

Engineering Learning In The University Using Computer And Information Technologies

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Abstract

This paper is about the preparations and methods used to teach, evaluate and test students without the use of papers in lectures or in mid and final exams for two classes: Computer Aided design CAD for third year students and Computer Aided Engineering CAE for fourth year students. Using both SolidWorks and ANSYS. This method was called paperless learning because computers are only being used for teaching and evaluating students and performing examinations. Students are involved interactively in the scientific material where this material is applied using computer programs which enable the student to perform simulations to solve all engineering problems. Also, students are given all electronic learning methods which are given in the first lecture and documented in discs, USB drives, and or external hard drives, these devices contain numerous eBooks, exercises, projects, educational films, and links and URLs for internet websites. This data is documented as Word documents or PDFs and students are free to copy and print any of these authorized materials to benefit from. Thus, the old-fashioned method of copying lectures on papers has been excluded so that the scientific material cannot be trapped within few exercises or fixed schedules during the academic year, but also given as electronic materials as mentioned earlier. This electronic material is being updated continuously along the academic year every year.

Keywords: Engineering Learning, E-Learning Technology, Computer and Information Technologies, CAD-CAE Environments.

1. Introduction

Students are given all electronic learning methods which are given in the first lecture and documented in discs, USB drives, and or external hard drives, these devices contain numerous e-Books, exercises, projects, educational films, and links and URLs for internet websites. These data are documented as Word documents or PDFs and students are free to copy any of these authorized materials to benefit from. Thus, the old-fashioned method of copying lectures on papers has been excluded so that the scientific material cannot be trapped within few exercises or fixed schedules during the academic year, but also given as electronic materials as mentioned earlier. This electronic material is being updated continuously along the academic year every year.

It was concluded that printing syllabus is not feasible approach due to the huge amount of electronically saved information and thus it will cost huge financial stress if each student was provided with this paper amount. On the other hand, this information can be saved on hard discs, for example, as films or interactive exercises, which cannot be used or modified without using specialized engineering programs. Moreover, updating the syllabus electronically will be much easier and will cost less if compared to updating the same material using papers, where there will be no need for references and electronic information that were used to be physically destroyed since there is nothing printed out. Thus, the exercises, homework and lectures are given electronically and interactively on computers to stay up to date with the scientific development in CAE and CAD fields

2- Goal

Technology has become a main ingredient in the educational process, the competition of production companies to provide advanced materials and learning devices helped university professors and lecturers to develop the educational process.

Thus, it is noted that in current time the world is going through a chain of changes within all fields of life, including the educational field, which is going through a transitional stage changing the traditional methods of learning and teaching: United States, United Kingdom and Europe already made huge advancements in the field of e-learning [1]. Some Middle Eastern countries are also offering paperless and e-learning classes such as Jordan Isra University, Petra University, and Hashimate University in Jordan [2]. Therefore, there are many calls for learning without using papers and without the presence of teachers and physical libraries. These calls make us rethink about the methods of teaching we use and enrich our methods by novel and beneficial resources of promising and active results for the learning process, these results may cause huge developments and benefits for the learner, not to mention the environmental impact by reducing the cut trees, which reduces deforestation [3]. The ease of using computers to print all sorts of documents has created a flood of new paper. Creating a paperless environment requires electronic documentation in a word processing document, as a digital image, for example, and submitting or uploading it directly either in its original form or in the previously printed form [4]. Education development is one of the important goals of all the developed countries [1] which focus on building well-educated generation and thus these countries lay out all their human and financial resources to achieve higher quality education, putting into consideration that human development is their top priority. As a result, in order to achieve higher standards, it is imperative to change the traditional learning process with interactive, learning-based methods using personal computers or tablets [5, 6]. At the University of Technology, a new paperless learning (PLL) method is introduced to replace the conventional method of learning. The PLL method is applied successfully in the CAD and CAE classes of third and fourth year students, respectively.

3- Literature Review

Although financial accounting practices in business have capitalized on the use of technology, this technology has not been fully integrated in higher education for accounting students. While traditional accounting courses laboriously involve rote transcription of debits and credits, educational technology in accounting courses may prove inherently beneficial. Faculty members at one U.S. institution designed and offered a paperless accounting course that utilized a variety of technologies, Steve et al. [7]. Their study explored student perceptions regarding the satisfaction and effectiveness of three of these technologies: 1) the Classroom Performance System (CPS) response pad (clicker) from eInstruction.com, 2) Tablet PC (teacher use); and 3) a course management system. Their study analyzes the reflective journals of sixty-two (62) students from two sections to find perceptions of satisfaction and effectiveness as well as initial feelings towards the use of educational technologies in the classroom. Within these findings key themes are discovered and discussed. The world is increasingly going digital. Many universities have one-to-one computing and campus Wi-Fi networks that allow teachers and students to interact digitally more than ever before, although the situation does vary from country to country, Kelly and Michael [8]. Teachers at one Japanese university are rapidly moving toward teaching paperless using various information and communication technology (ICT) tools. The article addresses how paperless teaching was applied in classes with first-year university students having low levels of computer skills, using specific tools such as Google Docs, Facebook, and Dropbox. It then provides general ideas of how to implement paperless teaching in classrooms, specific recommendations on tools and activities to use, and specific ways

that students can be prepared before they enter university. John et al. [9], recommended the best ways to integrate new technologies into the annual Eastern American Choral Directors Association Conference. They researched video conferencing tools, live streaming methods, music cataloging, and tech booth designs for our proposal. They presented their comparisons of these different tools to be used in future Choral Director Conferences. Choral music classrooms have not fully embraced many of the technological advances that could make for a more organized, efficient, and green classroom. This IQP team worked with the president of the Eastern American Choral Directors Association (EACDA) to create a booth at the EACDA conference to show directors and educators who attend the conference the benefits of integrating technology into their operations. This work reorganized the Worcester Polytechnic Institute (WPI) choral music library and integrated technology into the EACDA. The IQP team continued work on organizing and building an online reference for the music library. The group also collaborated with the College of the Holy Cross to improve manual data basing. In addition, the IQP team conducted research to help integrate a technology booth into future EACDA conferences and give them a viable means of conferencing via computer. The goal of this work was to improve the existing choral music library system, ensure the accuracy of the database, and help bring technology into the EACDA. Modern classrooms see many innovative practices in facilitation. Most facilitators prefer using presentations animated videos and multimedia to better explain their content. Campuses are Wi-Fi enabled and students use tablets, laptops and smartphones to capture the essence of a lecture. However, the one area where technological innovation is still lagging behind, in an academic setup, is in assessment. This paper, [10] looks at the perception of students to the use of clicker technology as a form of paperless assessment. Clicker technology was introduced as a tool for conducting formative and summative assessments to a first-year electrical engineering subject, Digital Systems 1. The paper first elaborates on the significance, types and the methods of academic assessments. It then discusses the pros and cons of assessments using clicker technology. Thirdly it sheds light on the research methodology used in acquiring data for this research. Finally, the results are analyzed which among others show that that 71% students enjoyed using clickers in class for formative assessments while only 52% appreciated its use in summative assessments. One of the reasons touted for this decrease is student anxiety. The key recommendation from this research is to increase the use of these assessment techniques within a formative assessment environment so as to familiarize students to eventually use it with confidence in summative assessments.

4- New Method Details

All details of our new method (pll) in the University of Technology-Mechanical Engineering Department, Baghdad-Iraq are as follows:

- 1- The number of faculty members for each class is constant and to be assigned by the senior class professor, the ratio of faculty to student is about 1:8, faculty members answer questions and inquiries of students and train them to use engineering programs. It is noted that teaching these materials using computers requires more than one lecturer for each class because teaching CAE and CAD must include a group of lecturers and professors in order to answer student questions equally based on the total number of students in each class and according the ration prementioned,

which will guarantee delivering the right information and knowledge to all students in the same time based on the type of the given lecture whether it is classwork, tutorial or quiz. Also, this includes questioning students about their homework and projects and grading them in each lecture. Thus, the class lecturer displays the class material on smart board or tablet and then answer student questions and discuss with them the lecture by dividing them into groups where each group is supervised by a teaching assistant.

- 2- The duties of teach faculty member is preassigned earlier, the main professor give the lecture in the first half hour, followed by his assistants in the next hour solving all student problems and questions in addition to computer-related problems of the engineering applications being used i.e. CAD program for the third year and CAE program for the fourth-year students then check and grade classwork. The last half hour of the lecture is designed for receiving homework from students and grade these assignments on computers in the same time after reviewing the files date and time. Each student must save what he/she has done on the computer as a short film that shows how the homework was being made on his/her own home PC. Thus, plagiarism will be eliminated.
- 3- The faculty member duties are not only answering student and questioning them, but also include the modification and review on the program that the student deliver whether it is a homework, seminar or project interactively on the computer in order to solve the problems and difficulties that face the student during his/her work.
- 4- A lecturer not from the group may be included during the academic year as an audit or trainee in order to gain skills and become prepared to enroll as a teaching group member in the next academic year in case one of the members leave for any reason.
- 5- In the beginning of the academic year and from the first lecture the students are familiarized with the syllabus of the material, grading and provide them with eBooks, lectures and solved problems in both English and Arabic languages (more than 10000 MB) for each subject. All of this information is saved on department computers on C drive. Also, the computers contain other auxiliary programs and antivirus software in order to prevent modification of computer software. Also, a backup is usually made on the cloud.

Students are also requested to:

- Bring a fast and reliable personal computer at home.
 - Flash drive to transfer and exchange all information from and to the lab.
 - Installation of CAD and CAE software on personal computers.
 - Installing other utilities required for recording and saving homework.
- 6- Communication through social networking sites such as Facebook for 24 hours 7 days in week: announcements and updates on grades and the fast answers to student questions while they are solving their homework are managed through Facebook website, where the staff has opened a special account for these classes. This approach is to mimic the 'Blackboard' system that exist in developed universities.

The main steps are listed below:

- a- The student searches for the lab account by typing the lab email in the search bar in Facebook.
 - b- The student then adds the lab account as a friend and send a message that include his/ /her name, year and class so that he/she can be verified by the lab staff.
 - c- One of the faculty members will add the student to the specified group after the verification of the student identity.
- 7- Each student saves the classwork and homework on his/her computer in the lab, which carries his/her number in the enrollment list. The student should save assignments in D drive inside a specific folder that holds the student's name according to the following procedure:
D:\ 3rd or 4th Year \ GE-A or -B (or AC-A or -B or AU or AE) \ Name of Student \ project1 (HW or CW).

Where GE: General Branch of the Mechanical Engineering Department.

AC: Air Conditioning Branch of the Mechanical Engineering Department.

AU: Automobile Branch of the Mechanical Engineering Department.

AE: Aeronautics Engineering Branch of the Mechanical Engineering Department.

- 8- Assignments: homework and classwork: these are called lab activities. These activities are collected and divided on the number of the assignments and delivered in every week, late submission is not accepted without official excuse, otherwise the late assignment may be graded out of %50 instead %100. In the case that the student wants to increase his/her grade then the student should submit additional assignment which is chosen by one of the faculty members, usually one of the former year's tests, or a specific assignment prepared specially for late submitters.
- 9- The periodic maintenance for the programs in the labs and students' computers that require software and hardware maintenance, usually students are provided with pictures and movies that show them how to install these programs. Such programs may need up to sixty-four steps to install. Students are pointed to purchase DVD's and install programs at their homes. Also, they are provided with links on the internet to learn more.
- 10- Students are taught to arrange the computer screen by dividing it into two windows: one for the main program and the second one is for the classwork or homework (an image or text document). The student can use one of these windows as the lecture or the exam question (instead of a physical paper), while the other window is being used to solve the problem on the same screen. Also, the student can use a huge number of opened windows in case the problem consists of different parts such as an engine with multi parts.
- 11- Quizzes, midterms and finals are held in the same approach as classwork evaluation is held. Final examination is performed exclusively on computers, while if the exam is confidential, the student saves his/her documents which include the design documents, drawings and simulation files in the same method excluding that the

student details are only kept on the main folder, while the sub folders are kept confidential and named as “project” or “exam”. The examination committee keeps these answers and copy it from computers to an external hard drive and then each student name is assigned a specific code and then these documents are handed back to the class professor to grade them. After that, the professor turn in the graded material back to the examination committee, which will put the names back to the graded material based on the assigned code for each student.

- 12- The final results for each student is displayed on the Facebook page of each class. Also, objections on final grades are recorded based on student comments and reconsideration of grading is made at the end of the exams and at the end of the first lecture after the exams.
- 13- The continuous development and maintenance for computers and software items being used: the department agreed to replace the computers whenever new ones are being purchased in order to obtain the most developed computers and the fastest, since such programs require super computers or work station, however, due to the lack of such computers, personal computers are being used and continuously updated.
- 14- Grades and evaluations for classwork and homework problems are final. However, if students would like to increase their grades they may turn in extra homework or more to improve their grades and thus we guarantee that students are building their skills. Extra grades are minimal. Late submissions are only accepted in exceptional circumstances.
- 15- Final projects for both classes are required: Each student must choose among the projects that are being presented in first lecture, or to bring a project that demonstrate a sophisticated engineering problem in order to obtain an outstanding grade. Thus, students are encouraged to solve more realistic problems that their topics are the same engineering topics they study such as heat transfer, mechanical vibrations, statics and so on to provide solutions for these problems. In this method students are catalyzed to solve the problem by himself/herself by recalling all the information obtained during college years.

5- Constraints and Needs

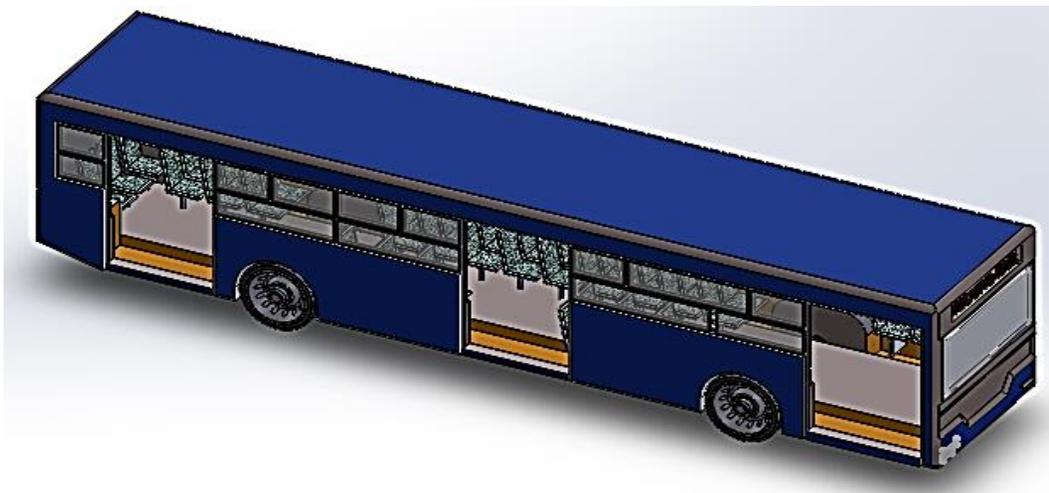
- 1- There are several constrains and needs that must be addressed in the future, which can be listed below:
- 2- Heavy Hardware is required to perform CAD/CAE software, this may include but not limited to supercomputers, workstations, and servers.
- 3- Lack of budget to purchase new original copies and license for the engineering programs.
- 4- Extra time should be scheduled for the CAD/CAE session because two-hour sessions are not enough to demonstrate everything.
- 5- Comfort computer desks and chairs are required
- 6- Headphones and mixers are required.

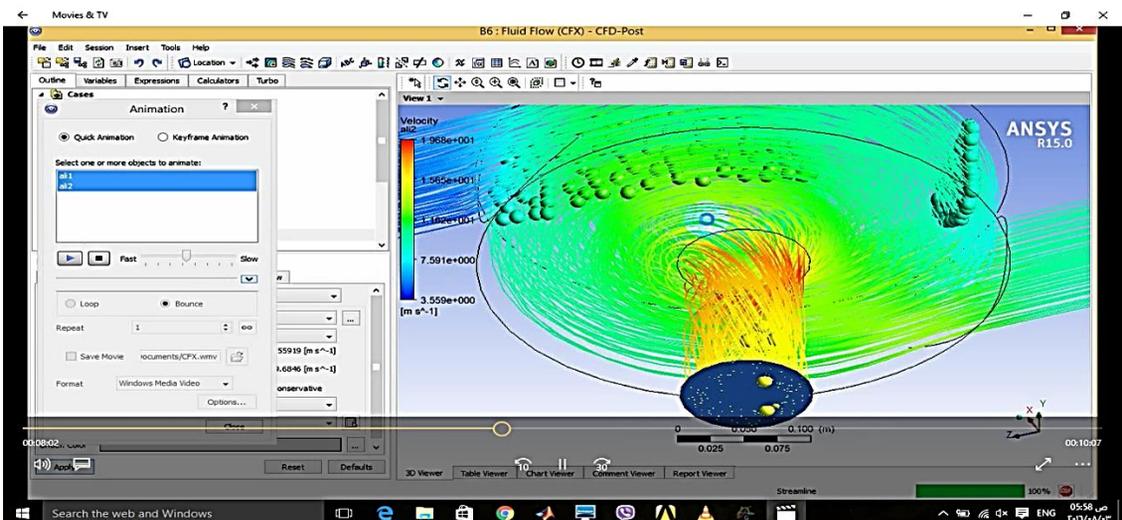
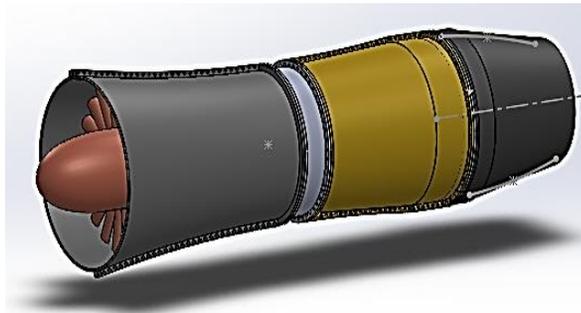
6- Results

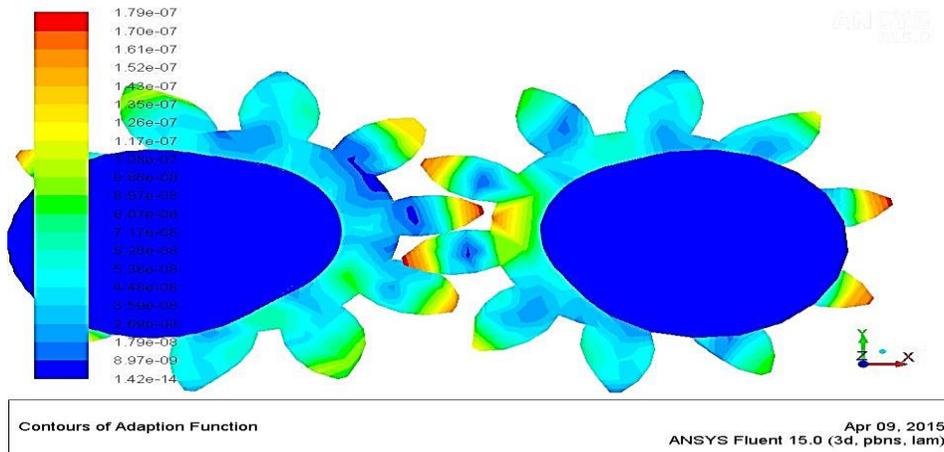
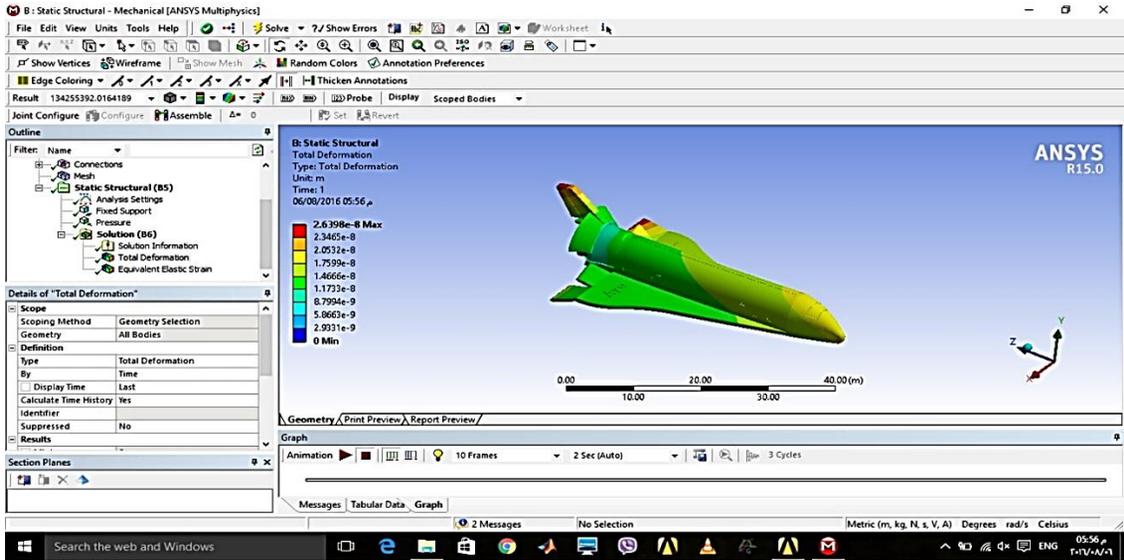
- 1- There are many advantages resulting by using this new technique such as:
- 2- One of the most outstanding results obtained from students is their enthusiasm and excitement in these two classes. Students do not leave the lab even after the end of the lecture. Some third-year students asked the last lecture to be an introduction for the material covered in fourth year so that they can learn the lectures in summer holiday. Also, a remarkable improve in student's levels and their understanding for a variety of engineering topics where they do not only study these topics but also apply them and search in the deepest details which will increase their ability by creating practical results and animated movies for such engineering cases. These approaches will make the taught material more understandable and memorable in students' imagination and solving skills.
- 3- The staff is continuously updating the lectures based on the notes of the previous year and students' feedback. Thus, the syllabus will be always updated to compete with the latest inventions and additions in these classes in western developed (top rank) universities.
- 4- The senior lecturers for both classes prepare and write textbooks due to the unavailability of textbooks for these topics. These books are in English but they are different than other books: the first one is electronic, which means it is given to the students as pdf with movies, examples, lectures. All of which are on a flash drive so they are not as hard copies. The context of these electronic books is the syllabus of these materials but includes most of mechanical engineering topics that are given to the students in the four academic years, moreover, the books include combinations of more than one material or science in the same problems, such are thermodynamics and fluid flow, or material deflections with vibrations and so on. Such combinations are more realistic problems that can be found in life, whereas it is difficult to find a book that put these topics all together. Thus, it is believed that writing such books will provide practical examples for all engineering aspects and link these topics and teach them to mechanical engineering students so that they can connect between these problems and view results, which will increase their awareness of the taught material, and this is the goal of our approach.
- 5- The control of the faculty member over the class is much higher: students must pay attention over the class material, otherwise they may lose track of information, which results in low performance, and hence, lower grade. Therefore, students focus in these classes better than other classes and sometimes they prepare for next week lecture, as these lectures are previously given to the students in the start (first lecture) of the academic year.
- 6- Students are learning how to use computers and solving hardware and software issues better than ever due to the need to install and use variety of computer programs.
- 7- Most students turn in their homework and projects fast and before assigned deadlines in order not to miss any grade: the earlier the students turn in their

homework, the higher the grade is. Some students are even asking advanced questions about problems of graduate level and insist on working on such complicated problems to assure an outstanding grade.

- 8- Grading process for finals are much faster when the answers are delivered on hard disks, most of the answers are graded on the same day.
- 9- Paperless approach led to the limitation of cheating among students since there is no specific start point in the modeling and solving processes in addition to the differences in computer skills and their respond using mouse and keyboard.
- 10- Paperless learning reduces textbook costs. The results have been significant, particularly in terms of savings on paper cost at approximately thousands \$ US per year.
- 11- Below, some of the students works in CAD and CAE software as final project picture without the scientific details or parts:







7- Student Survey

Below student's answers percentage as (yes, neutral and no) on some items which can be listed as follows for random 40 student:

No.	Item	yes%	Neut ral%	No %
1.	The student is provided with a class syllabus (content, goals, references, and grade distribution).	75	7.5	17.5
2.	The materials are beneficial and meaningful.	80	10	10
3.	The professor attends the lectures during the specified lecture time.	98	1	1
4.	The professor marks the absent students for each class.	75	17.5	7.5
5.	The professor encourages the students to practice college traditions and directs them to engage in various activities.	62.5	5	32.5
6.	The professor has various scientific approaches in evaluating the students.	65	10	25
7.	The professor has the ability to manage the class and encourage students to learn the practical side of the scientific materials.	77.5	7.5	15
8.	The students can substantially understand the scientific materials.	87	10	3
9.	The content of the class materials is acceptable.	67.5	20	12.5
10.	Practical applications and follow-ups are connected with the class materials.	70	22.5	7.5
11.	The lectures start and end according to the academic calendar.	85	7.5	7.5
12.	The professor provides illustrative examples during the lecture sessions.	90	7	3
13.	The professor's voice can be heard and clear.	92	6	2
14.	The teaching language used is understandable.	67.5	25	7.5
15.	Students are following up with the professor.	72.5	17.5	10
16.	The professor agrees to meet students outside the lecture time.	72.5	22.5	5
17.	The professor assigns homework and tests outside the lecture time.	75	15	10
18.	The professor returns homework and tests to students after grading them.	65	12.5	22.5
19.	The professor compensates for missed lectures in case of his/her absences.	96	1	3
20.	The professor uses a variety of teaching methods to deliver the scientific materials to the students.	52.5	27.5	20
21.	Textbooks and references are available in the library.	30	20	50
22.	References are available outside the library.	37.5	27.5	35
23.	The students use the library to read lecture references.	30	20	50
24.	The students use the library to read the material thumbnails only.	32.5	25	42.5
25.	The class professor is highly qualified to teach this subject.	70	20	10
26.	The professor is committed to teaching the class subject.	77.5	15	7.5
27.	The professor has acceptable and positive personality, decent looking, and cooperate with others.	75	15	10
28.	The professor exudes honesty and integrity inside the campus.	72.5	15	12.5

This survey was conducted for academic year 2014–2015 and is an improved version of the survey for the previous year. The results are expected to be better with the use of the PLL method for academic year 2015–2016.

8- Conclusions

The following represents the main conclusions drawn in this new method:

- 1- The students are showing their interest for subjects with a distinctive character and processions to develop and easy to handle.
- 2- When there is a visible application and movies illustrative lecture, solution and the whole work, the student will able to understand better, more accurate and faster.
- 3- The students used this method became almost professional in the use of computers and various software and hardware.
- 4- Students learn how to link many science topics with each other and that they were not previously elaborately where it was not available to them.
- 5- During the work of the survey, students tend to be positive in assessing the materials and professors and that's we did not observe in other subjects.

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