A STUDY OF UNDERGRADUATE COMPUTER SCIENCE STUDENTS PROJECTS

Dr. Mansoor Al-A'ali
Department of Computer Science
University of Bahrain

Abstract

In the same fashion as their international counterparts, undergraduate students doing B.Sc. in Computer Science in Bahrain must complete a final year graduation project in order to graduate. The project can either be practical or research oriented in nature, depending on the student's choice and what the supervisors offer. In this paper, we investigate the factors affecting the students' choice of graduation projects. The survey classifies students into three groups: students who have completed their graduation projects, students currently working on their projects, and students who are due to start on their projects. The outcome of this research can be used to guide the Computer Science departments to resolve these issues and provide alternatives in order to encourage the students to make the right choice and in order to graduate a diversity of students with knowledge in both the research and practice of Computer Science. This research is believed to focus primarily on computer science students' projects.

Keywords: graduation project, research project, computer science projects, B.Sc. computer science, practical projects, theoretical projects, undergraduate skills, graduate skills.

Introduction

Pinning a standard curriculum is difficult; there are many preferences which are hard to accommodate. Part of the problem is the fact that, unlike more established disciplines; the subject does not clearly distinguish the study of principles from the study of artifacts. In addition, the attitude changes of entry-level University students towards computers should be analyzed in order to discover the differences between the perceptions and attitudes of students[1],[2],[5].

Students who are doing B.Sc. in Computer Science (CS) need to attain life-long skills in research, communication skills (technical report writing, presentation) as well as the ability to complete a graduation project individually and reach some conclusions by either developing a piece of software and making it work or by analyzing a theoretical concept. They need to possess the ability to work efficiently in a team environment or individually. Whether the current curriculum of the B.Sc. in computer science helps the students in achieving this goal needs to be investigated.

There are two types of computer science projects, theoretical and practical. Theoretical projects focus mainly on systematic investigation or research to identify solutions to certain problems or to improve existing techniques. Some theoretical projects involve the development of software that is essential to perform some mathematical operations or data analysis. Practical projects are concerned with the development of software that is used to carry out sophisticated and sometimes complex computer operations. Software is divided into two categories: system software, which includes the operating systems, utilities programs that enable the computer to function, and applications software, which includes programs that perform specific tasks such as e-commerce web applications.

Universities normally require undergraduate Computer Science students to do final year undergraduate projects and they have to write reports for their projects and should complete both the project and the report within a certain period of time[3]. Computer science students

normally learn the fundamentals and principles of computing in several IT courses during their BSc program. They have to apply these principles and train their communication skills as well to recognize the difference between a real-world problem and a textbook problem. Real-world case studies are important to complement the academic skills and knowledge acquired by computer science students[9]. Many students find the transition to traditional practical work difficult so they need training and guidance to do real life project work. In order to prepare students for their real life projects, some sophomore-year courses include mini-projects[8].

Computer science students do their projects either individually or within a team. Some projects require teamwork due to the size or complexity of the project and this matches real life situations because teams involve a diversity of knowledge and skills[4]. Students need to acquire life-long skills such as: an awareness of need to function in the internationally networked world, skills in communication both oral and written, ability to work productively in teams and flexibility and adaptability in the job market[10].

The importance of senior projects in the Computer Science curriculum is because it develops students who will be independent and lifelong learners as well provide a venue for them to connect learning, life, and work. Further, a senior project is very important to Computer Science students because it gives them a chance to apply and develop their abilities and skills. One major objective of such a project is to develop students' technical skills[8]. Another objective is to implement the theories and principles, which they learnt in their senior courses and they can obtain experience, knowledge and technical skills as well as learn how to manage a large project within a deadline[3]. Other researchers show that it is an opportunity for students to learn to apply and integrate the knowledge gained in different courses[9].

By nature, we are different in our preferences and this can be seen in the student's selection of a computer science field to do their project in. Most work in the workplace is not done individually[10]. Projects vary considerably in their style. Some can largely be developing programs, while others are minor research projects. Undergraduate research project work is very demanding and requires a lot from the students[8]. The computer science curriculum doesn't normally have enough courses that encourage and help students to participate in research projects. The curriculum contains a series of project-based courses, in which real-world situations are simulated as closely as possible[9]. Undergraduate students do not have enough skills to help them do research projects. The faculty supervision, helping younger constantly struggling computer science students understand and visualize the new computing concepts is important to their research success[7]. Practical projects are normally easier than research projects. Students normally implement a lot of software of different levels of complexity; however, they do not get the chance to do research to recognize the difference between both types of projects. Many students find the transition from traditional practical work to open ended research projects difficult[8]. Practical projects normally require less time than research projects and graduating computer science students have the knowledge and skills involved in the development of software. Practical projects require software development and a lot of analysis time, implementing, testing and debugging. Students' desire to finish the work on time and to please the supervisor[3] and they normally feel safer with a practical project. Practical projects appear to students to be more useful than research projects. The benefits of real-world exercises are known, however, there is a sharp contrast between real case studies and constructed exercises[9]. Practical projects increase the experience and the chances of finding a job especially since the market in Bahrain and the gulf requires more practical software knowledge rather than research.

Presenting better guidance, advising towards the research projects, improving some courses and adding more courses related to research projects would certainly encourage students to take on research oriented projects. With hindsight a number of the third year students feel that the mini-projects have to be improved[8]. Providing more scholarships to the students who present outstanding research projects, offering more seminars that expand the students' knowledge on the difference between types of projects and discussing the importance and the benefits of both types of projects, providing more resources that help students and enhance their research skills are all factors that can only direct some students to accept the challenge of a research oriented project.

When the students finish their projects either practical or research based, they must prepare a report. The project report provides a complete account of the students' efforts towards completing the assigned project. Good report writing skills gives an easy flow for the reader; good report writing skills is as important as a good project. The purpose of the report is to inform and influence the reader that the project was worth doing. The data, the questionnaire used and the complete analyses are contained in a technical report[10]. The University must provide courses that involve the students in more technical writing practices. Repeated practice would be associated with superior writing skills[6].

Research projects will promote the university level by getting better academic value for students and the department and by getting credit that its students will be strong enough to continue their postgraduate programs and most of these programs require research. Furthermore, Computer Science students gain a lot of benefits to their present and future life when they do research projects. Whether Computer Science students are willing to research to achieve those benefits must be analyzed and evaluated. Students yearn for improving and increasing their knowledge and developing their skills and abilities and recognize and value the opportunity to develop their skills[8]. Most students would like to graduate with high skills and abilities in practical and research projects.

This research was intended to expose the issues causing Computer Science students to choose practical over theoretical projects. The outcome of this research will be used to guide the computer science departments to resolve these issues and provide alternatives by adding new courses and modifying others in order to encourage the students to make the right choice and in order to graduate a diversity of students with knowledge in both the research and practice of Computer Science.

To achieve these objectives we composed a carefully prepared survey addressed to the students at different project statuses. The survey targeted three main groups of Computer Science students, the first group have recently completed their projects and graduated, the second group of students are currently doing their projects and the third group are due to start their projects.

Computer Science Undergraduate Project Philosophy

Graduation or senior project courses are compulsory for Computer Science students at most universities. Computer science students are required to carry out graduation projects on theoretical and/or practical topic in computer science. These projects enable the students to apply the Computer Science knowledge that they should have acquired during their studies. They may work individually or in teams (usually 2-3 students) with one faculty advisor. The students must submit a final written formal report outlining the various phases and results of the projects and make an oral presentation.

Computer science includes many fields: Databases, Networks, Operating Systems, Multimedia, Artificial Intelligence, Information Security, Image Processing, Robotics, Programming Languages, Internet concepts, Systems Development, Data Structures,

Application Packages, Neural Networks, Computer Architecture, Software Engineering, Systems Analysis and Design, Formal Languages and Automata, Discrete Structures, Natural Language Processing, etc. Students may choose a topic that they are most familiar with and interested in and this interest is normally triggered after completing a course on the topic concerned. A supervisor is then selected to supervise the project and the supervisor will direct the project and sort out the difficulties faced by the students.

Once the students complete their piece of work, they are supposed to write a report describing their work and achievements and they are supposed to apply technical report writing skills. It is acceptable in their reports to include relevant quotations from books, research papers, the Internet and other technical reports in the department. Students should then give a presentation summarizing the contents of their project. In the University of Bahrain, three faculty members assess the student project independently and together they will agree on a mark. The main criteria for assessment by the faculty members are: complexity of the project, size of the project, level of analysis, literature review, research contents, practical element, technical report writing skills of the project report, originality of the work, ability to defend their own work, quality of the presentation, etc.

The Senior Project has many objectives and benefits such as:

- Graduate students who will be independent and lifelong learners.
- Develop an environment that fosters cross-curricular mentorship and resources.
- Provide a venue for students to connect learning, life, and work.
- Prepare students to do research or a post-graduate degree.
- Prepare students for job interviews, since it gives students a subject to discuss in detail, together with an opportunity to demonstrate their powers of organization, time-management and communication.

In this research a survey was conducted to thee different groups of students totaling 92 students of computer science from three different universities in Bahrain. Group 1 consisted of 23 students who have already completed their projects and graduated. Group 2 consisted of 18 students who are due to graduate and currently working on their projects. Group 3 consisted of 51 students who are due to graduate but haven't started their projects yet. A total of fourteen questions were asked to each of the 92 students. The questions were designed in such a way to identify the reasons why students choose to do mostly practical projects and if anything can be done to direct them to do research oriented projects. The questionnaire covered many aspects of student projects in relation to the computer science curriculum and the job market. The main aim was to identify the shortcomings of the current curriculum with regards to the graduation projects: the research methods, the student interests, the role of the faculty, the IT job market, the technical report writing skills, the fields of computer science, the time factor, alternatives to doing a project, motivations for doing practical projects, weaknesses in the curriculum, etc. The result of each of the fourteen questions is analyzed on its own and in relation to other relevant questions. No emphasis whatsoever was given to the issues of male and female students.

Results and analysis

The questions and the results of students' questionnaire are obtained from the three different groups as follows:

Group1: students who have completed their projects = 23 (11 male and 12 female)

Group2: students currently working on their projects = 18 (10 male and 8 female)

Group3: students who are due to start their projects = 51 (6 male and 45 female)

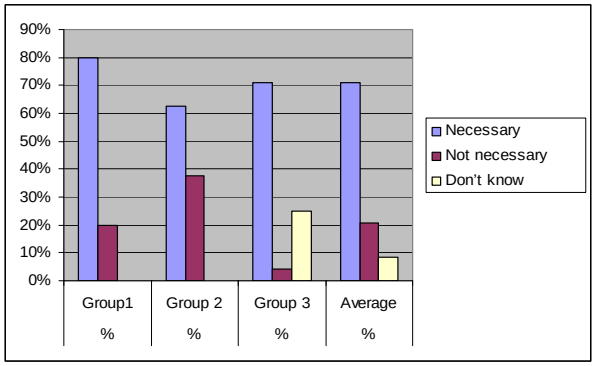

Figure 1: Do you think that the senior project is necessary in your study.

1: Do you think that the senior project is necessary in your study?

1- Necessary
2- Not necessary
3- Don't know

The majority of students, average of 71%, consider the senior graduation project as necessary, see Figure 1. Students from groups 1 consider it to be more necessary than the other two groups and this must be because they have realized the benefits after completing their projects and graduation as compared to doing an extra taught course. It is still worth considering the other responses where 20% of group 1 and 37% of group 2 thought that the project is not necessary. This must be due to their lack of confidence that one day they will be asked to do a major project on their own in the work environment and consider themselves to be just programmers or operators without decision making capacity. A quarter of group 3 students has not made their mind up and is thus subject to influence through seminars or from within taught courses that advocate an element of research. Students of group1 and group 2 are clearly aware of the project objectives and hence none of them gave the answer don't know. We can conclude that the graduation project must be kept as part of the Computer Science curriculum and that students appreciate its importance once they complete it.

2: What in your view is an alternative to doing a graduation project?

1- No alternative
2- Doing an extra course
3- Training in a company

When students were asked about what they thought was an alternative to Computer Science projects, the following answers were given: doing an extra course (20%), no alternative (67%), training in companies (13%). We can conclude from these responses that doing an extra course is valued by only 20% of students because students appreciate taught courses and possibly because some students may either have a phobia about doing a project or think that a project does not really teach anything extra. Some students thought that an alternative to doing a project is by doing training in a company, but the problem with training is that there is no guarantee it would meet the aspirations of the students or achieve equivalent requirements to projects. The majority of students (67%) though would not accept an alternative to doing a project and this must come from appreciating the benefits of the project. Students who opted for an alternative could be as a result of their departments not doing enough to educate the students about the benefits of doing a project.

3: Do you prefer to do a practical project or a theoretical research oriented project?

1- Practical project
2- Theoretical research oriented project

By referring to Figure 2, we notice that the majority of the students in the three groups (average 67.23%) prefer the practical project to doing a theoretical research project and this could be because they are more familiar with developing a practical piece of software to solve a specific problem using a specific programming tool. It is noticeable that group 3 who have not yet started their senior project feel more confident or safe with the practical project. Around 40% of groups 1 & 2 do not prefer to do a practical project and this could be because

they have learnt the skills of developing a practical piece of software and would like to learn another skill such as research. Our conclusion is that since 40% of students are interested in learning the research skills they should be encouraged in this direction in order to contribute to staff research and to prepare them for postgraduate research or for doing basic research at their future work place.

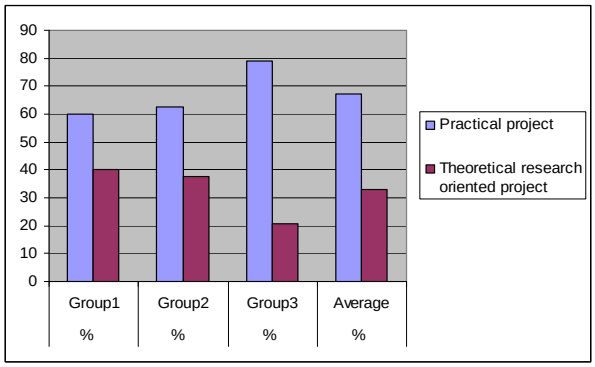

Figure 2: Do you prefer to do a practical project or a theoretical research oriented project.

4: In which of the following fields you have done or would like to do your project?

1- Networking
2- Databases
3- Operating Systems
4. JAVA/C++
5- Multimedia
6- Web development
7- Artificial Intelligence

This question produced some very interesting results where the majority of group 1 students preferred to do their projects in databases (40%) or networking (30%) and none of them were interested in doing their projects in operating systems, C++ or Java. This must mean that they do not think they will have a chance to work on Java or C++ development or operating systems or that these two courses require some improvement in presenting the potential of these two fields. Multimedia and web development received only 10% of the interest and the students' comments is that they found them to be interesting but easy to learn and thus they do not need to do more than they learnt in the taught courses. This must mean that the courses have enough practical elements and the associated course project is sufficient for the students to learn the skills for developing multimedia and simple web based systems. Overall, students chose all the subjects given in Figure 3 which is expected, but databases received the highest score (28.6%) then multimedia (18.6%) then networking (15.56%). The lowest score was given to programming languages and operating systems. People by nature are different and hence the different choices they would normally make. One unexpected result is Artificial Intelligence which received an average of 11.67%. Although the Bahraini and gulf job market do not have much room for Artificial Intelligence jobs, some students still opted for Artificial Intelligence projects.

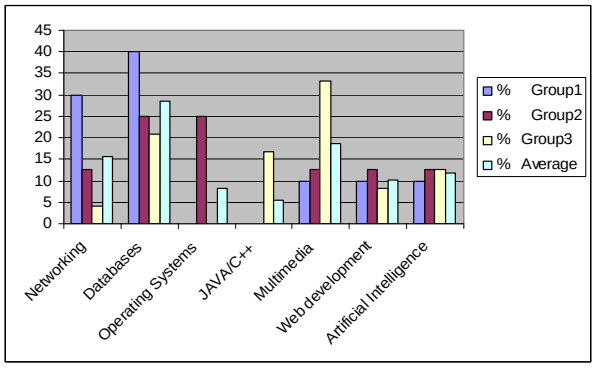

Figure 3: In which of the COMPUTER SCIENCE fields you would like to do your project

Group 2 put lesser emphasis on networking than group1 and put more on operating systems. Java and C++ received a zero vote of interest and commented on as easy fields. This meant that the students preferred to learn new tools for their project to add to their wealth of development tools which must mean that we should teach a variety of programming tools rather than focus mostly on Java and C++.

Group 3 gave more evenly distributed interests which must indicate that they have not finalized their decisions because they are still doing their taught courses and are thus still subject to influence.

Databases received the majority vote and this must be because most students find this field to be directly related to the job opportunities.

5: Reasons for choosing a practical project rather than a theoretical research oriented project? (You may tick more than one choice).

1- Practical projects are easier than research projects
2- Practical projects require less time than research projects
3- Practical projects are more useful than research projects
4- Practical projects increase the experience and the chances of finding a job
5- You do not have enough research skills that help you to do research projects
6- You do not have enough knowledge that helps them to do research projects

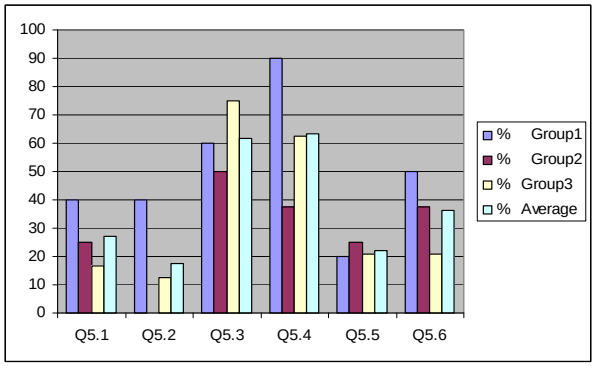

Figure 4: Reasons for choosing a practical project rather than a research project.

As shown in Figure 4, only 40% of the group1 students thought the practical projects are easier than the research projects and they require less time to complete. 60% of Group 1 students thought that practical projects are more useful in real life and this was confirmed in a stronger way when 90% of these students thought that practical projects help them get a job. This means that the majority are looking for an immediate job and they want to take the shortest path to getting it. Only 20% thought that they do not have the necessary experience to do research projects which must mean that with developing their research skills and emphasizing the benefits of research projects could turn more of them into doing research. When we analyze this 20% answer with the 50% of students who thought that they do not have enough knowledge to do research projects, we can then conclude that more students might take on research projects if they have the knowledge of doing research which confirms our earlier conclusion that research skills and knowledge can be disseminated to undergraduate students.

All the group 1 students have completed practical projects and hence appreciate the loss of not gaining the knowledge of doing research projects because they realized that the achievement of doing a practical project did not add too much to their skills in this aspect which was gained from the individual course projects that they have been doing throughout their four years of study.

6: Which of the following benefits you think that the students get when they do research projects

1- The students learn new technologies and concepts
2- Research projects increase the knowledge and information of the students
3- Research projects open the door to the students for innovations and creativity
4- Research projects qualify students to continue their postgraduate education.

The four parts of question 6 as shown in Figure 5, give the benefits from doing a research oriented project as wee see them. The results clearly indicate that group 1 appreciated the benefits more than all the others because they have completed their projects. Group 2 who have started their projects but not yet completed them appreciated these benefits a bit less than group 1. Group 3 appreciated these benefits even less. The question part which received the highest score is 2 where the majority of the students appreciated that research increases their knowledge. We can conclude from the high scores given to benefits of research oriented

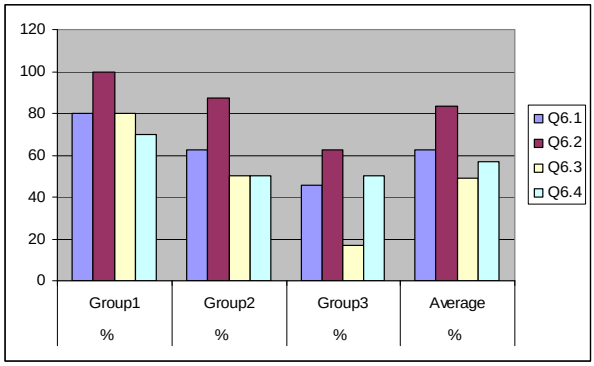

Figure 5: Benefits the students get when they do research projects.

projects that all students would like to do research oriented projects but the fact they the majority do not opt for such projects is because of factors explained in earlier questions. We can safely conclude that computer science departments should find ways of encouraging and directing at least some of their students to do research oriented projects. The high scores given by students to all the benefits of doing research oriented projects indicates that they have appreciation for them.

7: Does Computer Science curriculum have enough courses that encourage you to do research projects?

1- Yes
2- No
3- Don't know

Figure 6 shows the results of question 7. Only an average of 39.73% of all students from the three groups believe that the computer science courses have an element of encouragement towards research whilst a higher percentage (46.1%) of students from the three groups thought that Computer Science courses do not encourage students to do research. It can be concluded from these results that the Computer Science curriculum has an element of research orientation but not enough as far as the students are concerned. Of course it is not possible that all courses can be research oriented, but what we need is to officially identify the courses where we can incorporate research direction and decide what kind and level of research orientation we need to include in these courses. This aspect is currently missing in the curriculum.

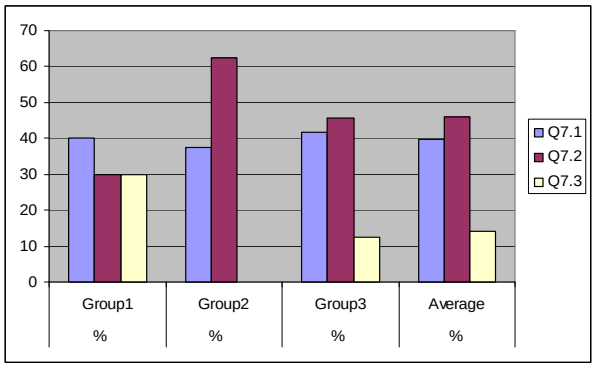

Figure 6: Does computer science curriculum have enough courses that encourage you to do research projects.

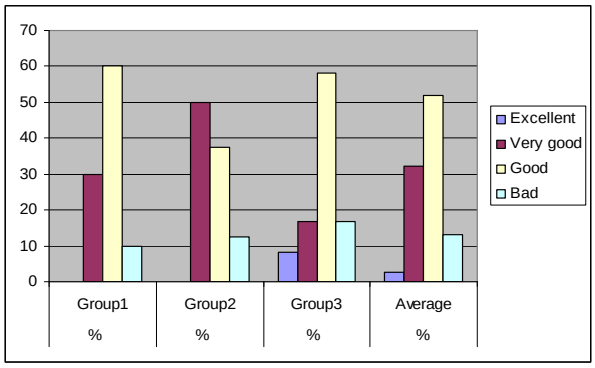

Figure 7: How would you rate your technical report writing skills needed for your project report.

8. How would you rate your Technical Report Writing Skills needed for writing your project report?

1- Excellent
2- Very good
3- Good
4- Bad

As shown in Figure 7, none of group 1 or group 2 students thought they had excellent technical report writing skills (TRWS). An average of 51% of all groups were confident about their average TRWS. The fact that only an average of under 2.78% of all groups regarded themselves as excellent and an average of

13.07% regarded themselves as having bad TRWS leads us to conclude that the Computer Science curriculum must be developed to enhance students TRWS.

9. Would you like to add to the Computer Science curriculum a course that teaches you how to write technical reports?

1- Yes
2- No

If YES, which year you would like to add this course to the Computer Science curriculum?

1- First
2- Second
3- Third
4- Fourth

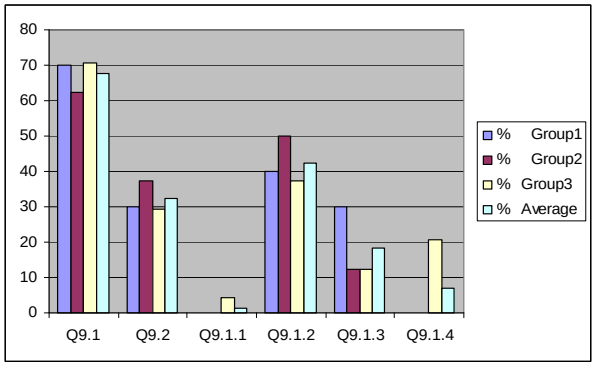

Figure 8: Would you like to add to the Computer Science curriculum a course that teaches you how to write technical reports and if yes in which year.

From the results shown in Figure 8, it is clear that most students (average of 67.77%) from the three groups would like to have some kind of a course to teach them TRWS. What is interesting is that the three groups gave similar scores to their Yes answer and to their No answer which means that they all appreciate the importance of the TRWS towards the success of their projects. The student who gave a No answer (average of 32.23%) are either not aware of the issues of the TRWS or enjoy good TRWS already from somewhere.

With regards to the question as to which year they would like the TRWS to be introduced, the highest choice is for year 2 (42.5%), followed by year 3 (18.33%). We can only conclude from this that they need these skills before they start their projects, which is normally in year 3 or year 4. It is interesting to note that although most students in Figure 7 thought they have good or very good TRWS, a large percentage of them still demand a course for TRWS.

10. Would you like to add to Computer Science curriculum a course or part of a course that teaches you to do research?

1- Yes
2- No

If Yes, which year you would like to add this course to Computer Science curriculum
1- First
2- Second
3- Third
4- Fourth

Figure 9 shows that most students from the three groups (79.43%) want research methods to be taught in the curriculum. It is interesting that most of the students in each of the three groups opted for a yes answer which must mean that they appreciate the importance of research methods and doing research in Computer Science. This response by this clear majority of students must mean that research methods should be taught to Computer Science students. Most of the students in each of the three groups chose years 3 and 2 for introducing such a course which could indicate that should such a course be introduced or the concept is introduced within other Computer Science course it could make more students opt for doing theoretical research projects in the Computer Science departments.

11. What other types of courses would you like to add to the computer science curriculum for example?

1- Practical courses
2- None computer science courses
3- Courses that teach you how to do research projects
4- Courses that teach you how to write technical reports

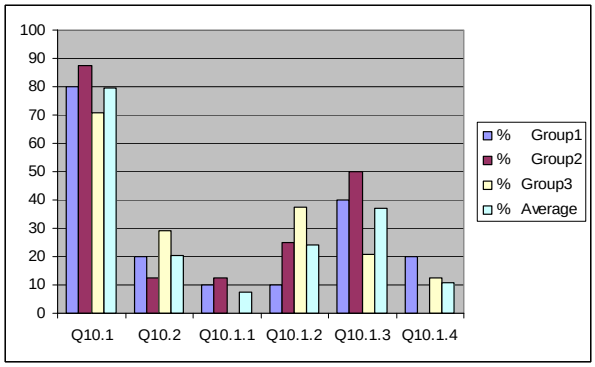

Figure 9: Add to Computer Science curriculum a course or part of a course that teaches you how to do research and in which year.

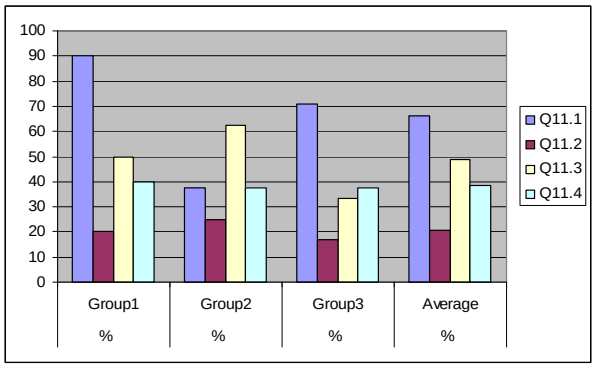

Figure 10: Courses you would like to add to the Computer Science curriculum.

The results shown in Figure 10 regarding the addition of an extra course to the curriculum indicate that most students (average 66.1%) prefer a practical course in Computer Science. This response is true for each of the three groups. It is interesting that group 1 gave 90% to doing an extra practical course and this must mean that they need a practical course for job purposes since most jobs in Bahrain are for practitioners, e.g., programmers. The second choice was for a course to teach students how to do research (average 48.6%). Adding a course to teach TRWS received an average of 38.33% which is high although in third place. We can conclude that adding to the curriculum as separate courses or incorporating in other courses, an extra practical course, a research methods course or a TRWS course should be considered and by a strong demand.

12. Students do not choose to do research projects because:

1- The supervisors do not encourage this direction
2- The time for a senior project is not enough to do research
3- The students are not trained to do research

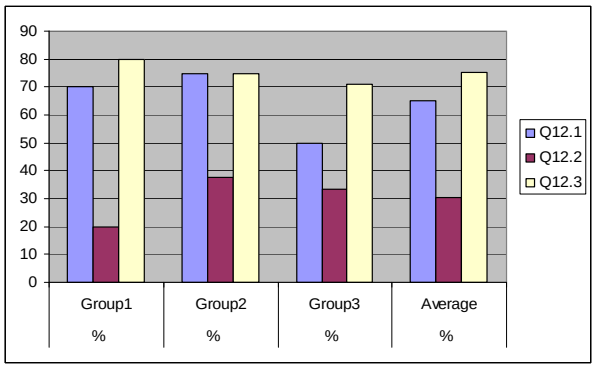

Figure 11: Reasons why students do not choose to do research projects.

Figure 11 shows the reasons why students do not choose to do research projects. Students here decided that they do not opt for doing research oriented projects mostly because they are not trained to do them (75.27%) and secondly because the supervisors do not encourage them to do these kind of projects (65%). Fewer students (30.27%) blamed the time factor for avoiding research oriented projects. There is a clear indication here that if research methods are taught in the curriculum and the supervisors would offer these kind of projects then surely more students would go for them. It is also interesting that all three groups gave similar percentages to the three reasons which indicate that the students hold similar views of this issue regardless of their project status. Group 1 and group 2 have placed a lot of blame on the supervisors and this raises an important issue because these two groups have either completed their projects or are doing it and this means that

they have dealt with their supervisor. Group 3 blamed the supervisors yet they have not yet started their projects and this must mean that students have formed their opinions from their experience with the faculty in the taught courses. In conclusion, it is clear that the faculty or supervisor have a lot of influence on the student thinking and choice of type of project.

13. Which of the following, you think that your Computer Science department should provide in order to encourage you to do research projects (You can choose more than one)

1- More guidance towards the research projects
2- Enhance some courses and add more courses related to the research projects
3- Provide scholarships to the students who present outstanding research projects
4- More seminars to highlight the importance and benefits of doing research projects

As shown in Figure 12, most students (average 67.77%) requested some courses to be enhanced or to introduce new courses to train and direct the students towards research oriented projects. The next request (average 54.73%) was for more guidance from the supervisors, then a request for more seminars (average 38.07%) and least (average 35.27%) request was for provision of scholarships for students with outstanding projects. The results shown here indicate again that the students would do research oriented projects if directed through the curriculum and given more guidance and direction by the faculty. It is interesting to note that group 1 students gave very high responses to the four different factors for encouraging research oriented projects since these students have already completed their projects. These responses are a further proof that Computer Science departments can direct the students to do research oriented projects.

14. Do you think that the market in Bahrain and the gulf requires practical software knowledge rather than research?

1- Yes
2- No
3- Don't know

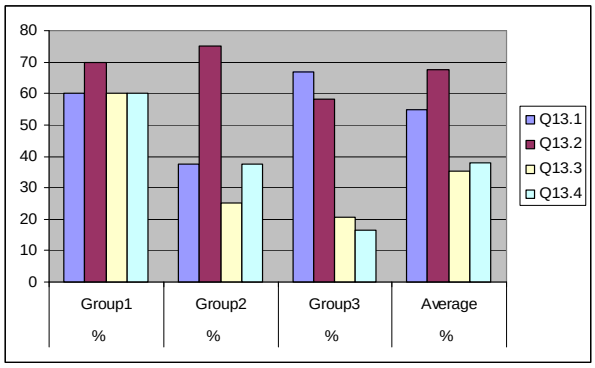

Figure 12: What the COMPUTER SCIENCE departments should provide in order to encourage research projects.

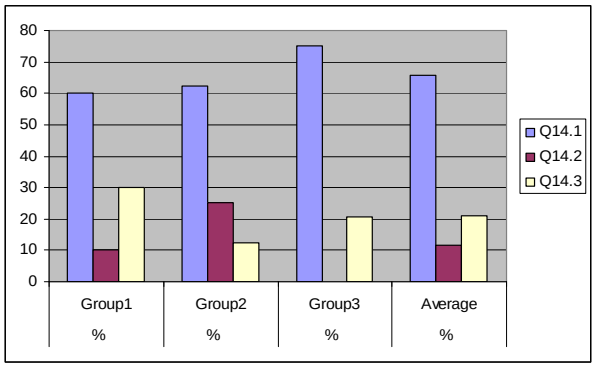

Figure 13: The market in Bahrain and the gulf requires practical software or research.

The IT job market in Bahrain and the gulf, Figure 13, is more of a consumer and user of IT products rather than a generator of software packages and hence needs more of practitioners rather than researchers and this has clearly been understood by all students doing computer science and consequently the majority of them (average 65.83%) said that they choose practical projects because of this fact. The fact that an average of 21.1% of students does not know this fact could be because these students are not aware of their environment and do not read much outside their field of study.

Conclusion

This paper investigated the issues concerning the graduation projects of computer science students and why they opt for practical rather than research oriented projects. The results of the investigation indicate that some students are willing and interested to do theoretical research oriented projects if a number of issues are resolved. The research clearly indicates that the current curriculum in the Computer Science department in the University of Bahrain is not designed to achieve this purpose and that research methods in Computer Science should be incorporated in the curriculum as an independent course or included within the taught courses. Another conclusion is that the faculty and project supervisors have a lot of influence on the students' choice and that the faculty must be directed to provide and supervise such projects. The Bahrain and gulf IT job market normally influence the students' decision to choose practical projects as they see it as a form job training or preparation. This appears to be acceptable but in reality we do need to graduate practically oriented students who are capable of doing original research.

References

1. Smith, E. and Oosthuizen, H. J. (2006). Attitudes of entry-level University students towards computers: a comparative study, Computers & Education, Volume 47, Issue 3, November 2006, Pages 352-371.

2. Joy, M. (2005). Group projects and the computer science curriculum, Innovations in Education and Teaching International, v 42, No. 1, Feb. 2005, p 15-25.

3. Belinda Ho (2003). Time management of final year undergraduate English projects: supervisees' and the supervisor's coping strategies, System 31, 2, 2003.

4. Robert Loo (2003). Assessing "team climate" in project teams, International Journal of Project Management, 21, 7, 2003.

5. Philip Machanick (2003). Principles versus artifacts in computer science curriculum design, Computers & Education, Volume 41, Issue 2, September 2003, Pages 191-201.

6. Karla M. Johnstone (2002), Hollis Ashbaugh and Terry D. Warfield. Effects of Repeated Practice and Contextual-Writing Experiences on College Students' Writing Skills, Journal of Educational Psychology, 94, 2, 2002.

7. Hosny, H. M. (1999). An interactive lab environment for computing concepts and courseware, Computers & Industrial Engineering, 37, 1-2, 1999.

8. Jenny Lewis (1999). The use of mini-projects in preparing students for independent open-ended investigative labwork, Biochemical Education 27, 137-144, 1999.

9. Klaas Sikkel(1999), Ton A. M. Spil and Rob L. W. van de Weg. A real-world case study in information technology for undergraduate students, Journal of Systems and Software, 49, 2-3, 1999.

10. Rénette J. Blignaut and Isabella M. Venter (1998). Teamwork: can it equip university science students with more than rigid subject knowledge? Computers & Education, 31, 3, 1998.

Biographical Information

Dr. Mansoor Al-A'ali finished his B.Sc. in Computer Studies from the University of Teesside, UK in 1982. He received his M.Sc. in Computer Science from the University of Aston in Birmingham, UK in 1984. He received his Ph.D. from the University of Aston in Birmingham, UK in 1989. Mansoor is currently working in the Department of Computer Science at the University of Bahrain. Since 1989 he has been working as a consultant for a number of leading Bahraini organizations leading the design and quality assurance issues of major industrial computer systems. His research interests include: AI, algorithms, software engineering, computers in education, and Arabization. He has over seventy refereed publications in these areas. Mansoor was the Chairman of the Department of Computer Science at the University of Bahrain from 1992 to 1995 and was the Director of Continuing Education from 1996 to 2000.