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The Comparison of the Learning Achievements Using the Online and Offline LADS (Learning Activities of Data Structure Course) Models

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Abstract

The objectives of this research were to develop the learning activities by using the online and offline LADS (Learning Activities of Data Structure Course) model, to compare the learning achievements using the online and offline LADS model, and to find out the satisfaction of the students with the learning activities of the online LADS model. The research methodology applied the experimental study and the pretest and posttest process. The sample were forty undergrad students divided into two groups of twenty students (online group and offline group). The research instruments were a test, a questionnaire, and the learning activities of the online and offline LADS models. The research statistics used were mean, standard deviation, and t-test. The results are as follows: the comparison of the learning achievement towards the Effectiveness Index (E.I.) of the learning activities with the online and offline LADS models was .6860 and .6801 respectively. Considering the learning achievements of the students (posttest), the students learning of the online and offline LADS models did not performed differently at the .05 level of significance. The degree of the satisfaction of the students with the online LADS model was very high as well (Mean = 4.53, S.D. = 0.54), while that of the students with the offline LADS model was high (Mean = 4.33, S.D. = 0.65). In conclusion, the online LADS model made higher satisfaction than the offline LADS model. It revealed that can be used the online LADS models for developing the data structure course successfully.

Keyword: LADS model, effectiveness index (E.I.), the 1999 National Education Act

1. Introduction

1.1 Background information and problem statement

Upon graduation of a computer science program, students are expected to have the necessary knowledge and skills to develop software. However, they often experience problems in topics such as data structure (Garcia-Martinez & Alain, 2010), this is consistent with the study of Josh Tenenberg as, one of the main areas in computer science studying that students must master is data structure. These are typically learned in advanced programming course, which students take during their second year after having completed an introductory programming course (Tenenberg, 2003). In the majority of the cases, the main goal of this course is to study advanced programming techniques including the design of data structure, abstract data types, interfaces, and algorithms for sorting and searching (Hilfinger, 2009). Once students have completed this course, they are expected to apply what they have learned. However, many times, this is not the case. Students have trouble remembering what they learned. They often resort to programming, through using a limited set of data structures that might not be most effective in their code. This generates poor software development skills, thus producing unstable software (Garcia-Martinez & Alain, 2010).

Because data structure course contains abstract contents, they are, therefore, quite difficult for beginners to understand. In teaching, most teachers usually give lectures and sometimes do not use various materials to draw learners' attention, resulting in the lack of contacts between teachers and students. Furthermore, students come with different background knowledge in the field, meanwhile data structure is clearly a very important topic and course in the computer science area. From the survey with experts in the field about the teaching and learning of the data structure course in the computer science program in Thai university, the findings suggest the following

information as follows: 1) The contents area includes the definition of data and data structure, the order of data types, the data replacement of the main memory and the algorithm. The elements to be studied are arrays, link lists, strings, stacks, Q3 and graphs. The study focuses on the definition and principles, memory data replacement, operation and data structure applications, 2) The learning methods used are lectures, discussion, group work, demonstration and project work, 3) The learning materials consist of transparencies, power point presentation, computer-assisted instruction, internet-based instruction, worksheet, sample programs and teaching materials, and 4) Measurement and evaluation can be various. The evaluation should be performed with student participation in the realistic conditions. The measurement and evaluation usually cover the three domains: cognitive, psychomotor, and affective domains. The recommended measuring instrument is the pretest, quizzes, posttest, questionnaire, worksheets, program writing checklist, project evaluation. In addition, the evaluation should include an observation and grouped or individual student interviews (Arreeraad, 2009).

Josh Tenenberg (Tenenberg, 2003) states that students in data structures courses are currently learning how to create these data structures from scratch, when they should be focusing more on how they can use them for real world situations. Similarly, Nicholas Zvegintzov (Zvegintzov, 2003) states that it is very important to know how to build, analyze, and modify software. He remarks that it is necessary to develop strong theoretical skills; but, it is also important to know how to apply all this knowledge into the real world. In order to know how to apply this theory, programming and problem solving skills are required (Ben-Ari, 2004). Both of them require strong skills to understand abstract concepts, and it comprises a wide range of topics with a high level of difficulty. However, learning in computer science also involves mastering the ability to develop well-structured, well-designed, and effective applications. This can be achieved using different teaching methods. Depending on the topic and course's objectives, learning computer science can be taught through: learning to deploy application programs, learning about isolated concepts, consolidating what is already known, analyzing and integrating systems, and giving meaning to concepts and developing software for real work situations (Berglund & Wiggberg, 2006).

In a study of Salvador Garcia-Martinez and Alain Van Thiel on "Exploring the teaching and learning methods for data structure courses", this study aims to explore the challenges when learning and teaching students. This research is based on a qualitative case study through interviewing five instructors and six practitioners in the field. This work confirms many widely held beliefs about teaching data structure in computer science program. The findings can be used as an introductory guide for instructors who do not have the sufficient teaching experience. The main challenge that students encounter when learning data structures is the difficulty to apply theory into practice. Theoretical concepts can be explained through the use of examples, and including more opportunities to practice, such as laboratories. Some techniques to improve instruction include using new technologies, using the right textbook, programming language, increasing student's interaction in the classroom, and considering student's background and the pace of the class (Garcia-Martinez & Alain, 2010).

Raman Lawrence (Lawrence, 2003) also states that one of the common reasons why students fail to complete the data structures course is that they do not complete the programming assignments or complete them in a substandard fashion. Since it is critical to the students' success that they successfully complete the assignments, instructors are challenged to developed interesting assignments that students want to finish, therefore, in this research entitled "Teaching data structures using competitive game". This paper has discussed how a project involving competitive gaming motivates students to learn advanced game intelligence programming and improves their opinion of the course overall. The use of competition during an assignment can be used in any course where a suitable project can be developed. The competition server architecture can be used to enable the competitive environment. The major contribution is that interactive competition during the assignment increases student effort and satisfaction compared with projects where the competition comes after the assignment is completed. Pedagogical results indicate that the combination of game development and friendly student competition is a significant motivator for increased student performance.

The Learning Activity of Data Structure (LADS) model had been developed for the data structure course. The LADS model comprises the nine stages of learning activities. After the tryout of this model, the students were found to gain a better learning outcome. They appeared to be satisfied and patient with the learning process. The researcher also suggested that the LADS model should be performed on the internet to allow students to learn at any time/place (Arreeraad, 2009). In this approach, the model would respond to the learning management in Sections 22 and 24, the 2002 edition of the 1999 National Education Act. The sections support the use of technology and student-centered instruction in teaching and learning (ONEC, 2004).

From teaching experiences in data structure course and previous research, the researchers had the idea to develop the LADS model on the internet, called online LADS model. The researchers had long studied the information from the survey, the trial results and the research suggestions in order to come up with the design and

development that suited the advanced information technology and got enough potentials to be applied as learning instrument, according to the learning principles in the 1999 National Education Act.

The main question that we will try to answer during this research are: firstly, how different between the learning achievement of the students using the online and offline LADS model?, and lastly, what are the degree of students' satisfaction of the online LADS model in the data structure course? Therefore, the objective of this research were to develop the LADS model to be efficiently available on the internet, to compare the learning achievement of the students using the online and offline LADS model, and lastly, to find out the students' satisfaction of the online LADS model in the data structure course. With this knowledge, teachers, educators, and administrators will be able to design and develop future data structure courses that will be more effective to create better practitioners.

1.2 The ADDID model

Pisutta Arreeraad and Monchai Tiantong conducted the research entitled "A development of the learning reform process through the computer network system" or "The ADDID model" is shown in Figure 1. The model introduced the relationship of the process or the stages and the development of the learning activities focusing mainly on the learners. The computer technology was also used as the instrument in producing the following learning materials and media: project presentation on the computer, computer-assisted instruction (CAI), and web-based instruction (WBI). These learning materials consisted of pictures, sound, animation and video clips with the interactive system available for users. There were five stages of the ADDID model: analysis, design, development, implementation, and documentation. The research found that the experts considered the model to be definitely appropriate (Tiantong, 2007).

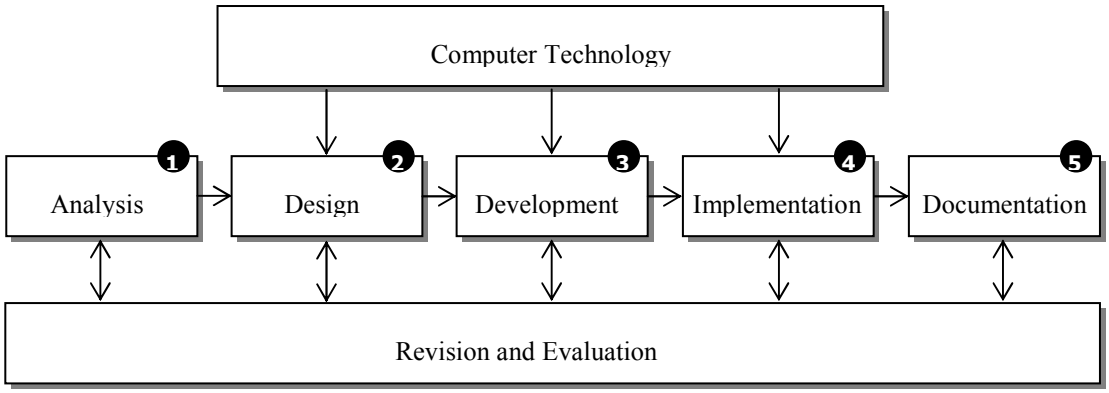

Figure 1. The learning reform process through the computer network system (the ADDID model)

1.3 The offline LADS Model

Pisutta Arreeraad studied the offline learning model of the data structure course using the Delphi technique (Haughey, 2000), that is a method used to estimated the likelihood and the outcome of future events, that collected the data from twenty-five experts in Thai university. A groups of experts exchange views, and each individually gives estimates and assumptions to researcher who reviews the data and issues a summary report. The research summarized that the learning activities of the offline data structure course of the computer science program for undergrad student at Rajabhat Maha Sarakham University included nine steps of learning activities are shown in Figure 2 as follows: 1) previewing activities, 2) pretesting, 3) giving interactive lectures, 4) self-studying, 5) doing additional research, 6) writing program workshop, 7) discussing and summarizing the study, 8) posttesting, and 9) concluding the learning activities (Arreeraad, 2009).

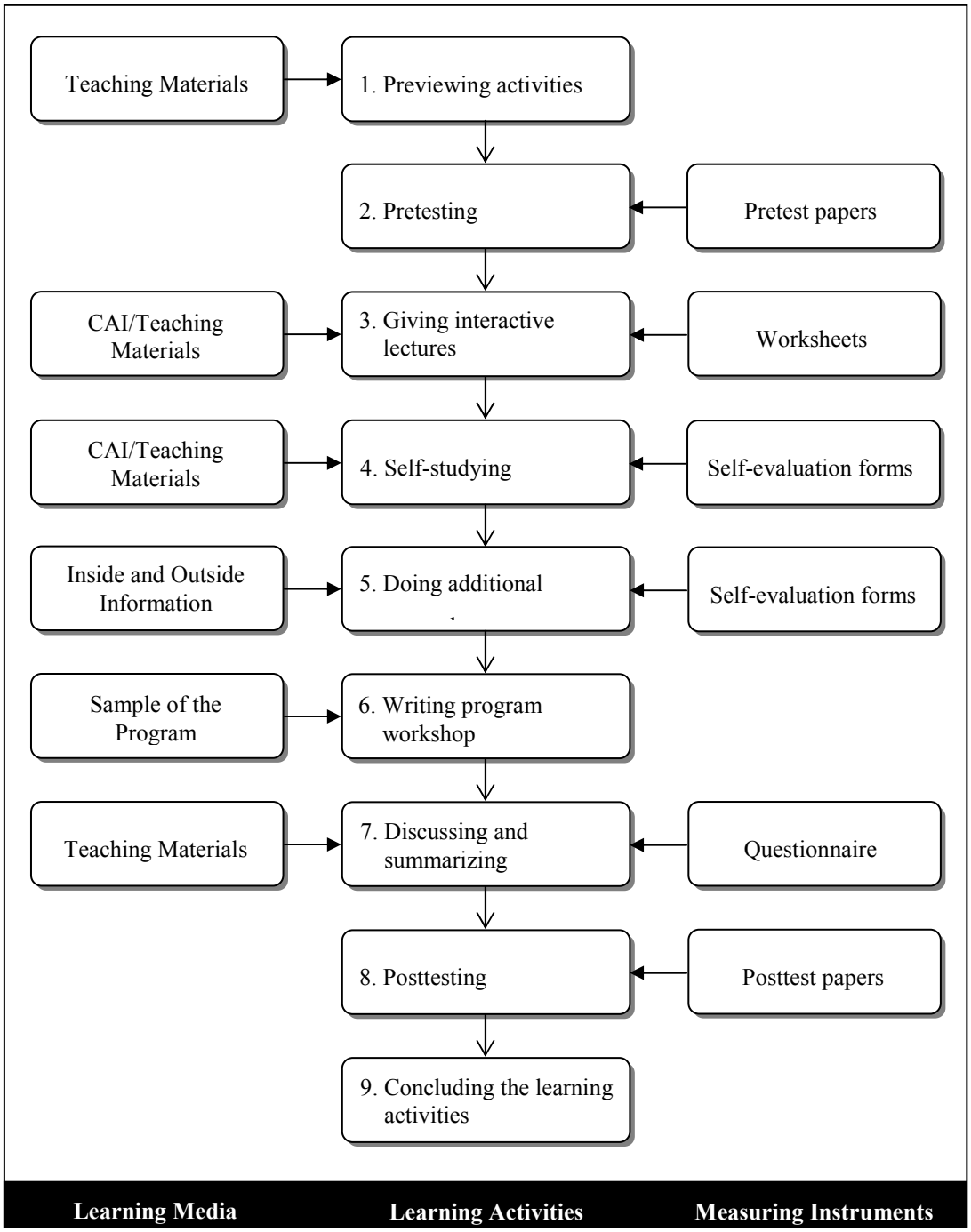

Figure 2. The learning activities of the offline LADS model

1.4 The online LADS model

Monchai Tiantong and Pisutta Arreeraad studied the online learning model of data structure course using focus group discussion from five experts, who are in computer education in Thai university. The research summarized that the learning activities of the online data structure course of the computer science program for undergrad students at Rajabhat Maha Sarakham University included seven steps of learning activities is shown in Figure 3 as follows: 1) previewing activities, 2) pretesting, 3) self-studying, 4) doing additional research, 5) discussing the findings and summarizing, 6) posttesting, and 7) concluding the learning activities (Tiantong, 2005).

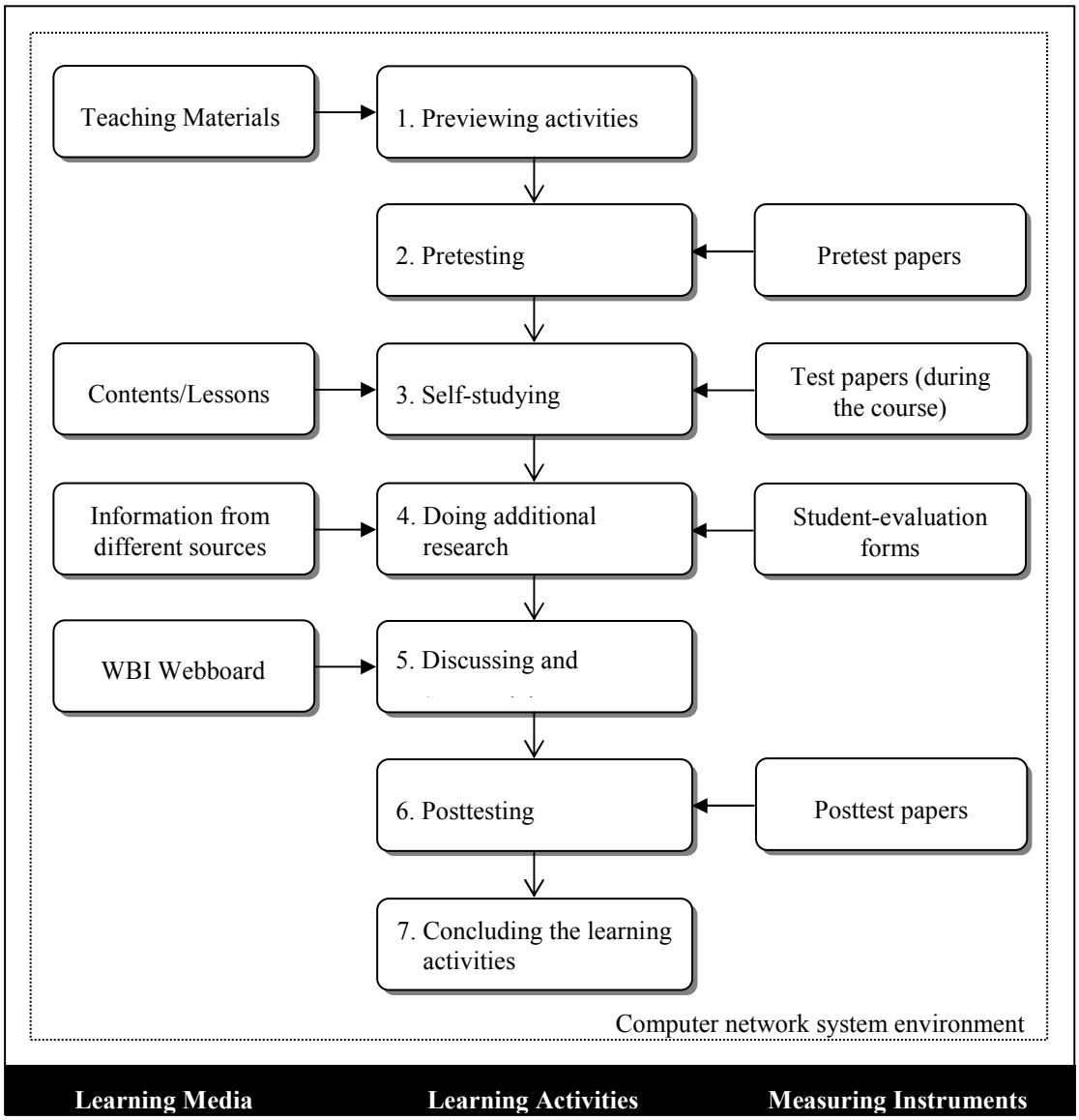

Figure 3. The learning activities of the online LADS model

The comparison of the offline and online LADS model are shown in Table 1, that the offline LADS model consists of nine steps, meanwhile the online LADS model consists of seven steps.

Table 1. The comparison of the offline LADS and the online LADS model

The offline LADS model (9 steps)	**The online LADS model (7 steps)**
1. Previewing activities	1. Previewing activities
2. Pretesting	2. Pretesting
3. Giving interactive lectures	
4. Self-studying	3. Self-studying
5. Doing additional research	4. Doing additional research
6. Writing program workshop	
7. Discussing and summarizing	5. Discussion and conclusion
8. Posttesting	6. Posttesting
9. Concluding the learning activities	7. Concluding the learning activities

2. Methodology

The methodology used in doing this study were given below:

2.1 The research procedure

This research studied only in the areas of the data structure course for undergrad students, computer science program, Rajabhat Maha Sarakham University. The research methods were performed to study about the learning reform process through the computer network or the ADDID model. The process of the ADDID model included the following:

- A – Analysis: the first stage is to study the previous research papers and analyze general conditions of the problems in teaching and learning.
- D – Design: this stage is to design the LADS model through the computer network, introduce the instrument and the learning activities of the model examined by the experts.
- D – Development: this is to develop the instrument and the learning activities, try them out with the small sample groups and have the instrument examined by the experts.
- I – Implementation: this stage is to try out the LADS model in the sample group. The implementation process was as follows: 1) taking pretest, 2) organizing learning activities, 3) taking posttest, and 4) surveying the learners' satisfaction.
- D – Documentation: the last stage is to complete paperwork, revise the learning activity manual, classify the learning activity models into categories, report the process and results, and present and publish the research paper.

2.2 Population and sample

There were forty undergrad students participating in this study. These students were from the computer science program, Rajabhat Maha Sarakham University. The students were separated into two groups of twenty persons as heterogeneous group with the mixed ability in each group. Both groups were randomly assigned the following learning activities:

- Group 1 (twenty persons) : using the online LADS model
- Group 2 (twenty persons) : using the offline LADS model

2.3 The experimental design

The experimental design in this research was two group pretest-posttest design. The diagrams of this design was given below:

Table 2. The experimental design

Group 1	O1 (Pretest)	X1 (Online LADS treatment)	O2 (Posttest)
Group 2	O1 (Pretest)	X2 (Offline LADS treatment)	O2 (Posttest)

O1 : Pretest observation

O2 : Posttest observation

X1 : Online treatment of the LADS model

X2 : Offline treatment of the LADS model

2.4 The statistics applied in the research

The statistics applied in the research were given below:

2.4.1 The effectiveness index (E.I.) (Goodman, 1980) was used to find out and compare the learning achievement of the LADS model.

2.4.2 The t-test was used to compare the average scores of the control and the experimental groups.

2.4.3 The average mean and the standard deviation were calculated to analyze the model evaluation and the learners' satisfaction.

4. Results

4.1 The learning achievement on the effectiveness index

The learning achievement of the learners using the LADS model on the effectiveness index (E.I.) (Goodman, 1980) are shown in Table 3.

Table 3. The learning achievement of the learners using the LADS model

Group	Pretest scores (O1)	Posttest scores (O2)	Effectiveness Index (E.I.)
Group 1	41.20	60.05	41.20/60.05 = .6860
Group 2	40.50	59.55	40.50/59.55 = .6801

In Table 3, it can be concluded that the learning achievement of the learners using the online and offline LADS model on the Effectiveness Index (E.I.) was .6860 and .6801 respectively.

4.2 The comparison of learning achievement

The comparison of learning achievement of the students using the online and offline LADS model are shown in Table 4,

Table 4. The comparison of the learning achievement after studying

Group	Posttest scores after studying	t	Sig.
Group 1	60.05	6.22*	.000
Group 2	59.55		

In Table 4, it can be concluded from the P-value or the significant value of the learners in both groups that their average scores after the course are not significantly different at the .05 level.

4.3 The results of the students' satisfaction

In the survey of the students' satisfaction, the rating scale questionnaire was given to both groups of students to ask about their attitudes upon using the online and offline LADS model. The results are shown in Table 5.

Table 5. The survey results of the students' satisfaction

groups	Mean	S.D.	Interpretation
Group 1	4.53	0.54	the most satisfied
Group 2	4.33	0.65	very satisfied

In Table 5, the students using the online LADS model were the most satisfaction with the online LADS model (Mean = 4.53, S.D. = 0.54), while the other group of students using the offline LADS model gave very satisfied level to the offline LADS model (Mean = 4.33, S.D. = 0.65).

Conclusion

Comparison of online and offline learning is no doubt of substantial interest to teachers and the focus of numerous studies. As preference for online learning increases, mostly due to the convenience and flexibility it offers students, universities find themselves increasing the number of online format courses to meet the growing demand. However, the question remains whether the delivery format of a course, such as online, offline, impacts

student performance, their satisfaction and learning. Many a priori studies report mixed results. In a study of Sheweta Singh at al. entitled "Efficiency of online vs. offline learning: a comparison of inputs and outcomes", they take a novel approach by opening a discussion for future investigators to consider measures that impact student efficiency. By using the DEA (Data Envelopment Analysis) approach to estimating student efficiency in this investigation, they have found sufficient evidence to indicate that students taking the online course format are more efficient than their offline counterparts. The results indicate a difference between online versus offline formats when considering the number of hours students spend studying as an indicator of student performance. Student performance includes the student's final grade and self-reported level of learning and satisfaction from their course experience. Additionally, the DEA approach reveals sufficient evidence to indicate the course load negatively impacts the efficiency of students. Finally, students that work full or part-time, have familiarity with the Internet, a have preference for online course material all positively impacts a student's efficiency using the DEA approach (Singh, 2012). Similarly, the results of this study revealed that the learning achievement on the effectiveness index (E.I.) of the developed learning activities was good and the two groups of sample students performed in the same way after the implementation, but their learning achievements were not much different. When surveying their satisfaction with the LADS model, the results showed that students were more satisfied with the online LADS model than the offline one. Similarly, in a study of Virginia Roach and Linda Lemasters entitled "Satisfaction with online learning: a comparative description study", this study was conducted to determine to what degree students were satisfied with the online program and their degree of satisfaction in comparison to on-ground courses. Results indicated that students in the online program were satisfied with the courses; however, they noted valuable concerns to be addressed (Roach and Lemasters, 2006).

Lastly, it can be concluded that the developed online LADS model in the data structure course was efficient and useful enough to be applied in organizing teaching and learning, because data structure is not only important for software development, but it is also for the field of computer science in general. Software, in an abstract level, consist of data structures interacting with each other. Almost everything that deal with is related to data structures in one way or another. Data structure is a representation for the information flow in the algorithm, software, application and system. Thus, it is crucial to choose the right structure for the data. Without these structures, the data would be indecipherable and effectively useless, meanwhile someone state as data structure is not only important, it is imperative for computer science area, such system developers, system analysts, system administrators, and programmer (Tenenberg, 2003). Because students of the next generation will be programming virtual machines at much higher levels of abstraction than those virtual machines that most of their teachers used in learning data structures. Many of students will make this leap of abstraction without teachers, however, aid them in this enterprise, and the increasing availability of textbooks that incorporate these frameworks makes this task considerably easier. The full use and extension of standardized data structures frameworks in the first university level data structures course places a stronger emphasis on abstraction and design and helps students to be able to put the knowledge from this course into practical application.

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