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ASSESSING THE SUCCESS RATE OF STUDENTS USING A LEARNING MANAGEMENT SYSTEM TOGETHER WITH A COLLABORATIVE TOOL IN WEB-BASED TEACHING OF PROGRAMMING LANGUAGES

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ABSTRACT

The development of collaborative studies in learning has led to a renewed interest in the field of Web-based education. In this experimental study a highly interactive and collaborative virtual teaching environment has been created by supporting Moodle LMS with collaborative learning tool GREWPtool. The aim of this experimental study has been to find out the success rate of students when using an advanced and a standard collaborative tool in teaching programming languages over the Internet. The system has been tested with a total of 58 students whose aim was to learn the programming language Java. Success rate of students have been measured using two different assessments. Our results show a higher success rate when an LMS system is combined with an advanced collaborative tool during the teaching of programming languages in a Web-based environment.

INTRODUCTION

The growth of Web-based education has been described as explosive, unprecedented, and above all, disruptive in academic settings. The Web-based learning movement is gaining momentum and the pressure to get courses online is increasing for teachers of Information Technology and Management. At the same time, the concept of collaborative learning is gaining acceptance and place in the classroom. More recently a number of educational institutions have been looking to the open source learning management systems (LMS) and collaborative learning tools to provide a less expensive and hopefully equally functional with competitive commercial products.

An LMS has recently become a very active domain among researchers studying online education. An LMS is often regarded as the starting point for developing an online course or program by researchers as it provides a means for managing, delivering, and tracking online instruction and student outcomes. According to Hall (2003), several factors should be considered when assessing the value of an LMS: availability, scalability, usability, interoperability, stability, and security.

An LMS system acts like a bridge between the instructors and learners. Instructors "configure" the LMS system by loading it with the course material and by enabling students to have access to it. The cognitive benefits of using an LMS system is that it enables students and instructors to meet in virtual classrooms. Further, an LMS system enables the instructor to keep close observation of the learning abilities and success rates of students. In return, students can benefit from an LMS system since they can study the course notes at their own places of study, meet their instructors and classmates in virtual classrooms, and also prepare themselves for the examinations by solving self-test quiz questions whenever they feel like.

Commonly used LMS systems include *Blackboard*, *WebCT,* and *Desire2Learn*. There are also many open-source and free LMS systems, such as *Moodle, Segue, Interact, CourseWork, Atutor*, *KEWL* and several others. Open source means that users have access to the source code of the software, and anyone can download and use source code, and more importantly users can write new features, fix bugs, improve performance, or learn how a particular problem has been solved by others. It is the authors' opinion that an LMS should be based upon open industry standards, not require any additional client applications, and support resources from a wide range of manufacturers.

Collaborative learning is another widely discussed topic in online education. There has been some deal of research on collaborative technologies (Hubscher-Younger & Narayanan, 2003). From a methodological point of view, the use of groupware to study collaborative learning has many advantages. Taneva et al. (2004) suggested that all interaction between students is mediated through the computer, and hence by logging it one maintains a complete record of this interaction. Another advantage of such an approach is that it allows for a detailed, machine-readable record of students' interaction with the reference materials that they utilized. Finally, the recent rise of instant messaging (IM) communication among students of all ages has opened the possibility of building peer learning groupware systems, which are likely to be well-received by the current generation of students.

The benefits of collaborative working has been known and used in industry for some years (William & Upchurch, 2001). Roschelle (2003) and Chi et al. (1989) reported that students can complete more complicated problems and gain a better understanding when working collaboratively. Although in general the benefits of collaboration have been recognized, many questions about its effectiveness remain. Is it better to pair a novice with an expert or pair two novices, or perhaps pair two experts? Is it more effective to learn a programming language as individuals or as pairs?

We recognize that learning methods of computer science students may have quite different characteristics to other learners. The Internet-based communication tools like chat, forum, e-mail are necessary but not sufficient to interact with the teacher or with classmates online. The collaborative tool to be used while teaching programming languages should be compatible with the logic and methods of teaching programming languages. A compatible collaborative tool must have a user-friendly graphical environment that allows asking questions, changing an existing code, trying a new code, viewing it and analyzing the results. Both teacher and students can simultaneously interact with the collaborative learning tool; perform online experiments in order to achieve correct results. We believe, however, the study of this type of students can shed light on research for such a student population and related intervention programs. A literature review on LMS systems and collaborative learning tools provide a foundation for this work.

Review of Related Literature

The educational potential for instructional technology, specifically the use of the Web and Internet, continues to increase. Kiesler (1992) outlined changes in the instructional environment necessary to carry out online collaboration. The following changes that she suggested both reflect constructivist thinking. Firstly, there are suggestions for changes in classroom organization: student-centered, team-centered collaborative learning, and a high-level of student-to-student interaction. Secondly, the suggestions for changes in the roles of teachers and students as needing to demonstrate: a) active learning; b) exchange of experience-based knowledge; c) socially constructed knowledge; d) learning from one another; and e) students' talking, teaching, and learning.

Liu (2005) investigated the current state of how instructors use technology in online courses. Major findings include that asynchronous discussion was perceived as being very important or necessary to be used in online courses; while real time chat were perceived as less important or less necessary. Positive correlations were found between the instructors' perceived importance and necessity of the technology and how likely they used it.

Jung et al. (2002) investigated the effects of three types of interaction (academic, collaborative, and social) among online undergraduate students in Korea regarding their satisfaction, participation, and attitude toward online education. Social interaction with instructors and collaborative interaction with peers were identified as important factors for enhancing learning and active participation in online discussions.

Wisher et al. (2004) used a Web-based tool that allows students to generate multiple-choice questions in a collaborative, distributed setting was evaluated through several comparisons. He found that students who collaborated within a topic scored approximately 7% higher on the test within that topic than students who either collaborated on other topics or did not use the collaboration tool.

A recent large-scale study of students in Introductory Computer Science courses demonstrated that those working in pairs performed significantly better on programming projects than students working alone, although their scores on exams were not radically improved (McDowell, Werner, Bullock, & Fernald, 2002). Another study found that collaborating students showed considerably greater improvement pre- to post-test, and rated the course higher (Sabin & Sabin, 1994). Most interestingly from an educational perspective, Chase and Okie (2000) discovered that introducing peer instruction and collaborative learning to the curriculum of their Introductory Computer Science courses decreased the combined rate of withdrawal and failure from 56% to 33%. Zhai and Liu (2005) found that real-time chat is used far from its full potential in some online courses. The good point of these researches is that new types of collaborative systems, brought about through communications technology, may prove beneficial to learning and teamwork in computer science.

Truong et al. (2003) describe ELP, an online, active, collaborative, and constructive Environment for Learning to Program, which is currently being developed at Queensland University of Technology to help students program successfully at an early stage in their learning. ELP allows students to undertake programming exercises by “filling in the blanks” of a partial program. The basic requirements of the system are an Internet connection and a Web browser which supports the Java Runtime Environment. Research concerning extending the environment to support collaboration between students learning to program is ongoing.

Moore (1994) notes that students at their local sites tend to cluster around an informal leader in an environment characterized by “a high degree of participation, division of labor, and collaboration.” Indeed, promoting teamwork and collaboration, rather than competition, among students at distant sites has been found to enhance collegiality and learning (Jones & Timpson, 1991).

A review of the two recent mainline e-Learning projects in the European Union, namely the e-Learning Action Plan, and the e-Learning Program have been fully supported (Uzunboylu, 2006) by the European Commission, who provided the necessary infrastructure and equipment, instructor training, encouragement, cooperation, delivery of useful services, and promotion of digital literacy.

Taking note of the concerns, as well as the benefits of advanced collaborative learning tool, lent to our design approach of a learning environment with computer science students. This will be reviewed in the results and conclusion section.

Theoretical Framework

The theoretical framework used in building the virtual learning environment in this study for computer science students is the blend of learning theories derived from cognitive learning theory, situated learning theory, and constructivist learning theory.

This experimental study is significant in that, it looked at pertinent online interactive and collaboration processes in Web-based learning as related to a particular constructivist model of learning. The relatedness of Web-based, synchronous collaboration, and the pedagogical application of constructivist learning theory provided a very interesting focus for this study.

Particular to this study, the notion is that present educational technology may effectively support constructivist learning. Constructivism is emerging as a philosophical stance toward education that aligns itself with the claims about Web-based synchronous collaboration (via collaborative tool). Both constructivism and Web-based synchronous collaboration assume that effective learning relies on active engagement by the student, and high levels of interaction, in social-dialogical environments and in real-world situations. Through socially based interaction, such as collaboration, mentoring, peer tutoring, and negotiation of meaning, students are able to construct knowledge, and this leads to meaning-making (Jonassen, Davidson, Collins, Campbell, & Bannan-Haag, 1995; Sheingold, 1991).

An increased facilitation of student interaction is moving the distance education paradigm toward networking via the Internet and Web, which provide a "many-to-many" communication setup (Harasim, 1990). It appears that Web-based learning may support recommended instructional strategies for improving collaborative activities, a key part of constructivist thinking (Lebow, 1993). Constructivist approaches in education, such as situated learning (Lave & Wenger, 1991) and collaborative learning (Sharan & Sharan, 1992) have gained popularity. Linking constructivist theory and associated instructional strategies to Web-based courses might provide valuable educational results in higher education (Bannan-Ritland, Bragg, & Collins, 1999).

As universities turn more and more to the utilization of Web-based learning, it becomes imperative to lay the theoretical groundwork, exploring and describing how particular environments relate to specific educational theoretical frameworks. This experimental study may be of educational value to higher education instructors and administrators, educational technologists, developers of online instructional software, online instructional designers, and educators interested in the possibilities of this virtual learning environment.

Basically two types of collaborative tools are considered in this experimental study: *standard collaborative tool (Appendix A)*, and *advanced collaborative tool (Appendix B)*. The main difference between the two is that the advanced tool enables students to compile, save, and run their programs inside the collaborative tool, making the learning process more enjoyable and more user-friendly. The advanced tool also enables the instructor and students to see each others' outputs during a session.

THE AIM

The aim of this experimental study has been to find out the effect of using a different kind of collaborative tool in teaching programming language in a Web-based environment.

In order to reach this aim the authors have sought answers to the following questions:

1. What is the difference in the success rate of students using the advanced collaborative tool and the traditional methods of teaching?
2. What is the difference in the success rate of students using the standard collaborative tool and the traditional methods of teaching?
3. What is the difference in the success rate of students using the advanced and standard collaborative tools?

METHOD

Setting

This experimental study has been carried out at the Near East University, Department of Computer Information Systems, using the Moodle together with GREWPtool. The Web-based virtual learning environment developed by the authors and named, NEU-VLE, has enabled students to follow the lessons in their own places of study, using their own computers. It was sufficient just to use the Internet Explorer to access the NEU-VLE system.

Subjects

- The experimental study was carried out between three different groups studying to learn computer programming language, Java. The GCPA (General Cumulative Point Average) grades of the students have been calculated and sorted in a descending list. For the course, 18 students were randomly grouped to use the *advanced* collaborative tool. Similarly, 18 students were randomly grouped to use the *standard* collaborative tool, and 18 students were randomly grouped to use the traditional methods of learning techniques. According to Fraenkel and Wallen (2006) there are no specific rules for determining how large the groups must be in an experimental research.

In order to determine whether or not the GCPA grades of students in each group may affect the results of the research, and if necessary to form new groups, the GCPA of students in each group were tested using paired sample *t*-test. The results were as follows:

- As seen from Table 1, there is no real significant difference ($t = -.10$, $p > .05$) in the GCPA grades of students in the advanced collaborative tool group ($M = 2.45$, $SD = 0.63$) and the traditional learning group ($M = 2.47$, $SD = 0.56$).
- Table 2 shows that there is no real significant difference ($t = -0.94$, $p > .05$) in the GCPA grades of students in the standard collaborative tool group ($M = 2.30$, $SD = 0.73$) and the traditional learning group ($M = 2.47$, $SD = 0.56$).
- Table 3 shows that there is no real significant difference ($t = 0.80$, $p > .05$) in the GCPA grades of students in the advanced collaborative tool group ($M = 2.45$, $SD = 0.63$) and the standard collaborative tool group ($M = 2.30$, $SD = 0.73$).

Based on these results we can say that the groups are suitable for the experimental study, i.e., there was no real significant difference between the GCPA grades of students in each group.

Materials and Procedure

The material is the NEU-VLE system developed by the authors. The Learning Management System MOODLE (www.moodle.org) has been used together with the collaborative tool GREWPtool (http://groupscheme.sourceforge.net/grewpedit)

Table 1. GCPA Grades of Advanced Collaborative Tool Group and the Traditional Learning Group

Groups	*N*	*M*	*SD*	*t*	*p*
Used Advanced Collaborative Tool	18	2.45	0.63	–0.10	0.92
Used Traditional Methods of Learning	18	2.47	0.56		

*The mean difference is significant at the .05 level.

Table 2. GCPA Grades of Standard Collaborative Tool Group and the Traditional Learning Group

Groups	*N*	*M*	*SD*	*t*	*p*
Used Standard Collaborative Tool	18	2.30	0.73	–0.94	0.36
Used Traditional Methods of Learning	18	2.47	0.56		

*The mean difference is significant at the .05 level.

Table 3. GCPA Grades of Advanced Collaborative Tool Group and the Standard Collaborative Group

Groups	*N*	*M*	*SD*	*t*	*p*
Used Advanced Collaborative Tool	18	2.45	0.63	0.80	0.44
Used Standard Collaborative Tool	18	2.30	0.73		

*The mean difference is significant at the .05 level.

in an integrated manner. Both of these are Open-Source software products. Various utilities such as interactive course tool, self-test, assignments, resources which can be downloaded, chat, quiz, and Internal mail have been offered to students independently whenever they wanted. Students met their instructors twice a week using synchronous collaborative tool, where each session lasted for an hour. Collaborative tool has been used to deliver the lessons to the students, and to develop sample programs interactively in cooperation with the students. In addition, students had the chance of communication and exchanging information with each other synchronously, whenever they wanted, using the collaborative tool.

Using the NEU-VLE System

Students using the online NEU-VLE access the system from their places of study at their choice of time, and a typical session is as follows:

- Students enter the system by linking to the Web site: http://cis.neu.edu.tr.
- Students register on the NEU-VLE system using the username and password assigned to them.
- Course notes are prepared in a weekly format and can be accessed by students interactively at any time and from any place. These notes were prepared interactively in SCORM (Sharable Content Object Reference Model) standards.
- After studying the course material students attempt to solve the self-test quizzes. Instructors can create timed assessments that help students to try quizzes multiple times. The system automatically scores multiple choices, true/false, and short answer type questions and can display instructor created feedback, explanations, and links to relevant course material. Although we have only used text, questions can contain images, video, and other multimedia files. The instructor can randomize the questions in a test so that alternative set of questions can be presented to students each time the system is accessed.

- One of the innovative elements of the NEU-VLE system is that students and the instructor can meet at pre-specified times using the collaborative tool. This feature has provided a highly interactive learning environment where students could ask questions to the instructor in an interactive manner while all the students could participate in such interactive sessions. With the creation of the collaborative learning environment students felt more like in a traditional classroom.

During a synchronous session students can either exchange information with all the other students in the group, or with just one particular student in private, or with the instructor. This makes the students to be motivated and also feel more comfortable. During a collaborative tool session students could record and save all communication which took place in the session and then, if they wished, the recording could be played back. Students using the standard collaborative tool could copy the programs developed jointly to their own PCs and then compile and run these programs. On the other hand, students using the advanced collaborative tool could save and compile a jointly developed program. The result of the compilation could be seen on their own screens and after a successful compilation they could run and test their programs. A student could see the screen of the instructor or the screen of another student by clicking on the name in the list-box. As a result of this collaborative study students could interact with each other, have discussions, and correct each others' mistakes.

NEU-VLE system has given the opportunity to the instructor to analyze the progress of each individual student in detail. Students were given the opportunity to see their own activity and progress reports so that they could assess their own status within the class.

A typical Moodle screen layout is shown in Figure 1. Course notes were largely in text format with audio enhancements at appropriate places. Students normally follow the course notes in the order shown on their screens. Sections of the course notes can be repeated as many times as required until the student is comfortable with the contents. It is recommended that students attempt to solve the quizzes at the end of each section and a high grade is a requirement. A section from the course notes is shown in Figure 2. As described earlier, course notes have been prepared using the SCORM standards and then integrated to Moodle by the instructor.

Data Collection and Analysis

In order to find out the success rates of students, two assessments have been carried out as outlined below:

1. *Assessment1:* The first assessment was carried out in the middle of the semester (after about two months). The NEU-VLE experimental study work continued after Assessment1.

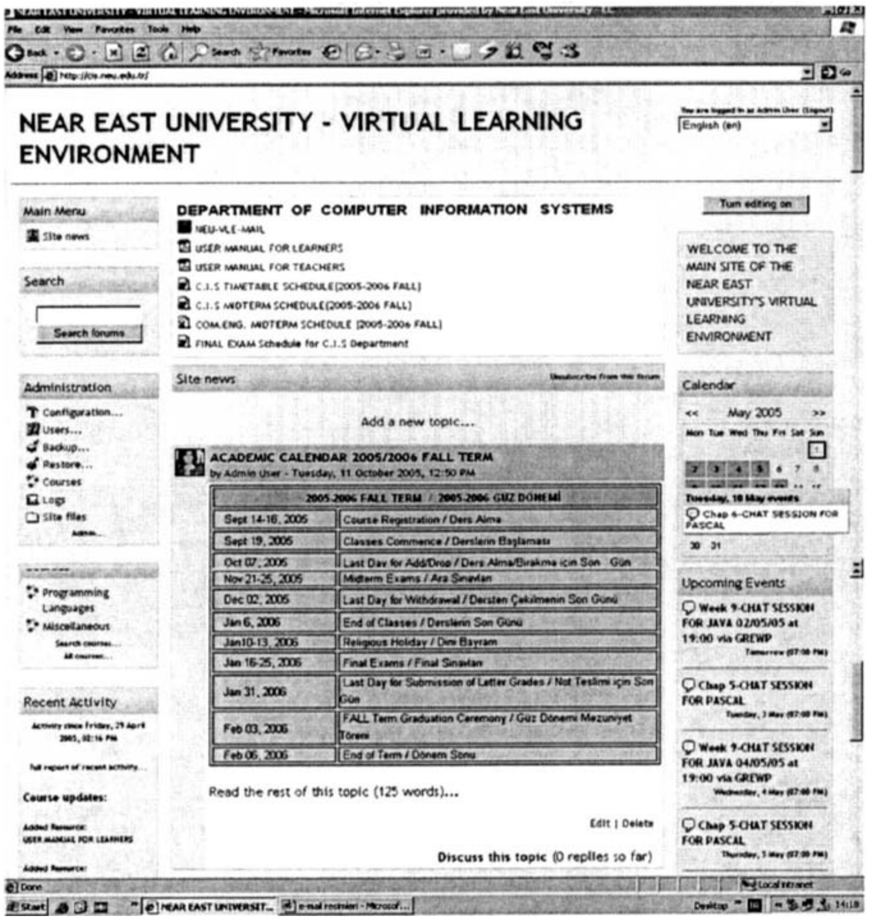


Figure 1. A typical Moodle session.

2. *Assessment2:* At the end of the semester (after four months) Assessment2 was carried out to find students' success rates. Assessment2 consisted of only the topics learned after Assessment1.

- The assessments consisted of five essay (restricted response) type and 10 multiple choice questions and the results were analyzed using paired sampled *t*-test based on the mean values of the assessment grades.
- Students in the experimental and the traditional learning groups took their assessments at the same time and at the same place during two hours at the University.

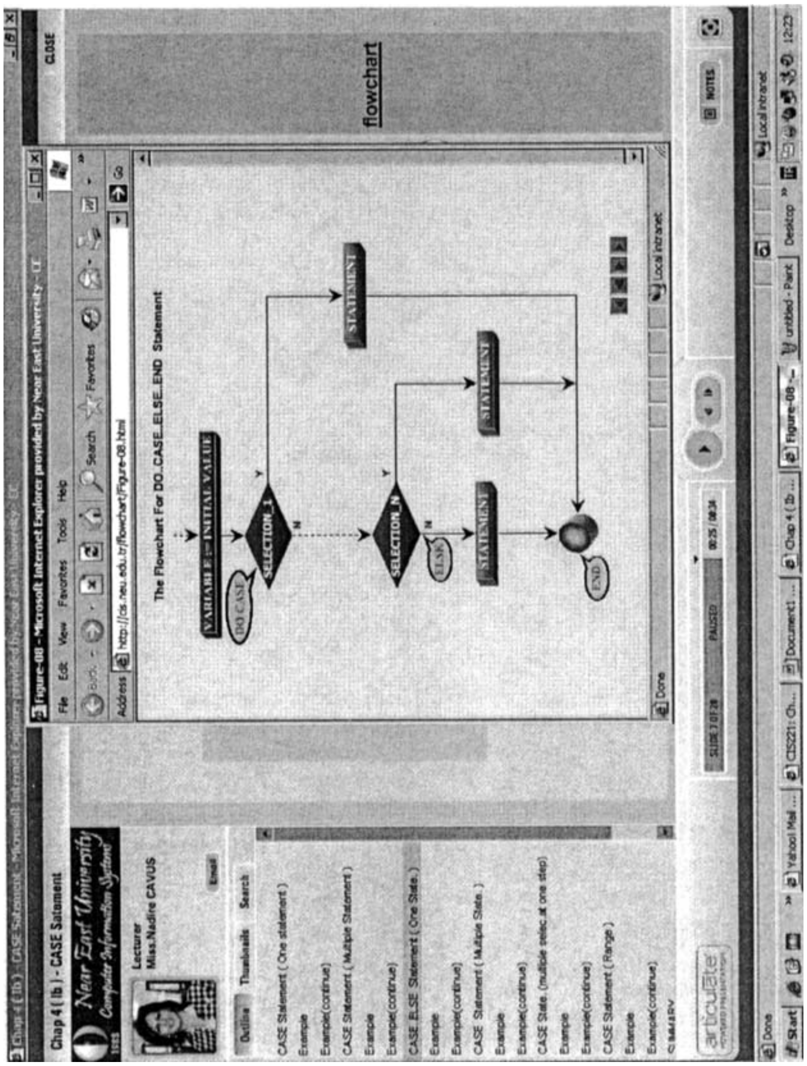


Figure 2. Section of course notes.

- The validity and reliability of the assessment papers were confirmed by two experts in the field of computer programming languages and two curriculum and instruction experts. The papers were modified based on the feedback received from these experts and then the papers have been evaluated by two experts in the field of computer programming languages who didn't know the identity of students as the names of students were hidden during the evaluation of the papers. The papers were evaluated on a scale of 100 as being the top mark and the results were analyzed based on the average grades.

RESULTS

The results given in this section are based on the student grades obtained in Assessment1 and Assessment2.

Findings about the Success Rates of Students Using the Advanced Collaborative Tool

In order to find out whether or not there was any statistically significant difference between students using the advanced collaborative tool and traditional methods of learning, a paired sampled *t*-test was carried out and the results are shown in Table 4.

Assessment1 results clearly indicate that students using the advanced collaborative tool (M = 71.83, SD = 17.33) had higher success rates than those learned using the traditional methods of learning (M = 57.06, SD = 12.54). A paired sampled *t*-test based on Assessment1 results has indicated a significant difference between the two groups ($t = 2.93$, $p < .05$).

Assessment2 results are similar to Assessment1 results and they show a higher success rate for the group using the advanced collaborative tool. The results of the paired sampled *t*-test found a significant difference between the two groups ($t = 2.84$, $p < .05$) in favor of the group using the advanced collaborative tool.

The reason why there was significant difference between the two groups in Assessment1 could be because students using the advanced collaborative tool could reach their instructor any time, from their own places of study, with their own learning paces. Because they were not face to face with their instructor, they could ask any questions to them without being shy. This may be considered to be one of the reasons for success. The difference between the two groups was higher in Assessment2 probably because students gained experience and confidence of using the advanced collaborative tool.

Based on these results we can say that an LMS together with an advanced collaborative tool could be used for the successful teaching of programming languages in a Web-based environment.

Table 4. The Success Rate of Students Using the Advanced Collaborative Tool and the Traditional Methods of Learning

	Groups	*N*	Mean	*SD*	Mean difference	*t*	*p*
Assessment1	Used Advanced Collaborative Tool	18	71.83	17.33	14.78	2.93	0.01
	Used Traditional Methods of Learning	18	57.06	12.54			
Assessment2	Used Advanced Collaborative Tool	18	72.83	19.81	14.83	2.84	0.01
	Used Traditional Methods of Learning	18	58.00	10.02			

*The mean difference is significant at the .05 level.

Findings about the Success Rates of Students Using the Standard Collaborative Tool

In order to find out whether or not there was any statistically significant difference between students using the standard collaborative tool and traditional methods of learning, a paired sampled *t*-test was carried out and the results are shown in Table 5.

Assessment1 results clearly indicate that students using the standard collaborative tool ($M = 57.39$, $SD = 13.99$) had approximately similar success rates as those learned using the traditional methods of learning ($M = 57.06$, $SD = 12.54$). A paired sampled *t*-test based on Assessment1 results has not indicated a significant difference between the two groups ($t = 0.08$, $p > .05$) in favor of the group using the standard collaborative tool.

Assessment2 results are similar to Assessment1 results and they show an approximately similar success rates as those learned using the traditional methods of learning. It is also interesting to notice that results of the paired sampled *t*-test didn't find a significant difference between the two groups ($t = 0.03$, $p > .05$) in favor of the group using the standard collaborative tool.

Based on these results, we can say that the properties of the selected collaborative tool should be compatible with the teaching of the general structure of the programming language, and this may be considered to be one of the reasons for failure of chosen collaborative tool.

Table 5. The Success Rate of Students Using the Standard Collaborative Tool and the Traditional Methods of Learning

	Groups	*N*	Mean	*SD*	Mean difference	*t*	*p*
Assessment1	Used Standard Collaborative Tool	18	57.39	13.99	0.33	0.08	0.94
	Used Traditional Methods of Learning	18	57.06	12.54			
Assessment2	Used Standard Collaborative Tool	18	58.11	15.74	0.11	0.03	0.98
	Used Traditional Methods of Learning	18	58.00	10.02			

*The mean difference is significant at the .05 level.

Findings about the Success Rates of Students Using the Advanced Collaborative Tool and Standard Collaborative Tool

In order to find out whether or not there was any statistically significant difference between students using the advanced collaborative tool and the standard collaborative tool, a paired sampled *t*-test was carried out and the results are shown in Table 6.

Assessment1 results clearly indicate that students using the advanced collaborative tool (M = 71.83, SD = 17.33) had higher success rates than those using the standard collaborative tool (M = 57.39, SD = 13.99). A paired sampled *t*-test based on Assessment1 results has indicated a significant difference between the two groups (t = 2.75, p < .05) in favor of the group using the advanced collaborative tool.

Assessment2 results are similar to Assessment1 results and they show a higher success rate for the group using the advanced collaborative tool. It is also interesting to notice that results of the paired sampled *t*-test found a significant difference between the two groups (t = 2.47, p < .05) in favor of the group using the advanced collaborative tool.

Results of Assessment1 and Assessment2 both indicate that the success rate is higher when an advanced collaborative tool is used for the teaching of programming languages. The properties of the selected collaborative tool were compatible with the teaching of the general structure of the programming language to be taught, and this may be considered to be one of the reasons for success.

Table 6. The Success Rate of Students Using the Advanced and Standard Collaborative Tools

<table>
<tr><th></th><th>Groups</th><th>N</th><th>Mean</th><th>SD</th><th>Mean difference</th><th>t</th><th>p</th></tr>
<tr><td rowspan="2">Assessment1</td><td>Used Advanced Collaborative Tool</td><td>18</td><td>71.83</td><td>17.33</td><td rowspan="2">14.44</td><td rowspan="2">2.75</td><td rowspan="2">0.02</td></tr>
<tr><td>Used Standard Collaborative Tool</td><td>18</td><td>57.39</td><td>13.99</td></tr>
<tr><td rowspan="2">Assessment2</td><td>Used Advanced Collaborative Tool</td><td>18</td><td>72.83</td><td>19.81</td><td rowspan="2">14.72</td><td rowspan="2">2.47</td><td rowspan="2">0.02</td></tr>
<tr><td>Used Standard Collaborative Tool</td><td>18</td><td>58.11</td><td>15.74</td></tr>
</table>

*The mean difference is significant at the .05 level.

The descriptive results obtained in the experimental study are summarized in Figures 3 and 4.

CONCLUSION

It is an important result that the experimental study carried out indicated that students using the advanced collaborative tool have shown statistically significant success rates. Although the common properties between the Advanced Collaborative Tool and the Standard Collaborative Tool, such as the ability to communicate with the instructor, sending messages to each other, and the presence of an editor are very important, these properties are not sufficient for the successful teaching of a programming language in Web-based environment. We can say that compiler/run feature and the ability of the instructor and students to see each others' outputs have added an effective learning power to advanced collaborative tool. This should be considered as a superiority of the advanced collaborative tool, especially in relation to teaching programming languages. It is interesting to note that this result is similar to the results reported by Booz (2004).

Students using advanced collaborative tool have been more successful than those using the standard collaborative tool group. One of the reasons for this is that advanced collaborative tool offers compile and run utilities. It is the authors' opinion that these tools may have increased the motivation of students, and this point is one of the fundamental reasons why students using the advanced collaborative tool were more in favor of the NEU-VLE system. It is not sufficient to use only the tools such as chat, discussion forums, or whiteboard in Web-based teaching of programming languages. As a nature of programming languages, when students have problems it may not always be possible to describe these

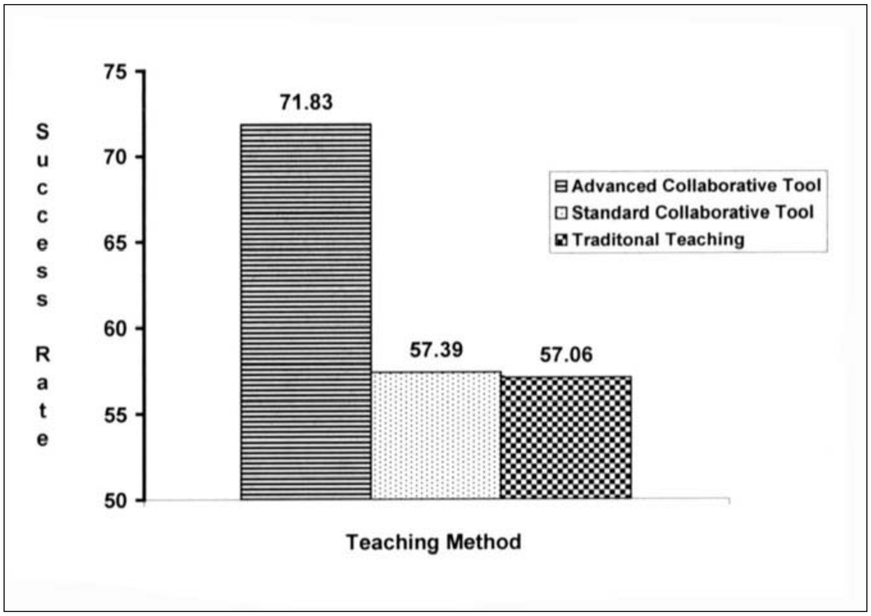


Figure 3. Comparison of success rates in Web-based teaching (Assessment1).

problems easily to their instructors. But, if either the program or the output from the program/compiler can be sent to the instructor, or if better the instructor and the student can see each others' outputs and work on the same program collaboratively, then a more efficient study environment can be established. Students can then solve their programming problems as a result of such collaborative studies. In other words, if the instructor and students work on the same problem at the same time then greater success can be achieved and students can learn the programming language easier and quicker.

As a result of this experimental study we can say by confidence that an LMS system with an integrated advanced collaborative tool can improve the success rates of students considerably during the teaching of programming languages in a Web-based environment.

The results of the experimental study showed that a Learning Management System can be made more efficient if it is enhanced by an advanced collaborative learning tool. In this article we have used the Moodle together with the GREWPtool for the teaching of programming languages.

The NEU-VLE system is currently being used at the Department Of Computer Information Systems of the Near East University. Both Java and Pascal programming languages are taught to undergraduate students using this system.

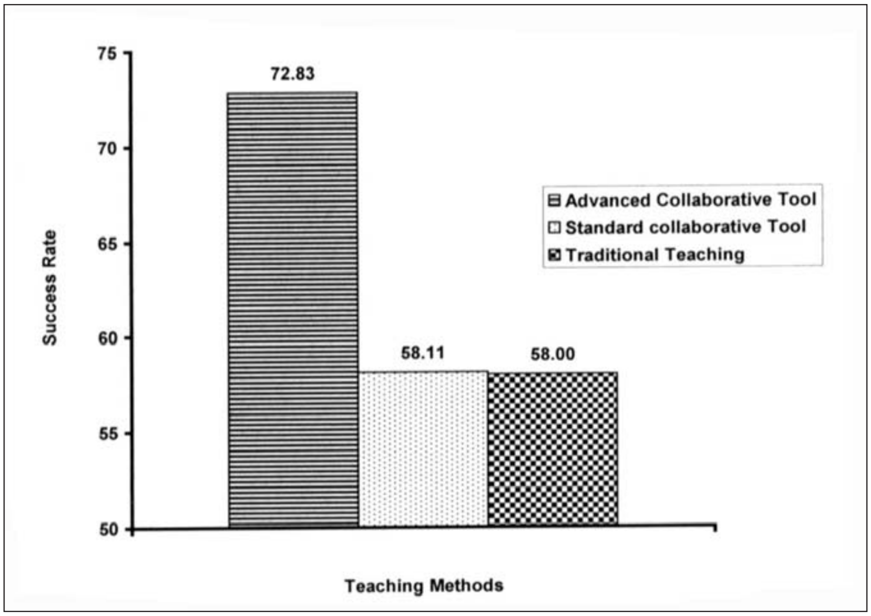
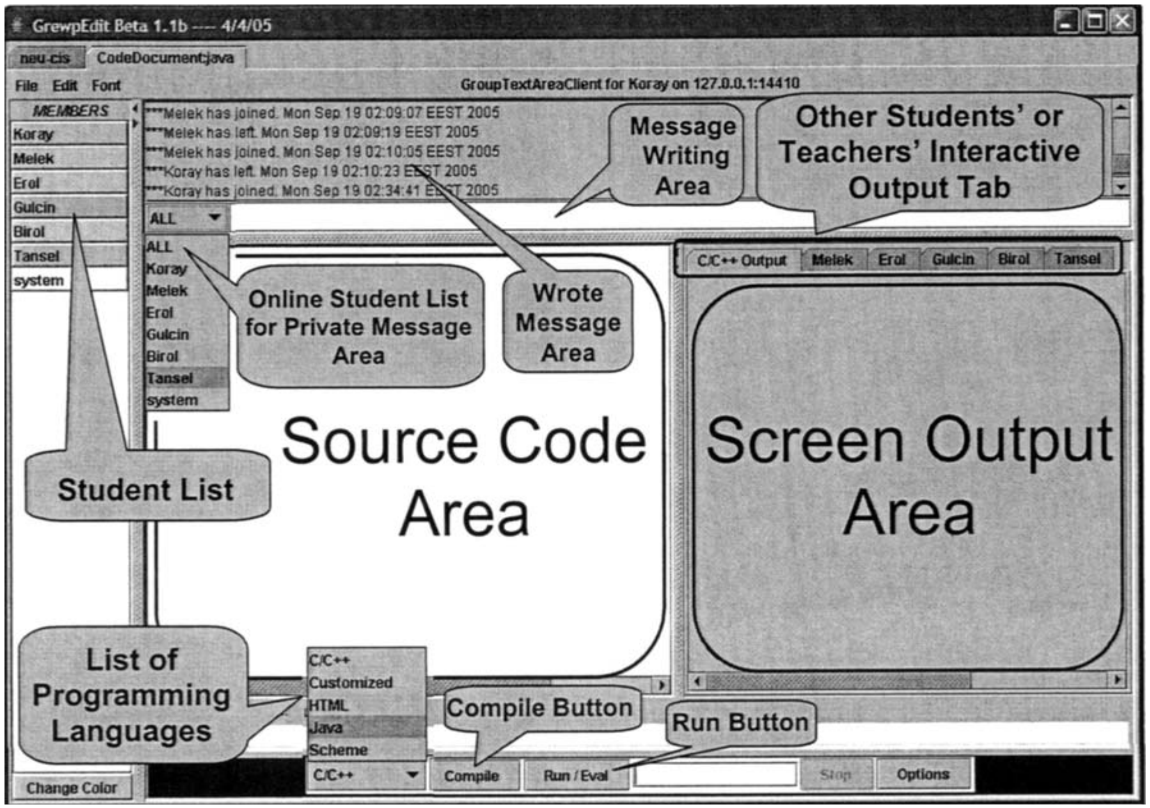


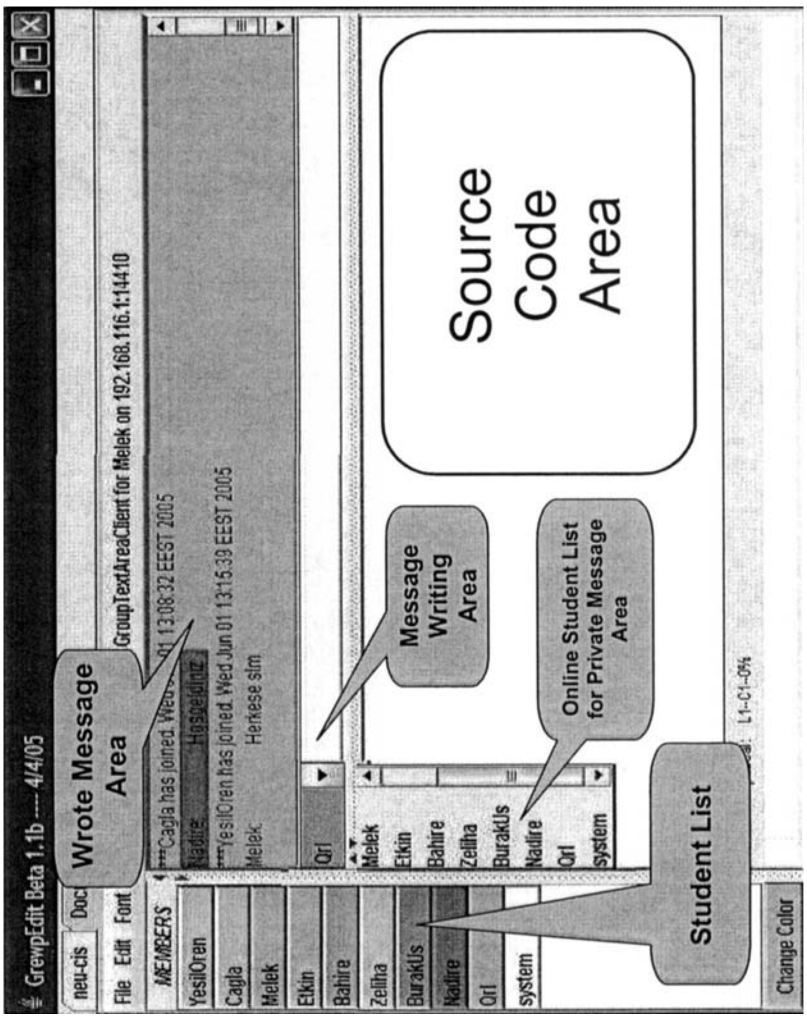
Figure 4. Comparison of success rates in Web-based teaching (Assessment2).

Students can use the LMS any time and from their own places of study. But the collaborative tool is used twice a week (one hour per session) only in advanced mode, since this mode has been analyzed and accepted to be superior to the standard collaborative tool mode. Usage data is being collected continuously and it should be possible to further elaborate the benefits of the system and student success rates once enough data has been collected for several semesters.

It appears that in common with other LMS systems, although Moodle on its own is sufficient and successful to deliver the lecture notes, it lacks the *instructor-student* and *student-student* interaction which exists in a "real" classroom environment. It is our recommendation that current and future LMS systems should incorporate an advanced collaborative tool so that the benefits of learning in a class-like group environment can be achieved.



APPENDIX A: Advanced Collaborative Tool



APPENDIX B: Standard Collaborative Tool

REFERENCES

Bannan-Ritland, B., Bragg, W., & Collins, M. (2001). Linking theory, educational constructs, and instructional strategies in Web-based course development. In P. Robinson & B. Bannan-Ritland (Eds.), *Web-based computer conferencing.* Sterling, VA: Stylus Publishing. Retrieved February 1, 2006, from http://www.provost.harvard.edu/factech/factech01/BannanWB.pdf.

Booz, W. (2004). The virtual curriculum laboratory: An online collaboration sandbox. In C. Crawford, D. Willis, R. Carlsen, I. Gibson, K. McFerrin, J. Price, & R. Weber (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2004* (pp. 2821-2826). Chesapeake, VA: AACE.

Chase, J., & Okie, E. (2000). Combining cooperative learning and peer instruction in introductory computer science, *SIGCSE Bulletin, 32*(1), 372-376.

Chi, M. T. H., Bassok, M., Lewis. M. W., Reimann, P., & Glaser, R. (1989). Self-explanations: How students study and use examples in learning to solve problems. *Cognitive Science, 13*, 145-182.

Fraenkel, J. R., & Wallen, N. E. (2006). *How to design and evaluate research in education* (6th ed., McGraw-Hill International ed.). New York: McGraw-Hill.

Hall, J. (2003). *Assessing learning management systems.* Oracle University, Web site: www.clomedia.com.

Harasim, L. (1990). Online education: An environment for collaboration and intellectual amplification. In L. Harasim (Ed.), *Online education: perspectives on a new environment* (pp. 39-64). New York: Praeger.

Hubscher-Younger, T., & Narayanan, N. H. (2003). Constructive and collaborative learning of algorithms. *Proceedings of the 34th SIGCSE technical symposium on computer science education, 1-58113-648-X, 6-10*, Reno, NV.

Jonassen, D., Davidson, M., Collins, M., Campbell, J., & Bannan-Haag, B. (1995). Constructivism and computer-mediated communication in distance education. *The American Journal of Distance Education, 9* (2), 7-26.

Jones, C., & Timpson, W. M. (1991). Technologically mediated staff development: A retrospective case study. *The American Journal of Distance Education, 5*(1), 51-56.

Jung, I., Choi, S., Lim, C., & Leem, J. (2002). Effects of different types of interaction on learning achievement, satisfaction and participation in Web-Based Instruction. *Innovation in Education and teaching International, 39*(2), 153-162.

Kiesler, S. (1992). Talking, teaching, and learning in network groups: Lessons from research. In A. Kaye (Ed.), *Collaborative learning through computer conferencing: The Najaden papers* (pp. 117-136). Berlin: Springer-Verlag.

Lave, J., & Wenger, W. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge, UK: Cambridge University Press.

Lebow, D. (1993). Constructivist values for instructional systems design: Five principles towards a new mindset. *Educational Technology Research and Development, 41*(3), 4-16.

Liu, S. (2005). Faculty use of technologies in online courses. *International Journal of Instructional Technology & Distance Learning.* Retrieved November 02, 2005, from: http://www.itdl.org/Journal/Aug_05/article03.htm.

McDowell, C., Werner, L., Bullock, H., & Fernald, J. (2002). The effects of pair-programming on performance in an introductory programming course. *Proceedings of SIGCSE 2003* (pp. 38-42). New York: ACM Press.

Moore, M. (1994). Autonomy and interdependence. *American Journal of Distance Education, 8*(2), 1-5.

Roschelle, J. (2003). Learning by collaborating: Conceptual change. *The Journal of the Learning Sciences, 2,* 235-276.

Sabin, R. E., & Sabin, E. (1994). Collaborative learning in an introductory computer science course, *SIGCSE Symposium on Computer Science Education,* (pp. 304-308).

Sharan, Y., & Sharan, S. (1992). *Expanding cooperative learning through group investigation.* New York: Teachers College Press.

Sheingold, K. (1991, September). Restructuring for learning with technology: The potential for synergy. *Phi Delta Kappan,* 17- 27.

Taneva, S., Alterman, R., Granville, K., Head, M. R., & Hickey, T. J. (2004). GREWPtool: *A system for studying online collaborative learning.* Computer Science Department, Brandeis University, Waltham, MA 02454. Retrieved August 03, 2006, from: http://group.cs.brandeis.edu/~group/papers/GREWPtool.pdf.

Truong, N., Bancroft, P., & Roe, P. (2003). A web based environment for learning to program. *ACM International Conference Proceeding Series, Vol. 35* (pp. 255-264), Australian Computer Society, Inc., Darlinghurst, Australia, ISSN: 1445-1336, 0-909-92594-1.

Uzunboylu, H. (2006). A review of two mainline e-Learning projects in the European Union. *Educational Technology Research and Development, 54*(2), 2006.

William, L., & Upchurch, R. L. (2001). In support of student pair-programming. *Proceedings of the 32nd SIGCSE Technical Symposium on Computer Science Education, 1-58113-329-4, 327-331*, Charlotte, NC.

Wisher, R. A., Belanich, J., & Orvis, K. L. (2004). A question-collaboration approach to web-based learning. *American Journal of Distance Education, 18*(3), 169-185 (doi:10.1207/s15389286ajde1803_4).

Zhai, M., & Liu, S. (2005). *Technology use in an online program.* 21st Annual Conference on Distance Teaching and Learning. Madison, WI.

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