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Evaluating Effectiveness of Group Project Model of Learning in a Programming Course: An Empirical Study Using Assessment Results and Students Reflection

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Abstract: **This paper attempts to evaluate the effectiveness of group project model of learning as used in a computer programing course, with the help of data collected from results of assessments when applying this model in real classroom environment as well as students reflection on their experience.**

Design/methodology/approach:

This paper suggests a two-part methodology:

- **Using data about students' performance in all course assessment methods, which would be compared with their performance for the assessment of learning model under study to identify patterns related to effectiveness of group project learning model**
- **Evaluation of how students have benefited from using group project learning model by analyzing data of students' reflection on their experience and relate the outcome to the benefits of group projects as discussed in related literature**

Findings:

Data analysis revealed patterns related to the use of group projects models of learning its assessment

Originality/value:

The experiment and the methodology applied could be used for similar situations or even broadened to address researches related to effectiveness of learning models used in programming courses.

Keywords: **Learning models, pedagogy, Assessment methods, Programming courses, Students reflection, Practical projects, Functional knowledge, Declarative knowledge.**

1. INTRODUCTION

Of the learning models used in programming courses is group project.

Group projects model of learning is extensively used in courses that teach all disciplines. It is a method that is gaining popularity as people are now more concerned with educating students with the necessary skills needed in the work place (Latu and Blackshaw, 2005; Biggs and Tang, 2007)

1.1. Study Context:

This paper attempts to assess the effectiveness of group project model of learning as used in a computer programing course, with the help of data collected from results of assessments when applying this model in real classroom environment as well as students reflection on their experience.

The experiment has been conducted for an advanced Java programming course in one of the top 5 Saudi Arabia public universities. All data has been aggregated for confidentiality reasons.

This work stems from an experiment of replacing a laboratory model of learning/ assessment with a project-based model due to lack of technical resources. We wanted to evaluate the effectiveness of this model in order to identify whether it could be appropriate to recommend such replacement and to highlight any added advantages of project-based model of learning and assessment.

1.2 Paper Organization:

Section 2 will attempt to layout the theoretical framework for the research by reviewing past researches and publications. Section 3 lays down the methodology that has been developed and later used to for comparison. Section 4 is dedicated to the documentation of the data collection and analysis on the selected topics. Section 5 concludes with elaboration on the findings that has been drawn from the practical experiment in the light of the theory applied and gives recommendations regarding the results of the experiment.

2. GROUP PROJECT MODEL OF LEARNING IN PROGRAMMING COURSES

Livingstone and Lynch, (2000), in their study entitled Group Project Work and Student-centred Active Learning: two different experiences concluded that "if care is not taken in the design and execution of such projects, then the problems that may ensue can reinforce the `myths'. However, if carefully and appropriately designed and managed, team-based learning is a valuable experience"(p.1)

Rensburg (2012) conducted a literature review of Assessment of Group Work. The study supported the idea that though group work model of learning is highly valued and rewarding, there is an inherent challenge of assessing individual contributions in group-related work.

The issue of difficulty in measuring individual contribution in group project model has been discussed by Biggs and Tang (2007) as well.

Both Rensburg (2012) and Biggs and Tang (2007) suggested peer-evaluation as one way of assessing individual members' contribution though Rensburg questioned how reliable is peer evaluation .

Bigg and Tang(2007) suggested the practice of asking students to submit a "reflective report" with details of their contribution to the project as a whole , and "how they think they have achieved the ILO's through their participation in the project" (p. 220).

Researchers have listed the added benefits of adopting the group project model of learning as the improvement of students' interpersonal skills, such as negotiation, team work and collaboration skills (Latu and Blackshaw, 2005).

Interestingly, Gardner (2003, cited in Latu and Blackshaw 2005) added more benefits that can be obtained when students are assigned to conduct "software projects in groups" -: the development of a software at a large scale than individual work, weaker students can learn from their peers , and that students learn similar-to-real-time experience. (p. 3)

Biggs and Tang (2007), while discussing the suitability of ways of assessment for different learning models have linked this to the two categories of knowledge defined by them as declarative knowledge and functional knowledge:

Whereas an assignment usually focuses on declarative knowledge, the project focuses on functional knowledge applied to hands-on pieces of research. Projects can vary from simple to sophisticated or carried out individually or by a group of students.

Group projects are becoming increasingly common for two reasons: they aim to teach students cooperative skills; in line with ILOs "Intended Learning Outcomes" or graduate attributes relating to teamwork; and the teacher's assessment load is markedly decreased (p. 219).

Chamillard and Braun (2000) suggested two forms of laboratory learning models, namely "collaborative labs" and "individual lab practica". While both forms are constructed as a number of programming tasks that goes from less complex to the more complex task, collaborative labs allow for some degree of collaboration between students but the work has to be completed by each student individually and there is a limitation to how much collaboration is allowed (p,

2). Chamillard and Braun used statistical analysis to discover "relationships of student performance using the different evaluation techniques" (p. 2).

Despite the fact that Chamillard and Braun (2000) study has focused on two forms of laboratory learning model, it was able to compare correlations between all the possible pairs of assessment types used in their programming course.

The study found that the correlation between case study and the final exam or other assessments results are weaker than that between other assessments and the final exam and between the assessments themselves.

3. METHODOLOGY

This paper suggests a two-part methodology:

- Using data about students' performance in all course assessment methods, which would be compared with their performance for the assessment of learning model under study to identify patterns related to effectiveness of group project learning model
- Evaluation of how students have benefited from using group project learning model by analyzing data of students' reflection on their experience and relate the outcome to the benefits of group projects as discussed in related literature

The group project learning model is assessed by asking students to design a prototype of a system using specific criteria, applying standard Java principles. The students will be assessed on the ability to apply design principles and techniques that they have learned throughout the course. The group project is assessed according to the following criteria:

1. The completeness of the prototype design. The marking will be allocated to measure different levels of student's achievements
2. Documentation of their application to facilitate future enhancements
3. Documenting their experience by self-reflecting on their experience

The second part of the methodology will address how students have benefited from using group project learning model by analyzing data of students' reflection on their experience, Students were asked three different questions as listed in Table 1 bellow.

Question 1	What have you learned as a result of this project?
Question 2	How could team working skills be improved as a result of working in this project?
Question 3	How would you improve your knowledge in the subject area after this project?

Table 1: Self-reflection Questions

The duration for the group project was a six-week period.

Gender	**Female**
Age/Level	Year 4 course (graduate students)
Disciplinary Background	Computer and Information Systems program

Table 2: Students who represent the sample

4. DATA ANALYSIS

4.1 Data Analysis for Students Results:

Table 3 below represents overall summary of statistics of the whole dataset results (40 students) using mean and standard deviation. This covers all methods of assessment used during the course including assessment of the group project learning model. All values in the table are shown as percentages

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	Mid-term exam 1	*Mid-term exam 2*	*Group Project*	*Final Exam*
Mean	66.83333	64.83333	72.85	70.25
Standard Deviation	19.66314	15.96785	14.07045	15.1327

Table 3: Summary of Statistics for the Whole Dataset (40 students)

(Adopted from Chamillard and Braun (2000))

While the standard deviation values are quite close for three methods of assessments, the value for the Mid-term exam 1 is relatively high. A suggestion here is that some students on the first exam were still not familiar with the exam techniques and were lacking behind at the beginning of the course, a criteria that may be reduced as we move further with the learning process.

The mean for the Group project work is higher than those of other assessments and is closer to the final exam achievement. This is similar to what Chamillard and Braun (2000) have noted when comparing mean and standard deviation of different assessment methods of their study.

we note that the percentages on the collaborative work (labs, case study) are much higher than the scores for the work that students accomplish individually (practica, tests, and final exam).

Part of this difference is surely due to the fact that the individual work is conducted in a controlled, timed environment, while for the collaborative work the students can use as much time as they need to accomplish the assignments. Some of the difference may also be accounted for by the collaborative versus individual nature of the evaluations, but it is unclear how we can quantify the extent of this effect (p. 3)

One more suggestion for why the exam results are higher than the first two assessment is that students may have learned programming skills while working on the open environment of the practical project, a cause that have further evidence from students reflection.

The results indicates a variation in the performance of different groups in the group project assessment. By Drilling down into the data we could see further the variation at the individual groups' levels as illustrated in Table 4 bellow.

	Result out of 25	**Percentage out of 100**
Lowest performing group on the group project model of learning	13	52
Highest performing group on the group project model of learning	24	96
Difference	11	44

Table 4: Variation at the Individual Groups Levels for the Group Project Learning Model

This result indicates that not every group examined has benefited from the advantages presented by using the group project model of learning. That also raises the question of whether the teacher should decide the allocation of students in groups or leave that to students to have freedom in forming their groups, as adopted in this particular case.

UTS (2013) discussed how important "group formation" is to the effectiveness of the group and suggested some forms of group formation.

Liu et al () developed a " model for integrating student activity traces in a collaborative programming project using SVN, and relates different attributes of the SVN activities to student and team performance" (P. 1). SVN is an open source version control system (https://subversion.apache.org/). Liu et al used graph theory and entropy analysis to analyse the data and find participates patterns. The aim was to evaluate how influential team members or group leaders can have impact on the group performance. The results indicated the great influence those type of students are having on the group performance. They also found out that "work pacing and management of the work throughout the project period can be an important fact for a successful team programming" (Liu et al, pp. 1-4).

Figures 1-4 depict students' marks distribution for each of the four types of assessments applied. The x-axis represents a serial numbers allocated to each students for the purpose of this study (1- 40).The y-axis shows the result for each student.

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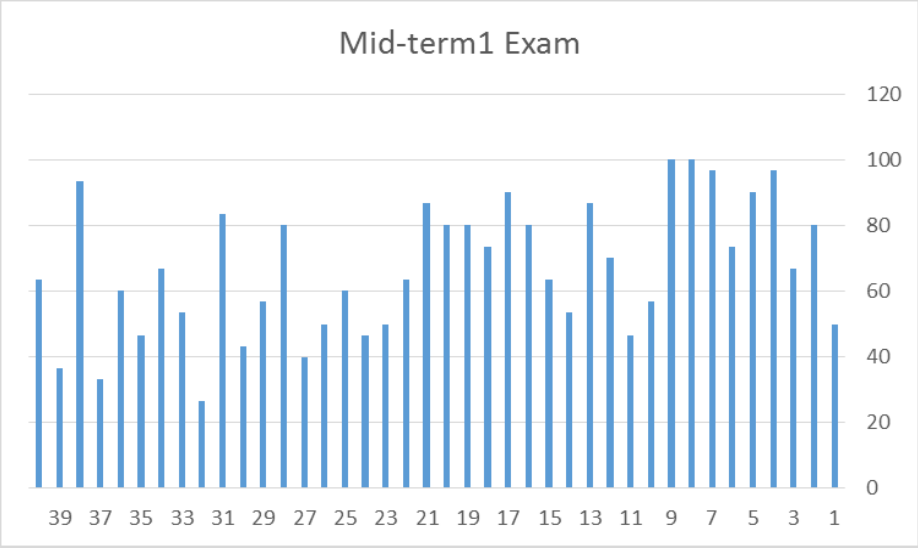

Figure 1: Distribution for Mid-term 1 Exam

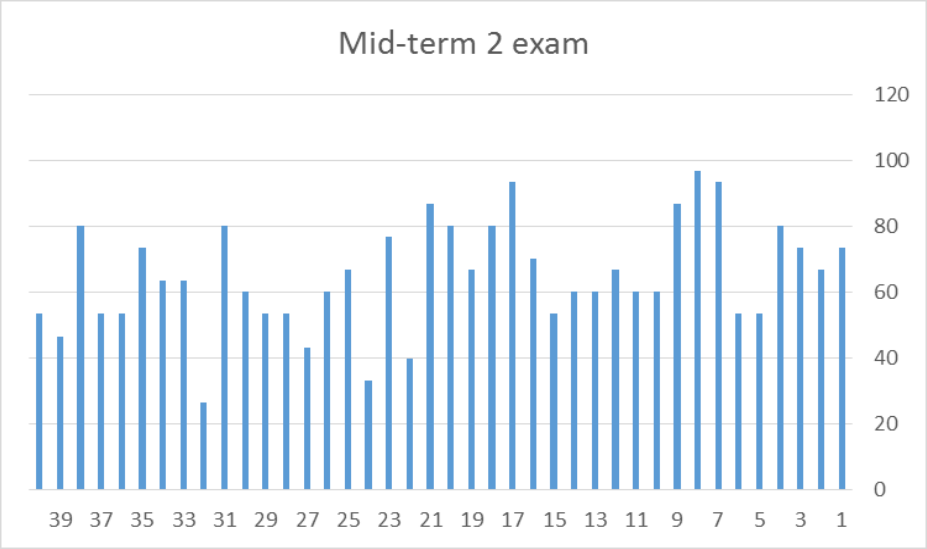

Figure 2: Distribution for Mid-term 2 Exam

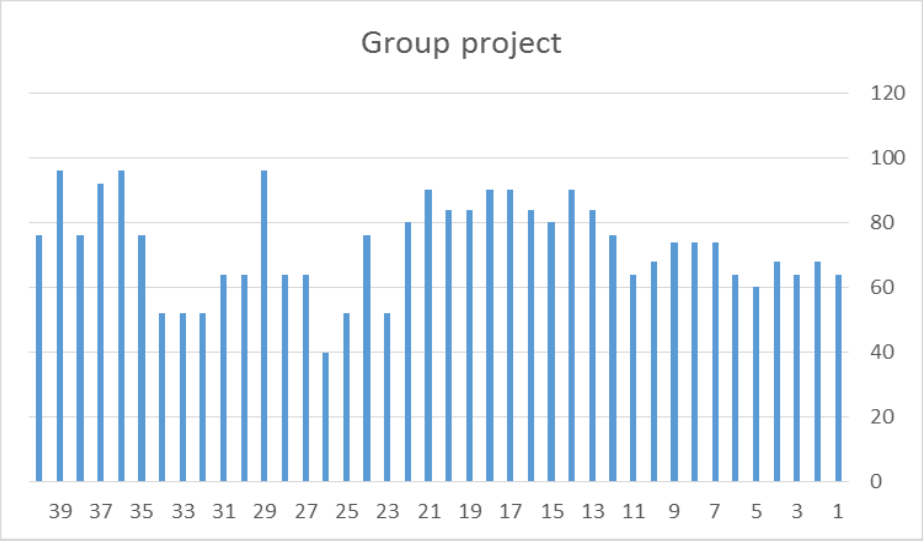

Figure 3: Distribution for Group Project

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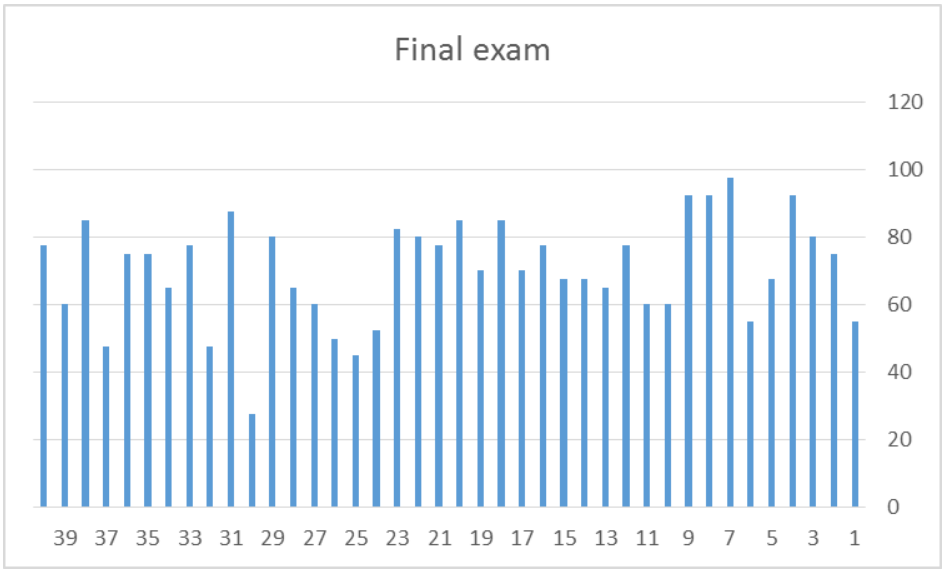

Figure 4: Distribution for Final Exam

Marks distribution among the 40 students of our dataset indicates how the assessments results data is scattered. This has been observed by Chamillard and Braun (2000) and led them to suggest that this observation supports the assumption that students must be given number of different methods in the course to cater for their different abilities and background. Chamillard and Braun (2000) also noted restrictions posed by institution and the course available time with regard to how many assessment methods could be applied in a course.

4.2 Data Analysis for students' reflection:

This part of the analysis will, based on student reflection, discuss whether project model of learning benefits / issues as discussed in the literature review are being recognized by students involved in this study.

The three questions presented to the student were structured as open-ended questions which gave the students the freedom to reflect on their experience. It was not the aim of the reflection to direct students to some answers but rather the analysis will try to link what students have reported to some of the suggested benefits/issues of the group project learning model in order to discover if the students were able to appreciate these benefits/issues or not.

Table 5: bellow summarizes students reflection linked to the benefits of using group project learning model.

We applied what we learned in the lecture room
Designing a real application
Learning to use NetBeans IDE
We Learned from each other
Communicating with team members in an honest and transparent way and not being afraid of suggesting and discussing ideas
Becoming active member of a team
This project gave me a very good idea about how programmers are writing applications and answered my questions about designing software
Better and deep understanding of what I have learned in lectures
Discovering new information about programming in Java by searching the Internet and reading more books
Better understanding of the development lifecycle
Made new friendships
Learned that the user interface design should serve the purpose of the application

Table 5: Summary of Students' Reflection Linked to Benefits of Using Group Project Learning Model

The quality and depths of students' answers were varied. The comments confirm that students were able to appreciate most of the important benefits of using group project model of learning in general as well as in computer programming courses in particular.

Table 6 bellow summarizes students reflection linked to the issues of using group project learning model.

How to be innovative in designing solutions and identifying alternatives
Identifying project objectives
Setting measures to ensure the outcome of the project is reached in the minimum possible time
One error can lead to a chain of errors
Following steps correctly help find the solution for the problem
Do not neglect small details
Learned that the user interface design should serve the purpose of the application
Using technology for better communication and collaboration between team member
Respect each other
Active team leader facilitates distribution of workload
Improve workload distribution
Improve collaboration
Finishing task in time
Facilitate the use of collaborative technology
Constructive feedback means discuss ideas not persons
Listening to other team members
Learning from each other in an open and honest environment
Punctuality
Identifying strengths and weaknesses of team members in project areas can help giving the right task to the right person
Being responsible
Initial design should facilitate team work and splitting of tasks
Every team member should have a reasonable knowledge about what other team members are doing at the beginning of the project
Arrange periodic team meetings
Everyone should be part of the decision making process and must take responsibility for that
Documentation is essential for teamwork and collaboration
Harmony between team members is important (it is good we had the freedom to select our teams)
The role of the team leader is crucial for the success of any project

Table 6: Summary of Students' Reflection Linked to Issues of Using Group Project Learning Model

The quality and depths of students' answers were varied. The comments confirm that students were able to appreciate most of the important issues of using group project model of learning in general**.** For example, students are able to identify issues with group settings, lack of good communication between team members, and distribution of workload among team members.

5. CONCLUSION AND RECOMMENDATIONS

Both the data analysis and students reflection revealed patterns that are commonly discussed in research on group project model of learning.

Though group project model of learning is an efficient model when teaching programming courses, care should be taken with issues such as evaluation of individual learners' performance, group formation, and setting of the project.

Each learning model and type of assessment caters for a particular area of students learning and group project fulfil an important gap in collaboration and communication skills that is not covered by other learning models.

we would like to demonstrate that each of the evaluation techniques evaluates different student skills, or at least evaluates the same skills in slightly different ways. In other words, we would like to compare the means for the different evaluation techniques to show that the evaluation techniques yield different distributions (Chamillard and Braun (2000, p. 3)

This paper has limited scope as the sample used represent a small size of students in a particular institution, generalization for the results will not be possible if it is taken alone. However, the paper discuss issues that has been addressed in other papers and its results could be useful to support or otherwise available research. For example, the fact that a project model of learning represents opportunity for students to learn skills that are not attained in other models of learning and/or assessments, and that the diversity of assessment methods help cater for different abilities of students.

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