Research Papers on Knowledge,
Innovation and Enterprise,
Volume iv, 2016, pp. 99-115

E-Learning in Mathematical Computer Related Courses at Faculty of Information Technology, Al-Ahliyya Amman University

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Abstract

This paper deals with the utilization of a new version of technology in teaching mathematics-computer related courses to encourage instructors to make use of e-Mathematics in teaching their courses at university level. As a case study, we selected Discrete Mathematics course to apply the approach. This course is a basic compulsory course for the all Information Technology majors. We introduced Maple, the Computer Algebraic System in demonstrating and explaining pure mathematics abstract concepts, and make it appreciated, understood and more relevant to students in their majors. We explore issues in mathematical-computer related concepts of students learning; we describe our experience on blended e-learning via the utilization of Maple. Concluded outcomes from this pilot project indicate the Effectiveness, Ease of Use and Self-Efficacy of the platform. Students were satisfied and accepted the new structure of the course. Students depend on e-lab as central component of the course. The approach would be extended to all math courses offered in the Faculty of Information Technology majors' curricula.

Keywords: discrete mathematics, maple, blended e-Learning, student centric

Introduction

Al-Ahliyya Amman University (AAU), is the first privately owned university in Jordan, it was established in 1991, it has 32 undergraduate majors and 7 graduate programs distributed on 9 faculties; more than 22000 students graduated from the university since its opening. AAU strives to provide and maintain quality education system, to achieve this, the administration and top management of the university put a strategy to utilize information technology in the education process from both sides: the teaching/learning activities and the management. On top of that a rigorous quality assurance system is followed to guarantee that the objectives are achieved, the quality of education is maintained and the improvements are always in line with the development and planning for the future. From the university management and operations point of view, a total integrated Management Information System is implemented covering all the activities available in the universi-

ty, covering the three levels of operations, namely: daily departmental operations, middle management requirements and the higher level governance body for planning and high level top management. The covered areas include: Admission and Registration, Students' Information, Academic Staff Management, Research and Graduate School Management, Human Resources Management, Administrative Affairs, Financial Affairs, Material and Stores Management, Transportation, Clinic, Security, and some other subsidiary modules.

On the academic side, and since more than four years ago AAU launched a massive e-learning project through establishing *Horani e-Learning Center (HEC)*, that aims at building the digital content of the courses offered at the university, and providing e-learning platforms to build, manage and maintain the new environment and the new methodology in learning. This includes a Learning Management System (*LMS*), Assessment Management System (*AMS*), Learning Objects Repository Management System (*LO-RMS*), Content Management (*CM*), Document Flow Management (*DFM*), and some development tools, utilities and applications. Both the Education Management Systems and the Learning Management Suite are seamlessly integrated, accessed via a Portal, with single sign on capabilities.

As any other institution who launches e-learning projects, Horani e-Learning Center at AAU developed policies and guidelines for development and usage of e-learning content hosted by the center and used internally in the offered courses at academic departments in various colleges at the university. Those manuals were used in induction and training of instructors and used as reference in developing content and publishing them as learning material. The work related to developing those manuals was result of efforts of committees formed for this purpose who tried to adopt best practices in the domain, also there were many material used as samples and references to guide instructors in preparing their material. The guidance and policies were applied on university level and not on specific department, it also goes in line with the university policies in using technology and utilities at the university provided and supported by the computer center. Guidelines included issues such as: application processes for creating online course; approvals; guidelines for creating an online course; evaluation and assessment; teaching and learning using technology; how to interact with class in the e-learning blended model and related teaching methods; online: instructions, procedures, guidelines and resources; e-courses policies.

The strategy followed in the e-learning project is based on the Blended e-Learning Model (Elkins and Pinder 2015); the pedagogy is focusing on the student and not on the instructor, it is a student centric model, where learning is the target and not teaching as in the old conventional model. In the conventional educational model, the instructor was the center of activities while the student is just a passive receiver. It is basically a blending of technology with face-to-face interaction in the classroom teaching experience.

There are five attributes considered in the e-learning agendas of institutions (Sharpe et.al. 2006), at AAU, we considered four of them to be part of the Blended e-Learning Mode of teaching agenda, those are: Widening Participation of Students, Enhancing Learning Experience, Flexibility of Provision, and Computer Aided Assessment (Sharpe et.al. 2006). The blended e-learning model, utilizes

technology, providing learning objects within the material, depending on the nature and necessity of the material at hand, and allowing the instructor to be a facilitator and director of the learning process among the students. In this model, the Face-to-Face methodology is still available, but students have to come prepared, already learned the concepts by themselves through reviewing the digital content of the specific topic assigned to them, and the instructor will act as facilitator who stimulates thinking and directs discussions. Students are not anymore memorizing the text, but rather they are trained on the critical thinking skills and generation of knowledge.

One important aspect in measuring success in any information system application in general, is how users will perceive the system, how they will use it and when it will be used. This is a critical factor to look at especially in e-learning projects, it involves users from both sides, the receiving; i.e. "Students" and the sending/creators; i.e. "Instructors". Technology Acceptance Model (TAM) explains how users accept and use Information Technology. (Davis 1989) started with two models, Perceived Usefulness (PU) and Perceived Ease-of-Use (PEOU). Those models were developed further and expanded to consider other factors that might affect the decision about how and when using technology will be useful; TAM2 (Venkatesh and Davis 2000) and (Venkatesh 2000), TAM3; UTAUT Unified Theory of Acceptance and Use of Technology (Venkatesh et al. 2003). TAM has been effective for explaining many kinds of systems use (i.e E-learning, Learning Management Systems, Webportals, etc.) (Fathema, Sutton, 2013). This model was used in a similar environment in an Egyptian University, Mansoura University; the results reveal that students' perception of ease of use, usefulness, attitudes towards online learning, and the social influence of students' referent group were identified as significant determinants of students' intention to practice online learning (Farahat 2012).

Moreover, results from evaluating the TAM framework in the e-learning project in Konkuk Universit, South Korea, proved that TAM is a good theoretical tool to understand users' acceptance of e-learning. E-learning self-efficacy was the most important construct, followed by subjective norm in explicating the causal process in the model (Park 2009). This basic model that focuses on the users, in our case "Students" and how they use computers, and "Instructors" and how they create content is used, the model developed by (Davis, Bagozzi, Warshaw, 1989) is mostly applied model, a conceptual framework was developed using this model for evaluation of students interaction with the system and acceptance of the system in our e-Learning project at AAU.

Challenges faced AAU in this project were like any other similar experience in developed or developing countries (Anderson and Gronlund 2009), those are classified into four categories: Courses, Individuals, Technology and Context (Anderson and Gronlund 2009). A very critical part in this project is the training and preparation of instructors to adopt the new methodology and to change their old teaching style and conventional pedagogies to a new non-conventional approach in teaching, preparing the material and interacting with their students. This was major challenge that has to be taken to guarantee involvement of instructors and gain their support. Many training and orientation courses took place, deanships

at all faculties where involved heavily in the process along with the management of Hourani e-learning center. As a pilot, each faculty at AAU selected several courses to start with in creating the e-content and to construct the e-learning material for the blended e-learning method. For each course, an instructor (in some cases more than one participated in a course) attended the training courses so they become ready to develop the electronic course material.

The perception, enthusiasm and readiness to change varied among faculty members in the university. This also applies to the academic staff at Faculty of Information Technology. The professors are encouraged to participate and start adopting the new methodologies, as any newly ideas there is always some resistance and needs for mechanisms to manage the change. Mathematics professors are among those who have the same orientation; some are enthusiastic about getting into this experience while others are conventional and a bit reluctant resisting the change. In this paper we will cover one of the success stories related to Math professors in utilizing the new technologies related to e-learning in developing material for a very basic course in information technology majors' curricula. The course under consideration in this paper is Discrete Mathematics, we will demonstrate how Maple, the Computer Algebraic System (Rosen 2015, Maple 2016, Scherger 2009 and Yaseen and Aljiboury 2010), is utilized effectively in this course, it will be a basis and example for using Maple in other applied mathematics courses that involve computational methods and they are part of the Faculty of Information majors' curricula. This pilot study was conducted based on the experience of one of the authors who has been teaching Discrete Mathematics for IT students for many years following the old conventional method, and now he is shifting to the new trend, using the blended e-learning model and utilizing Maple in this course.

Overview and Background

This paper explores issues in e-mathematical computer oriented courses and the aspects of students' learning. The difficulties in teaching mathematics (especially for non-mathematicians) are well known, moreover the usage of new technologies in such domains is important inducement for both the instructors and the students in order to obtain an adequate transmission of knowledge, and subsequently to reduce the difficulties in teaching such abstract yet important subjects. From this prospective, many similar projects have been launched by groups of professors of applied mathematics at many universities (Yerion and Rinehart 1995) and (Hic and Pokorny 2005).

As mentioned earlier, at the Faculty of Information Technology at AAU, we are trying to be innovative through introducing new teaching methods to replace the traditional old methods in teaching Mathematical oriented courses for non-mathematicians, by adopting new e-related activities and applying them to the syllabus, i.e. reducing the abstraction and rigid concepts typically associated with mathematical concepts, and making them easier to understand and closer to be comprehended and more interesting to students. This is achieved through the blended e-learning model where we are converting our traditional mathematics

courses to incorporate Computer Algebra Systems, such as Maple and become e-mathematics courses in nature. The new approach is based on developing e-content and blending the program with the usage of applications such as, Maple, in teaching mathematics. This is a novel area of applications especially in teaching mathematics subjects for non-mathematicians in domains such as Information Technology and Engineering, as far as we know, none of the Jordanian Universities, has taken such approach; it is still novel and we are pioneering this area.

Maple (Maple 2016) is a powerful Computer Algebra System to handle symbolic algebra, numerical calculation and plotting of graphs. Using this application software allows students to spend more time on modeling and interpreting results rather than just memorizing the theory. Maple also has a text editor, which enables students to explain their results in writing and take notes and remarks as needed.

(Scherger 2009) presented a classroom activity where students doing mathematics are given tasks to enhance their understanding of the Numerical Integration through the Maple technology. Using this technology in such activity, it is noted that students can see for themselves that not every function has an anti-derivative with an elementary formula and that some numerical methods, like the *Simpson's rule*, are dramatically more effective than previously learned numerical techniques. Closed formulae for the forward, backward and symmetric solutions of an ARMA-representation were presented, and how they were implemented in the symbolic computational language Maple (Scherger 2009), providing supporting evidence of the suitability and effectiveness of such system in abstract math courses.

Early Maple work sheets were technology-focused, that is based on using the mouse and click buttons, write statements, use commands …etc. (Rosen 2015) and (Maple 2016). As an example, how to express and solve by Maple to perform three tests of the function say

$$f(n) = \{\{0, 0\}], \{1, 1\}, ..., \{[n, n\}\}.$$

We can use Maple to define the sequence function f as follows:

```
f := n => [seq ([k, k], k=0.. n)];
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If technology is going to be used to support the learning of Discrete Mathematics, learning basics and how to use this technology must be done first. In a new experiment especially when changing approach is needed, straightforward and simple questions are usually raised by students: Why do we need this extra work? Another question is raised: Why don't we use the textbook only? The answer to those questions and similar ones is simply resulted the new blended e-learning environment and associated teaching methodologies. We need to be aligned by using a platform technology such as Maple, and to enhance the self-paced learning capabilities and teach yourself approach in math courses in our IT majors' curricula.

In this case, from our experience as academics been into this business for a while, we simply found that the classical textbook used in the conventional way of teaching along with Maple sometimes did not fit and couldn't be used to convey the understanding of basic abstract concepts. There are a number of reasons attributed to this fact; such as, it may be related to the time needed to get acquainted

with the application and have a feel for how to use Maple as planned for, a need to integrate Maple in the syllabus and restructuring the course to reflect this by adding an e-lab to the course.

Moreover, our roles as instructors are to enhance students skills to explore different routes and to explore alternative solutions rather than just memorizing one specific solution as "dictated by instructor", so they learn the abstract theoretical concepts and discover solutions themselves. It is a methodology and pedagogy to lead the students into thinking, so the objective of building a student-centric approach is enforced. Maple and the Introducing Maple in teaching math courses, and restructuring the associated courses help in achieving this target. For the new generations, whose involvement with technology are very close, as it is known, smart devices are part of the lives for almost all young generation, so education, learning and teaching must be in line and methodologies must change accordingly. The gap between textbooks and current students is increasing, and it is noticed that they try to be always away from using textbooks, by introducing e-labs, and new pedagogy, concepts can be absorbed and understood much easily and the rigid math courses become easier, this could be a good approach to come closer to students acceptance of the new approach.

Some interesting examples were presented in (Shi 2009) and (Mauch and Shi 2005), those examples can be used even in teaching mathematics classes students. A few interesting ways to apply this sequence of points in teaching Math related Information technology students courses such as Linear Algebra, Numerical Methods in Computing, and Discrete Mathematics were discussed (Krampetakis and Pugh 2003). Studies like these are likely to promote students' interests and get students to be more involved in the learning process, therefore make the learning process more effective, accepted and interesting.

Maple was also used in electrical engineering field where many students have difficulty in learning technical subjects because they lack sufficient competencies in mathematical modeling and in Algebra (Yaseen and Aljiboury 2010), it was also shown in (Royeyik 2002), that the design of Maple documents is suitable for EE teaching. A computer algebra program for verifying *soliton solutions of ultra-discrete equations* in which both dependent and independent variables take discrete values was presented; Maple was used to implement the solution (Shi 2007). An integral approach is presented to strengthen the teaching and learning processes in the environment of the undergraduate course Numerical Analysis for Engineering (Gao and Masaaki 2009), they examined the advantages of combining the symbolic and numeric paradigms. In particular, the methodology is illustrated with the iterative methods: *Gauss–Seidel* and *Conjugated Gradient*, for the numeric solution of *Linear Systems*. The computer tools MATLAB and MAPLE are used in a pedagogic model that requires the explicit definition of Prospective Learning and Activities of Learning (Gao and Masaaki 2009).

Abstract concepts are very hard to be completely comprehended by students especially at the junior level. Discrete Mathematics is used to be taught to IT students as pure mathematics approach; this made it extremely difficult to understand and master the basic concepts by the students. In addition, the difficulty faced in appreciating the course value for their major and how it impacts certain aspects of

structures and/or concepts in some IT related courses cannot be usually seen by students. Issues and questions such as: *Why Math courses are needed for IT students? and, How Math courses should be utilized?* What matters more is comprehend the rigid abstract theoretical and difficult mathematical concepts. Such approach was faced in similar situations with abstract concepts in areas such as Numerical Analysis, Programming and Cryptography courses. The use of Maple worksheets was explored in a course on modern cryptography for undergraduate sophomores and juniors (Cariaga and Nualart 2002). The worksheets allow students to explore deep topics without requiring many prerequisites. The conclusion was in favor of using Computer Algebra Systems in teaching Cryptography (May and Mike 2009).

At Faculty of Information Technology at Al-Ahliyya Amman University; we are taking this endeavor to demonstrate the success and suitability of applying such paradigm to abstract concepts in pure mathematical courses in order to increase the interest of students attract their attention and raise appreciations and understanding of those abstract theoretical courses.

e-Lessons in Mathematics Computer Science Courses

Discrete Mathematics is a basic core course in the curriculum for computer science major; this has been the case since launching the program at faculty of information technology at AAU. In general, it is a fundamental course for Information Technology (IT) students as it lays the foundation for dealing with structures, the first lesson involving the structure is about sets; such topics are among the most important and valuable for IT majors' students. So far it has been taught in the conventional typical theoretical method of teaching that can be found anywhere in a higher education institution in Jordan or anywhere else.

Usually in this course, we try to provide students with opportunities to develop and demonstrate practical examples of how the concepts being treated and used in developing information; in addition to the way of thinking properly, we decided to enhance the perception and appreciation of this course by introducing the use of Maple application as a practical and application part of the material covered in this course, restructure the course and require an e-lab, and have the student practice their exercises and examples in the lessons of this subject in the labs as practical sessions and as part of the requirements that students should fulfill in the course.

At the beginning our aim was simple, instead of writing a lot of details, theorems, definitions in classical way as we do in the conventional way of teaching pure mathematics and as many mathematicians still do, we prepared Maple worksheets on sets and operations on the sets considering many different examples to introduce the concepts. During our long academic life experience, we discovered that the pure math teaching approach (the conventional way) is neither good nor suitable way to teach computer science students and other related Majors' students especially at their early stages. Our objective initially was not set to compare the learning outcomes of the classical and conventional way of teaching with this new e-content (blended e-learning) approach, but rather to verify whether our students

are capable of using a new independent form of study, and then decide how suitable it is to develop a whole e-content for discrete math course using Maple.

We gave students a list of all sets' rules which they already knew as a worksheet, also the instructions and commands to use Maple. Maple has a few built-in set theory commands; our initial goal was set to apply them to some simple problems modified from the text, and measure the effect on students. In the following section, we will give example of the lab sessions given to the students to work on under the supervision and mentoring of the instructor.

Lab Sessions analysis and Discussion

In the following we are going to give an example of a practical lab session, where students are given this activity; then we will explore students' behavior, reaction and attitude in dealing with this experiment using various sets' operations. The students were not exposed to Maple before, our objective is to have the students learn and get acquainted with the system by example and by solving problems from a course that is part of their requirements.

The details of the activity is detailed below, our observations to students' behavior is reported too. Total number of students in this lab session was 32, each student has his own computer, and they are connected and monitored via a special classroom management system called *Teacher*, instructors can monitor and control students' screens from their own monitor, thus allowing instructors to take over, correct, guide or show students anything they want, while sitting on their computer. This software is a tool provided in the e-learning environment.

Activity Example:

Given the universal set *U={-2,2,3,-3,4,5,6,7,8,9,10,11,12,13,14,15}; # small universe.*
And the subsets: *A={3,5,7,9}; B:={2,3,5,6,7}; C:={2,4,6,8};*

a) Find the following set operations by direct Maple commands:
   A union B; B intersect C; B minus A; A minus B; complement (A); complement(B);
b) Find the sets of all even, odd, and prime numbers of the given set U
c) Generate random subsets A, B, and C of size 3, 5, and 7, respectively and find the above set operations in items (a) and (b).
d) Write a maple program which will compute the intersection of any finite number of sets.
e) Write a Maple procedure, *Union( )*, to compute arbitrary unions. Be sure to check it works correctly.
f) Write a Maple procedure which accepts as input of any finite number of finite sets and returns: True, if they are pair wise disjoint and returns False otherwise.

The 32 students immediately logged in and started the tasks in the activity sheet, they all appeared on instructor's screen and his assistant where they moni-

tored their work and interact with students by answering questions or addressing students with questions to help them out of their problems whenever they stuck or face any problem, through the *Teacher* software. The reaction was smooth at the beginning, then when the patterns became harder to spot for many students, the students' reaction and attitude towards the work began to change, some of them gave up and were turned away from the computers, they wanted to switch the machine off, lost interest and wanted to do the tasks at home; of course we know this will not be done it's just an excuse to leave out of frustration. Other reactions were more impressive to us and attracted our attention directing us towards some critical conclusions regarding this exercise; students are then grouped together to compare their answers and discuss what they were doing, trying to use many commands, from Maple to test and amend their results, this good learning behavior was not available in the typical conventional theoretical classes that we used to teach.

This attitude signifies a new learning behavior, which was not seen in the typical classical theoretical teaching and learning behavior. Students are now the focus of the teaching process and it is not the instructor anymore, we are moving towards the essence of *Student-Centric Model*. In this exercise, we, as instructors, were just facilitators, mentors and learning aid. This exercise triggered the utilization of computer software and special purpose applications in teaching such abstract and pure math subjects, to make it more apprehended, and to enable students to master tough and hard abstract concepts.

From this experiment, we can conclude that computers can motivate students and help them to initiate discussions among themselves; they can generate new knowledge and create new learning patterns. Even with the existence of a group of students who were not motivated and didn't take part and gave up quickly, we thought that this is normal and always, there will be a group who will not participate regardless of the adopted methodology.

Computers can also introduce another dimension related to the students' solving problems, for example generating answers that students cannot understand. A typical question always raised by students is: *How can Maple do that?* In this example, it's evident to us that there are difficulties in the original basic concepts related to sets and programming associated difficulties at this early stage in the major for the students. By giving them the tools (such as Maple), they now have the chance to go back, review the material, understand and analyze the structures one more time, and even try to write their own programs challenging Maple, so they can test the behavior of the system and comparing it to their solutions. It's a mechanism to creativity and understanding.

Based on this initial exercise and the success achieved, we directed our attention to create the e-Discrete Math Course, restructure it and modify the curriculum to incorporate Maple along with a scheduled e-lab as requirement for the course. We concluded that using systems such as Maple in abstract theoretical courses such as Discrete Mathematics could be of great benefit to students and of great interest to Math instructors. We also concluded that understanding, appreciation and mastering of abstract theoretical concepts become easier, interesting, more affordable and reachable to most students.

Comments on Using e-Environment with Discrete Mathematics

Here in Jordan there is not much research on the behavior of the professors and students, toward teaching mathematical courses by Computer Algebra Systems, but from our own experience over a period of time, we observed the following:

1. Through our experience with Math Instructors, they tend to use software in mathematics only when it comes to answer specific questions that are already present in their minds. In many cases they are interested in the final result only without going through the detailed steps of generating the answer and that's the only reason that they tend to use Maple for example, or any other application.
2. Abstract theoretical concepts, in general, are very hard to be completely comprehended, appreciated and understood by IT majors' students; especially to students with weak background in Math, when taught following the conventional pure mathematics approach.
3. Difficulties in abstract theoretical concepts not only affect the low level of understanding the concepts but also in appreciating the related courses and their relevance to their major.
4. For Information Technology Majors' students, Discrete Mathematics course is just another extra tough and boring course, and it is irrelevant to them when taught as just another pure mathematics course; i.e. the concepts in the course are not connected nor related to any computer science concepts. This will give students the conclusion that the course has no benefit to them, it is just another extra tough and boring course, and it is irrelevant to them.
5. Using applications such as Maple, allows students in computer science and other IT related majors to bridge the gap between Math subjects and IT subjects, by applying the abstract mathematical concepts in a computer lab with a computer application; realizing the difference and the importance of the specific IT subject and the Math subjects in general.
6. Maple worksheets allow students to explore deep topics without requiring many prerequisites. The conclusions from the students' performance statistically found that they were in favor of the using Computer Algebra Systems in teaching Discrete Mathematics, and subsequently other math courses.

e-Discrete Mathematics Students Satisfaction

To measure the satisfaction of our students and collect their feedback about courses in general and instructors in particular, as any other institution, we do course evaluation. The following demonstrate our findings related to this experiment and show the degree of satisfaction and appreciation of students and their reaction, in addition to demonstrating the process and associated mechanisms.

a. FIT conducts students evaluations of every course during every semester, the evaluation process is done online through *Horani e-Learning Centre*; the student must log to a secure system and may submit only one evaluation per FIT course in which they are enrolled, no identifying information about the student is associated with the evaluation, the evaluation consists of 20 multiple choice questions and sections for comments, the multiple choices allow the students to rate various aspects of the course and the instructor of the course, the ratings are scaled from (low) 1 to 5 (high). The course related questions covers: course objective, difficulties, text book, assignments, labs…,
b. The results of these evaluations indicate that students who took the e-Discrete Mathematics are more satisfied with the new methodology (i.e. blending the course with Maple application) than the other students attending same course but tought in the traditional conventional method, the results for course-related questions show that the course evaluation scores above the average.
c. The e-Discrete Mathematics course' students are increasingly happy and more satisfied with the course and attributed this to the changes introduced in the course especially the e-lab and the Maple application utilization in the lab.
d. Final examinations analysis for the academic year 2012/2011, which is the year we started this experiment, indicated that students scored higher than previous years in same course but taught in the old conventional way. Table (1), shows statistics related to scores for first term, while Table (2) represents statistics of second term of the same academic year. Variation is measured to be around 6% comparing scores of students in the new e-Discrete Course using Maple and introducing e-lab for the course, and the old traditional course.

Total No. of Students in the class	25
Mean	60
Median	61
Lowest Marks	28
Higher Marks	76
Absents	2
Withdrawn students	1
Suspended Students	0

Table (1)

Total No. of Students in the class	32
Mean	63
Median	63
Lowest Marks	26
Higher Marks	99
Absents	none
Withdrawn students	4
Suspended Students	3

Table (2)

Feedback collected from students indicates that they can learn independently by themselves with little assistance of the instructor, we can conclude that the "learning objective" is fulfilled and satisfied. This experiment encourages self-learning pattern, where students can go through the examples embedded in the Maple lab session and learn it by themselves, when they encounter difficulties in understanding some concept or topic in the course,. The students' learning curve increased and their dependence on instructors decreased.

The usefulness, ease of use and self-efficacy related to the pilot implementation of changes done to the Discrete Math course are summarized and concluded from surveys done at the end of the term, Table (3) demonstrates the conclusion and responses of students regarding preference of new platform.

Students Preference	Percentage	Average class marks	Average class absence
I do prefer New Platform	13%	71	1%
Prefer a class with entirely on line New Platform	70%	68	3%
Prefer a class with limited New Platform	9%	64	3.3%
I do not prefer New Platform	3%	69	4%
It does not matter	6 %	55	11 %

Table (3)

Students were asked to choose one of the statements listed under "Students Preference", it was intended to measure their feedback regarding usage of new

platforms in teaching Discrete Mathematics, i.e. Introducing Maple as an integral part of the course that follows the implementation the e-content, in the Blended e-Learning Model and as a new platform. So we can conclude students' acceptance, effectiveness and ease of use of the new platform. Responses were captured during the final exam so each response is linked with the specific student because we wanted to study the effect of their performance and overall grade they scored in the course (This is tallied under the column "Average Class Marks"), and their attendance average to reflect their presence in attending the lectures in the course.

Going through the analysis of the survey shows that 92% of students Accept the new Maple platform; while just 3% specifically rejected the new platform, and the rest (6%) responded by it doesn't matter; this last group scored the lowest marks and their attendance was not significant in class. This is a strong indicator about the preference of students and their enthusiasm about this experiment.

More interestingly, is the group of students (83%) of the class who scored high in the course were for online platform utilizing information technology and specialized applications (e.g. Maple) in the course, and consequently in similar courses and probably in all courses of similar nature in their curriculum. This is a strong indicator about the Effectiveness, Ease of Use and Self-Efficacy of the platform and dependence on e-lab as central component of the course. It also represents good basis and guideline for Instructors to start applying the concept in other courses of similar nature; moreover, it enhances and strengthen the *Students Centric Approach* introduced in the e-learning blended model thus going toward more independence between instructor and student, focusing on the Learning vs. Teaching.

Limitations

Given the fact that students level of competency in math is generally weak, and the amount of information in math courses involve lots of new concepts, theories, proofs, …etc., which make it very hard to understand, comprehend and appreciate the benefits in their majors. On the other side, it is well known that math instructors are strong believers in transmitting large amounts of theoretical information in their courses. They believe that using computers and software systems will hinder the delivery and coverage of all topics in their courses. This was a major limitation that we faced. After conducting the pilot project, and by following the blended e-learning approach, it was proven that this misconception is not valid and that students could master the hard abstract concepts much easier than they did before, and that instructors had the time to cover difficult concepts more deeply and their role changed from lecturing to mentoring. The limitations still there in acceptance from all and the change management process needed to be undertaken to enforce the change.

Another dimension for rejection of this new approach by instructors and their resistance to change is their lack of expertise using computers and e-learning environment. This is another limitation, and could be an inhibiting condition to utilizing computers and Computer Algebra Systems in Math courses in IT majors' curricula. This limitation is handled by giving extensive training to instructors on the

environment and methodology of teaching in an e-learning environment, and through providing assistance from technicians and technical staff support at Horani e-Learning Center to help and guide instructors and be with them at the beginning in the lecture itself to take the burden of them and to save them from lake of knowledge embarrassment if something (usually technical) went wrong during the lecture.

Those can be seen as major limitations we faced in adopting this concept. Other general limitations are attributed to time, effort and costing/budgets typically associated with e-learning projects. Those dimensions were handled in the overall project, and specifically in our pilot project.

Implications of study

Maple is a Computer Algebra System appeared in 1985, we introduced Maple as an integral part of the Discrete Math course and as a platform used in the e-lab associated with the course taught at all IT majors in Al Ahlyya Amman University in Jordan. From this pilot project we concluded that using Maple in Mathematics courses proven to be of great benefits to students, made it interesting and effective in the learning process. Throughout the e-Discrete course, by using Maple students were able to discover rules, deeply understand difficult abstract concept, realize the implication and the link between math course and IT majors in general. They were also exposed to testing and exploring relation between representations of functions, structures and abstractions (especially in Structured Data Types used heavily in computer related courses) and mathematical objects using computational approaches. As a result of the impact realized from this pilot project can be seen from students' performance. Students became empowered with the tools and their understanding and appreciation of the whole course is deeper and demonstrated more comprehension of the concepts and why they were introduced.

Moreover, the main outcome of the experiment was establishing the link of abstract "difficult" mathematical concepts introduced in courses such as Discrete Mathematics to courses and concepts in the IT majors' curricula and justify the reason behind the link. This is very important, since the old traditional way of teaching math courses was always theoretical, with no evidence of direct benefits or links to students in their majors. Now, students can see why they were taught math in principle and how it formulates the basis of majors such as Computer Science, which has so many theories built on mathematical concepts.

This experiment has also impacted our directions in teaching all math courses for IT majors in general following this approach. All Math courses such as, Linear Algebra, Statistics, Numerical Analysis,…etc. now have e-labs, with utilities and systems been introduced as appropriate as the courses require. Yet, we need to evaluate and analyze the outcomes of those courses, initial outcomes are encouraging but we still need to collect more statistics, this will be reported in a coming report.

As another dimension, at AAU; the Faculty of Engineering are following the same in their Math course, since almost all of those course are taught by same

group of Math instructors at our Faculty of Information Technology. The outcomes are encouraging and there is acceptance and satisfaction from both students and faculty members in the different engineering majors. We are planning to give reports in local gathering so other universities in Jordan can benefit from the experience, and we will share structure and approach followed in teaching Math courses for non-mathematicians in general with colleagues from other universities.

Conclusions

To match what the new model of learning that is adopted by university, and in order to prepare our students to attain critical thinking skills and have them capable of self-learning, through this project, we planned to utilize Computer Algebra Systems, in core basic math courses included in the IT majors curricula. Thus we introduced using Maple software application in Discrete Math course as an example. The outcomes of this pilot project proved that utilizing mathematical/algebraic software in demonstrating and clarifying abstract concepts and ideas is successful. The results are excellent and encouraging, we succeeded in achieving our objectives and we demonstrated that this is a suitable approach for teaching math courses to application side majors like information technology majors, and to be followed by introducing Maple or other systems (as deemed suitable) in all Math courses taught in general in IT majors' curricula. This would also apply on math courses in engineering majors.

Our main efforts were to make e-Discrete Mathematics and other related courses converging the way of thinking of the students hence we provided students with opportunities to develop and demonstrate practical examples of how the concepts being treated in computer science and this will help to become part of their lifelong ability to formulate and solve problems. Supported by results from the survey conducted at the end of the course, we can conclude that the survey reveals that students are very satisfied with the quality and the effectiveness of their e-lab work embedded with the theory in the class secession and then applying what they learned through using Maple application program. Effectiveness, Ease of Use and Self-Efficacy of the platform and dependence on e-lab as central component of the course are concluded as outcomes from this pilot project.

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