visual tools were used. Moreover, they felt responsible for their learning and prepared more at home, because they realized that if they don't they will not be able to participate in class discussions.

Another study was done on first year graduate students at the Indiana University School of Medicine in the spring of 2013, to assess the effectiveness of a traditional lecture-based curriculum versus flipped classroom model in cardiovascular, respiratory, and renal physiology.

The students were divided into two groups, the control group who got the traditional lecture system and experimental group, which had the flipped class module. Both the control group and the flipped classroom group were given the same notes and objectives. They all had access to same-recorded lectures yet these recorded lectures were not obligatory to watch for the control group unlike the second group. The flipped classroom group was asked to watch the recorded videos prior to the class time, and they did quizzes or homework on the prepared material, followed by a question and answer problem-solving period. The attendance in the control group was optional and there were no quizzes or assignments. Finally, both groups were given the same multiple-choice exam. The Flipped classroom students performed significantly higher than the control group. The flipped classroom method improved students' performance in cardiovascular, respiratory, and renal physiology. A survey was conducted on students of the flipped classroom group to ask them why they think they have performed better than the other group. The students said that the quizzes, and the class problem-solving periods made them more active in class, eager to participate and made them cooperate and brain storm together in order to reach the correct answer. Consequently they started preparing more

at home and thus engaged them in the class content thus improving their performance (Tune, Sturek, & Basile, 2013).

The flipped classroom method is still novel especially in our society thus it is important at this point to test the actual effectiveness of the flipped classroom once adapted to our culture, educational system and implemented on Lebanon-based students. This will help us decide if it is serving the purposes anticipated and stated in many western studies. This study is a pioneering study, which evaluates the effects of implementing the flipped classroom method on Lebanese based education. Till this moment no study has been found on this issue, thus the value of this action is in giving researchers data to base their studies on.

III. METHODOLOGY

This study is a quantitative study; the aim of it is to show the effect of the flipped method on classroom experience and students' academic achievements. It focuses on detecting the feasibility of applying the flipping method on "Cells and Molecules" students. The aim of this study is to challenge, motivate, engage students in their learning process, and use class time in a more effective way.

This study was performed in academic year 2013-2014 on 2 different sections (A, B); section "A" is the control group and section "B" is the section under study. Sample population of the two sections is 133 students; 67 in section "A" (control group) and 66 students in section "B" (examine the flipped classroom). Their ages varied between 18 and 22 years and registered in the course of "Cells and Molecules". This course is a prerequisite for students enrolled in junior year of "Clinical Laboratory Sciences" and "Forensic Sciences" majors.

The doctor of the course mentioned in the interview that the students' grade in this section "The Role of COPI and COPII" usually is low due to many factors mainly that the COPI and COPII concept is complicated for the students as she has noticed from the previous semesters. Although in previous years the instructor repeats this part several times, but still students gets low grade. The average of the student's decreases, as the material covered in this course gets harder.

The chosen material to be subject of the experiment was "The role of COPI and COPII". This material was picked due to its importance in the course, contained sequential steps and several major concepts. Due to that, the researcher designed 2-D animated interactive application to allow students visualize the consequence of the concept process. The COPI & COPII interactive application design process took over 45 days to study the content and divide it into sections. Four important criteria's were taken into consideration while designing the application. The four criteria's that directed the production of this COP I & COPII Interactive application were attractiveness, familiarizing the subject of study, development of confidence in material learned and invoke satisfaction.

All vectors were drawn and colored using Adobe Illustrator CS6 included the cells, molecules and other parts which help the COPI and COPII mechanism. The layout was designed using Adobe Illustrator CS6 and the location of each section was specified in the design stage. The font used for titles in the COP I & COPII Interactive application is: Helvetica-Bold, color CMYK (0,0,0,80) text size 16pt. Helvetica-Regular was used for the body text, color CMYK (0,0,0,80). While the text size of the body is 13pt. Then the vectors of the cells were animated using Adobe Flash CS6 and was developed using Action Script 2 (AS2). The COP I & COPII Interactive application was equipped with an online tracker to collect data on the number of times it was visited.

Learning theories are used in production of the COPI & COPII interactive application and are the guidelines. The application was designed in a way that at the end of each section, students have to answer question/s that covers the main important points studied, and he/she will receive feedback on the answer given. The feedback questions at the end of each section were created using action buttons. The questions and their feedback ensure the behavioral engagement of students. It evaluates students understanding of the material studied and is a self-assessment tool for student to know if he/she needs to repeat the material or move on. Moreover, these questions give explanatory feedback that will guide students to give correct answers the next time. If student follow the process as expected, by the time he finishes the section he/she would have mastered the material. The need for practice and feedback available in the COPI and COPII interactive application comply with the concepts of behaviorism, where students are rewards and move to the next level. This generates results similar to the Drill and Practice exercises in which learners get continues feedback and get rewarded for a correct answer [22], [23], [24]. Also, the presence of text, multimedia, complies with the concepts of constructivism. The constructivism stresses on engaging students in the learning process, and considers learning is the procedure of cumulating information. Technology can assist realize the purpose of constructivism in classes and helps students in constructing their own education based on what they already know [25], [26], [27]. "Effective e-Learning comes from using Information Communication Technology (ICT) to broaden educational opportunity and help students develop the skills they need to thrive in the 21st century" [3].

The COPI & COPII interactive application used second person tone, an informal language to familiarize the material studied for students. This is very important to strengthen and maintain the engagement developed at first encounter with the application. The material selected is related to human body, mechanism of the cells, and students are expected to relate to it once introduced in an easier language.

It is very important to develop an attractive a user-friendly application. The first impression will grasp the attention and interest of the learner and will encourage him to be more engaged with the material. Thus the layout was designed to be stable, simple and clear throughout the

application, for example the navigation bar is in the same place and easy to notice on every page.

The interface of the application includes the set of objectives covered by the application. When the student presses the next button, an introductory tour is initiated and explains the different sections of the application. When the next button is pressed again, the main menu will appear and the student can select the section he/she wants to study. Each section contains multiple videos to cover the information needed. Each video is preceded by highlighted text of the material to be explained and some videos are followed by obligatory instructions that the student has to perform in order to proceed. The division of information into small chunks is primarily to not overload the cognitive of students'.

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Through this application, students are not only learning something new, they are also practicing and have the freedom to repeat until they feel confident and satisfied with the things they learned. When they follow the instructions required, students are no longer passive learners they become involved in the learning process and satisfied with their learning achievements done on their own.

The application was uploaded before initiating the experiment to test if it is properly functioning on the following link [http:// goo.gl/sUo7Y0](http://goo.gl/sUo7Y0). The performance of the COPI & COPII interactive application was satisfactory and no errors were found. The instructor then introduced the flipped class method to section "B" students and asked students to check their online system for the application link, to study the material required prior to the next session. She also asked them to prepare a creative question and be ready for a quiz. Section "A" students continue studying the usual way they usually do.

IV. RESULTS

The quantitative analysis encompasses the pre-questionnaire, the quiz, the post-questionnaire and the Exam. The probability uncertainty for all tests of statistical significance for the study was set at $p < 0.05$.

A) Online Analysis

During the 48 hours period the tracker recorded 50 visits from different IP addresses, and 14 visits from the AUST IP address tracked through the link assigned for the students.

B) During Class Analysis

In section "A" (control group) the instructor started explaining the lesson. She was able to finish the concept of the COPI and COPII mechanism over one session and a half; around 75 minutes. She started the second session by questions to make students re-explain what was covered over the first session; however she didn't find any of the

students willing to explain or to answer the question. Thus she had to review some concepts to make sure students can follow up with the coming materials. More than 90% of the time was spent lecturing and minimal interaction was done with the students. The instructor asked if the students have any questions, only one student asked a question and the instructor answered her. The last 15 minutes were dedicated to the quiz to test the students understanding on the concepts that was covered, the results of the quiz was the following:

- (44%) 30 students answered the quiz correctly.
- (43%) 29 students were able to answer half the quiz correctly.
- (9%) 6 submitted a white paper.
- (3%) 2 were absent.

In Section "B" (flipped classroom section), the instructor asked students their opinion about the application and asked them to present their questions as agreed. Few students came up with creative questions that were directed by the instructor to other colleagues, which initiated a discussion amongst the few interacting students. The instructor then gave them the assigned quiz and the results are as follows:

- (57.5%) 38 students answered the quiz correctly.
- (32%) 21 students were able to answer half the quiz correctly.
- (4.5%) 3 submitted a white paper.
- (6%) 4 were absent (Table III).

Table III: Quiz results

| | All Correct | Half Correct | White Paper | Absent |
|-----------|-------------|--------------|-------------|--------|
| Section A | 44% | 43% | 9% | 3% |
| Section B | 57.5% | 32% | 4.5% | 6% |

A post questionnaire was distributed to students in section "B" after the class discussion where students were asked to give their feedback on the class experience and if they would like to enroll in another course implementing the flipped class module.

During the session after the students had the COPI and COPII interactive application, the class time was divided as following: Ten minutes teacher spent on taking attendance and stating class objectives, 20 minutes students spent collaborating and discussing the COPI and COPII interactive application content with their colleagues where the Instructor guided the class. The next 15 minutes was dedicated for the quiz to ensure the students understanding. Finally, ten minutes were remaining from the original 50 minutes of the session where she used that time to add extra information. This shows that the flipped classroom was able to save the instructor time, and students were able to repeat the material on their own pace.

Students in section "B" (flipped classroom section) results were better than that in section "A" (control group) on many levels, time, interaction, Quiz and Exam results, and performance. In section "B" the instructor only spent 35 minutes to make sure that students have acquired the knowledge where in section "A" instructor took more than 75 minutes to explain the material. Students in section "B"

collaborated and interacting with each other's where in section "A" students were taking notes and listening to the class lecture. The control group section "A" students had the two sessions to finish the material and after the second session they did the quiz. While students section "B" directly did the quiz in the same session of the discussion. The class discussion and students interaction with each other's and with the instructor might be the factor why the students had higher percentage of passing students or because the students were able to be repeated as they needed.

During the Exam, student again were asked about the material of COPI and COPII, the results of the Exam was the following (Table IV).

Table IV: Class time distribution

| | Class Objectives | Lecture | Class Discussion | Quiz | Extra Time |
|-----------|------------------|---------|------------------|--------|------------|
| Section A | 10 min | 75 min | 5 min | 15 min | 0 min |
| Section B | 10 min | 0 min | 20 min | 15 min | 5 min |

C) Exam Analysis

The quiz was designed to test the level of students understanding to the covered concepts the following results were conducted.

The students in section "A" results were the following, 49% (33) of the students answered both questions correctly, 40% (27) failed the exam and 10% (7) of the students were absent. The flipped classroom students' results were promising, only (3%) failed the quiz, accounting for two students, while (18%) 12 were absent and the students answers showed clear understanding of the concepts as shown in (Table V).

Table V: Exam Results

| | Passed | Failed | Absent |
|-----------|--------|--------|--------|
| Section A | 49% | 40% | 10% |
| Section B | 79% | 3% | 18% |

Moreover the flipped classroom had the chance to review the material before the exam specially those who were absent to review the material while the control group only had the book to read the material by themselves, ask a colleague to help or visit the instructor in her office hours and ask for help.

D) Post Questionnaire Results

The post questionnaire revealed students positive feedback on the COP I and COP II interactive application and flipped class method. Students enjoyed studying using the application as 83.9% of the students answered that. Answering the question if the classroom was active and helpful, 80.7% of the students agreed where more interactivity and collaborated was present. Moreover, 96.8% of the students found that the questions in the application helped by reinforcing the idea covered by the animation (Table VI).

Table VI: Students' experience with the online application

| | Strongly Agree | Agree | Neither-Nor | Disagree | Strongly Disagree |
|--|----------------|-------|-------------|----------|-------------------|
| | % | % | % | % | % |
| I enjoyed studying using the application | 32.3 | 51.6 | 12.9 | 3.2 | 0 |
| I feel confident about your knowledge on the subject covered? | 61.3 | 32.3 | 3.2 | 0 | 3.2 |
| The questions helped me better understand the material | 38.7 | 58.1 | 3.2 | 0 | 0 |
| The question's feedback reinforce the new knowledge covered in the application | 32.3 | 58.1 | 6.5 | 0 | 0 |
| The discussion in class was very active and helpful | 32.2 | 48.4 | 12.9 | 3.2 | 0 |

Students found the layout of the COPI & COPII interactive application interesting and well designed. Above 90% of the students found the application interesting, well organized, comprehensible content and agreed on the effectiveness of animation used in making information easier. In addition the application was successful in increasing students confidence in the material studied 67.7% of the students in the trial answered that they felt confident about the material. This was clear in the class discussion when students were able to answer each other's questions and were confidently sharing their understanding of the materials. 77.4% were excited about their experience with the new application (Table VII).

Table VII: Feedback on the layout

| | Yes | No |
|---|------|------|
| | % | % |
| Did you find that the application interesting and well organized? | 90.3 | 3.2 |
| Did you find the navigation of the application clear and easy? | 96.8 | 3.2 |
| Did you find the content covered easy to understand? | 96.8 | 3.2 |
| Did you feel confident about your knowledge on the subject covered? | 67.7 | 32.3 |
| Did you feel excited learning with the application? | 77.4 | 22.6 |
| Did you take the application section seriously? | 96.8 | 3.2 |
| Did you like the application idea? | 96.8 | 3.2 |
| Do you consider yourself as self-motivated, independent learner? | 83.9 | 16.1 |

Only 3.2% of the students considered that the flipped classroom was bad experience, while the majority of student found it very good and good and as they stated they also liked the idea of the application (96.8%).

Moreover, the majority of the students would like to enroll in flipped classroom again (Table VIII).

Table VIII: Enrolling in future flipped Classroom

| Enrolling in flipped classroom | Percent |
|--------------------------------|---------|
| Yes | 74.2 |
| No | 19.4 |
| Total | 93.5 |

In general the application had a positive feedback and impact on students' experience, the structure, layout and material presented were positively received by students and the feasibility to repeat and forward helped them concentrate on sections they didn't understand making the material more comprehensible. Finally the feedback questions were built to ensure that students understood the content, and build their confidence with what they achieved and that what the students reported.

V. DISCUSSION

In the pre-questionnaire students average daily hours' time they spend using technology was around (8.67) hours and 51% of the students consider the course as difficult one. 72.7% of the students strongly agree that the courses are based on lectures and 87.9% strongly agree and agree to integrate more technology and digital material in their education. As we are dealing with digital citizens, 78.8% believe that adding technology in classroom will make it a better place to learn. Moreover, 72.7% of the students prefer to have digital format of the material to study. The students expressed that they wanted to interact with the material they are studying in the course 90.9%.

In the post questionnaire a high percentage of students said they liked the general layout of the Cells and Molecule COP I & COPII Interactive application, which they considered it as user friendly. They also stated that they consider themselves as independent learners and the application gave them the freedom to study according to their own pace. A high percentage of students said they were excited about the experience and it made the learning experiment enjoyable. Although students answered in the pre-questionnaire that they were satisfied with their course as it was, the increased satisfaction shown in the post questionnaire reflects that the flipped classroom has been effective in increasing their enthusiasm and motivate them to study as suggested in H1. Thus flipped classroom was able to engage and motivate students in class.

Students stated in the pre-questionnaire that they prefer a more multimedia integrated with the material given. Section "A" students used the usual classroom method, lecturing and taking notes if they needed that, while students in section "B" studied with the application according to the students pace.

In the post-questionnaire section "B" students said the animation used made the material easier and that the class discussion was active and helpful. Students X stated "It was very interesting, and exciting. The idea of watching biological processes taking place was really helpful".

In the post exam, 10% of students in section "A" and 18% from section "B" students didn't do Exam IV (that contains the COPI and COPII materials). The department has seen such absences during the exams; the department analysis of these absences is because the system will automatically eliminate the lowest grade between (Exam I, Exam II, Exam III, Exam IV). The average of the students in Exam IV in section "A" is (mIVA= 60.6) where in section "B" is (mIVB=73.75). Although higher number of students did not attend the exam but still section "B" average exceeded that in section "A". The flipped classroom has improved the student's performance. Students in exam IV has shown increase in the student's grade by 13 grades. Moreover, the answers of section "B" students were more elaborated than that of the section "A".

Section "A" results in Exam IV is relatively lower than that in Exam I, while section B students' results in Exam IV was the highest among other exams. The average grade in Exam I was 69.32, where the material covered in Exam I is considered as introductory material, and the material covered in Exam IV is conceded as harder than that in the beginning of the semester.

While in previous semesters, the average of the students in Exam IV was 58.7. Exam IV material is always the same, which contains the COPI and COPII material. Comparing this to the flipped class average grade, the average increased by 15.05 points. This increase of grade is significant value that changes the students' average letter grade, and shows improvement that both students and the department want. Thus this experiment worked well with the students under study and increases the achievements among students H2 (Table IX).

Table IX: All Exam Results

| | Exam I | Exam II | Exam III | Exam IV |
|-------------------|--------|---------|----------|---------|
| Section A | 69.3 | 65.2 | 50.3 | 60.6 |
| Section B | 67.4 | 66 | 46.9 | 73.7 |
| Previous semester | 68.7 | 64.2 | 49.7 | 58.7 |

A high percentage of students were willing to endeavor the flipped classroom module as they answered in the pre questionnaire although most of them did not know what it was. They believe they need more technology in the classroom.

In the post questionnaire students said they took the COP I & COPII Interactive application seriously and intended to study in order to get high grades. Also a high percentage evaluated the experience as "Very Good". Around 74% of the students are willing to enroll in a completely flipped course, to give them the freedom to study, test their knowledge and interact with the material under study. The percentage of the students is encouraging considering the short time of trial and the novelty of experience. Not only students had positive attitude towards the integration of flipped classroom, but also they understand the material covered more than that in the control group (section "A") consequently H3 is proven.

The instructor in section "B" was able to meet the objectives of the class during the assigned time, she guided the class discussion, did a quiz, and had extra time to discuss other topics thus flipping the classroom can be considered time saving. In the flipped session students became the center of the class making it more active, students were able to ask and interact more with the materials, and more students participated in the discussions according to their feedback in the post questionnaire. Students can read and learn information on their own, but they need instructor to act as coaches and mentors to stimulate and challenge their thinking, guide them in solving problems, and encourage their learning and application of the material [25], [17]. This complies with the statement made in H4.

VI. CONCLUSION

The aim of this study is to find and test an alternative Learning-teaching method that has the potential to humanize the classroom and make what students consider as hard material easier and digitally accessed. Technology has become a primary element of our daily lives, almost everyone is familiar with tablets, smart phones, and laptops even children at early ages now prefer using such tools over traditional games. Thus technology has become the language of this era, which should be used in communication at all levels including the educational sector. Ignoring this fact will create a large gap between the students' life styles and education, consequently leading to a lack of enthusiasm towards their learning and minimizing the development of the 21st century skills.

The reasons why the flipped classroom module was chosen as a hypothetical solution for the problems found during the observation, lie in its blended nature of digital as well as classroom based learning-teaching technique. Flipping classroom integrates the learning process into the daily lives of students giving them the freedom as well as triggering class interaction and boosting motivation and enthusiasm to learn. Learning becomes a personalized process and the instructor's acts like enabler and supporter rather lecturer and controller.

To evaluate the effectiveness of flipping as an alternative learning-teaching tool, the data collected in the pre and post questionnaire, grades and instructor's feedback were used as the basis for evaluation.

This study is one of the pioneering researches assessing the impact of flipping classroom on students in Lebanon; in the "Cells and Molecules" course for junior leveled on AUST Students. The outcomes of this study are encouraging and pave the road for future trials to better assess the impact of flipping on education. Comprehension, enthusiasm reflected through participation and collaboration and class time effectiveness for both instructor and student. Students prepared prior to the class time, the class time was active; students collaborated together and talked about the material in a very dynamic atmosphere according what the students reported, while the instructor was the moderator of the discussion. Finally student's grades were increased

and were able to elaborate their answers better the section "A" (control group).

The limitations in this study on assessing the real impact of flipped classroom on students are time, background of students, material, and lack of skills that are essential in implementing similar teaching methods.

The time assigned for the trial was short, only one section was covered. This does not allow students to adapt to a new learning method to see the actual impact on the long run. Testing the effect of the flipped classroom on students over a semester would reveals the actual effect of the students were the material will vary between hard and easy concepts.

Students in this trial are in the junior year and still haven't acquired the higher education skills; independent learning and being responsible for their learning, as our school system doesn't prepare students for that. Many students at this level change majors or drop courses if they find they don't relate with the material. Testing the effect of the flipped classroom on senior students would show how students' maturity affects the result of the study.

The effect of the flipped classroom in this study showed promising results, however studying if the flipped classroom will have the same effect on students under non-scientific courses.

Part of the Flipped classroom depends on class discussions, which need special skills. Students can gain these skills through time and practice, this study was not able to develop these skills for students. Having the students discuss the material and check their understanding, analyzing and criticizing are skills students need to have for their future.

Finally, students are not used to study with online or e-material, 51.6% of the students prefer reading or studying from a book rather than studying online according to their feedback in the survey. Students' online educational background was null, as what the students answered in the pre-questionnaire. Students' online educational skills can be gained in such blending class through time. These skills are also essential for their future, and for their professional development to develop their skills and to stay up-to-date.

The results of this study are encouraging; yet need developments on the stated points. This trial should be repeated on a longer period of time and target senior students. Lengthening the span of experiment will allow the researcher to test the development of skills and their impact on classroom experience and achievements.

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