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ABSTRACT

Universities teach project management to information technology (IT) students. The project management principles that students previously have learned often are put into practice in a project course that is intended to give final-year students the experience of applying their knowledge to real or simulated projects. This article reports on research that investigated the use and usefulness of project management in student IT projects. The results show that there was a wide range in the application of project management practices, with students being more likely to produce the initial documentation associated with some of the project management knowledge areas than to make use of it throughout the project to monitor the project's progress. The results also showed that the number of project management guidelines applied in student projects was not linked to IT project success. However, there was a strong relationship between project management plan quality and obtaining a good software product.

Keywords: IS project management methods and tools; IS project teams; IT education; project based learning

INTRODUCTION

Universities all over the world teach project management to information technology (IT) students (Goold, 2003; Grundy, 1997; Stein, 2002). The project management principles and system development methodologies that students previously have learned often are put into practice in an IT project course that is intended to give final-year IT students the experience of applying theoretical concepts and practical techniques to real or simulated student

projects (Grundy, 1997). The research reported on in this article investigated the use and usefulness of project management in student IT projects.

Student projects usually are defined and scoped to run on a one- or two-semester basis within an academic program and are not as complex as industry projects (Jih, 2003). Within the time limitation placed on these projects, students have to plan, design, and implement their systems and create relevant documentation. While stu-

dent projects are not comparable in size and complexity to industry projects, the rigor expected is the same as for industry projects. Past experience reveals that IT students find it difficult to manage their project for reasons such as lack of understanding of project management tools and techniques (Lowe, 2000; Pournaghshband, 1990).

The Project Management Institute's (PMI) 'Project Management Body of Knowledge' (PMBOK) provides a solid base of standards, procedures, and practices for managing all types of projects and is used by many organizations to apply project management principles to projects (Freedman, 2002). The goal of project management guidelines is for project managers to achieve better outcomes in projects. IT students also can make use of project management guidelines in order to try to achieve the same goal.

Project Management and the PMBOK Guide

Project management is "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements" (Project Management Institute, 2000, p. 6). The PMBOK Guide is a handbook that provides broadly accepted knowledge and practices that are generally applicable to most projects. There has been widespread consensus as to the value and usefulness of these guidelines (Schwalbe, 2004). The PMBOK Guide consists of five project management process groups and also is divided into nine key sections called the project management knowledge areas. These knowledge areas are divided further into their component project management processes, which describe the activities that need to be fulfilled for each knowledge area. In addition, each of the nine knowledge areas has specific project management

tools and techniques that help to carry out the activities in each process. The project methodologies and practices presented in the PMBOK Guide are used to control and manage projects and cover every aspect of project development.

The Role of Project Management in IT Projects

Generally, project management is considered important for three reasons. First, project management can clarify a project's goals because it makes the project manager produce documentation that identifies the project's unique characteristics, which have to be addressed throughout the project. Second, project management will enable a project manager to identify the required resources, thus assuring the project's stakeholders that resources are being managed effectively. Finally, project management can help to succeed in the achievement of both project and organizational goals.

There has been some research into the value of project management in IT projects. An early study by Pinto and Slevin (1988) tested the importance of factors that are believed to be critical to project success. Each of the critical factors was tested independently against project success, and the results showed that having a project schedule and plans was significantly related to project success. They concluded that project managers need to create project schedules and plans and to use them on a regular basis.

More recently, the Standish Group's (2001) CHAOS project investigated the scope of software project failures and the major factors that cause software projects to fail. The results showed that project success rates have increased since 1994, which partially is attributable to better project management, including the availability of

better tools to monitor and control progress, better skilled project managers, and better management processes. This study also found that 46% of successful projects used a formal project management methodology, compared to 30% of challenged and failed projects. Hence, having a formal project management methodology appeared to increase the chances of success by about 16% (The Standish Group, 2001).

This research is supported by the findings of Aladwani (2002), who studied the mediating effect of project planning among three project uncertainty variables and IT project success and showed that IT project planning was the most important contributor to IT project success. Gowan and Mathieu (2003) tested a model of the relationship between technical complexity, project size, use of a project management methodology, and project performance. The results showed that the use of a formal project management methodology is positively related to project performance, particularly when project size is large.

The research already described illustrates the value of applying project management practices to IT industry projects, and hence, it is vital for IT students to learn and apply the standard practices in order to manage projects successfully. Phillips, Fairholme, and Luca (1998) noted that while student project teams address some project management issues, many focus more on the development of the product. IT students need to be aware of the value of project management, and they need to be encouraged to use project management principles.

Du, Johnson, and Keil (2004) conducted a project to find out what project management topics are being covered in information systems curriculums and concluded that project management prac-

tices have not been incorporated fully into university IT degree programs. They argue that preparing future IT graduates to apply project management guidelines will increase the success rates of industry projects.

RESEARCH QUESTIONS

The study reported on in this article was conducted in order to explore the use and usefulness of project management in student IT projects. It considered both project management in general and, more specifically, the application of PMBOK guidelines.

Phillips et al. (1998) argued that it is important for IT students to be aware of project management guidelines. Therefore, the first research question relates to awareness of project management principles:

RQ1. Are IT students aware of project management principles that can be applied to student projects?

An objective of the research was to establish how IT students apply PMBOK Guide practices and to identify any relevant project management knowledge areas that are not applied. The second and third research questions, therefore, relate to actual application of project management principles:

RQ2. Do IT students apply PMBOK Guide practices in their IT development projects?

RQ3. What are IT students' perceptions of the usefulness of PMBOK Guide practices?

The final objective of the research was to identify whether the application of

project management principles increases the likelihood of students completing IT projects successfully.

Therefore, the final research question is:

RQ4. Does the application of project management principles increase the success of student IT projects?

Given the evidence that use of project management increases the likelihood of industry project success (Aladwani, 2002; Gowan & Mathieu, 2003; Pinto & Slevin, 1988; The Standish Group, 2001), it is likely that this is also the case for student projects. Therefore, the following hypotheses were proposed:

H₁: The application of project management practices increases the chances of completing student projects successfully.

H₂: Increasing the quality of project management plans increases the chances of completing student projects successfully.

THE STUDY

The research sample consisted of final-year IT students enrolled in an IT project course at an Australian University. Students formed their own project groups to undertake the project. However, groups were subject to approval by the course coordinator to ensure that they were well-balanced in terms of the skills of the group members. Each group had approximately five students. The group members were assigned different roles, but after a few weeks, the roles were rotated.

The students had a range of IT project management backgrounds prior to the project. However, most students had completed at least a systems analysis and

design course that included an introduction to project management.

The data for this study were collected partly by means of a questionnaire that was administered during the final weeks of the IT project course. The questionnaires were given to the course coordinator, who distributed questionnaires to all students during project group meetings. It was stressed that the completion of the questionnaire was voluntary, that all information would be kept confidential, and that data would be used only for the purpose of the study. Forty-one students completed the questionnaire. They represented 14 project groups. Evaluations of project management plan quality and IT project success for the groups also were used in the analysis. These were based on course assessment undertaken by the project group supervisors.

The Questionnaire

The questionnaire included the following sections (see Appendix 1 for a complete set of the questions asked).

Background Information

Background information, including gender, age, and major(s), was collected for each student.

PMBOK Awareness

Each participant was asked to rate his or her awareness of project management and PMBOK Guide practices before starting and after completing the IT development project. The answers were measured on a five-point scale from 1 (very little) to 5 (a lot).

PMBOK Use

The section of the questionnaire relating to PMBOK use was divided into seven sections that corresponded to seven of the

nine project management knowledge areas: Project Integration Management, Project Scope Management, Project Time Management, Project Quality Management, Human Resource Management, Project Communication Management, and Project Risk Management. Project Cost Management and Project Procurement Management were not included in the questionnaire because these projects were not given a budget and did not obtain people or sources from an outside organization. Use of the guidelines that corresponded to the seven knowledge areas were measured with a series of question that were answered Yes or No.

Perceived Usefulness of PMBOK Guide Practices

Students' perceptions of the usefulness of the individual PMBOK practices were measured on five-point scales from 1 (not useful) to 5 (very useful).

Additional Study Variables

The following variables were measured separately from the questionnaire after completion of the projects.

Quality of Project Management Plan

The IT students worked in groups and, hence, produced only one project management plan per group. Project management plan quality was measured based on the mark that each group of students received from its supervisor for their project plan.

Project Management Practices Applied

The number of project management practices that were applied by each group was used as a measure of overall application of project management principles. In each student group, there were up to five students. In some groups, all students were involved in all parts of project management,

but in some groups, students were involved in only some. Therefore, if any member of the group had carried out a particular practice, it was counted toward the total for the project group, and this was used as a measure of the number of project management practices that were carried out.

IT Project Success

Traditionally, project success has been measured in terms of the project objectives of time, cost, and scope known as the triple constraint (Brock, Hendricks, Linnell, & Smith, 2003; Schwalbe, 2004). The triple constraint makes it relatively easy to evaluate project success by comparing the actual time, cost, and performance with the planned time, cost, and performance objectives. However, in these student projects, only one of the three criteria was applicable. There was an absolute deadline for completion set, and the projects were not given a budget. Therefore, this study used only one of the triple constraint criteria. This was the scope and software quality of the software product that was created for the client. As was mentioned before, the participants worked in groups, and they developed only one software product per group. This software product was marked by the team's supervisor. Consequently, each group had only one IT project success score.

RESULTS AND DISCUSSION

IT Students' Awareness of Project Management Guidelines

The first research question related to student awareness of project management principles. Table 1 shows the levels of awareness of project management in general, and of PMBOK both before and after completing the IT project. These were

compared using t tests. Students' awareness of general project management practices was significantly higher after completing the IT project course ($t=-6.58$, $df=39$, $p<0.001$). Likewise, students' awareness of the PMBOK also was significantly higher after completing the IT project course ($t=4.868$, $df=40$, $p<0.001$). Therefore, doing an IT project raised the awareness of both project management in general and PMBOK Guide practices.

As discussed earlier, it has been argued that it is important for IT students to learn project management theory and then to practice it in student projects. This study confirms the role of IT student projects in reinforcing project management knowledge obtained from earlier courses.

However, awareness of general project management was higher than awareness of PMBOK Guide practices both before and after completing the IT project. That is, IT students know more about project management in general than they do about the specifics of the PMBOK practices. Before the IT project, the average level of awareness of project management in general was 3.33, and the average level of awareness of PMBOK Guide practices was 2.17. The means for awareness after the IT project increased for both general project management (mean=4.34) and PMBOK Guide practices (mean=2.93). However, even though there was an increase in the average, there was still 14% of all students who had very little awareness of the PMBOK Guide practices after the IT project. On the other hand, no students had low levels of awareness of general project management after completing the IT project, as the lowest level reported was 3.

Project management is important; however, knowing just about project management in general is not sufficient. IT

students need to be aware of the PMBOK Guide, as it is one of the main project management frameworks that provide standards to manage software development projects in industry (Freedman, 2002), and practical experience in how to use and apply the PMBOK framework will be useful when they seek and gain employment. The gap between general project management awareness and specific awareness of the PMBOK practices found in this study, however, may be a result of the way in which project management was taught to these students. Universities should consider this and Du et al.'s (2004) finding that project management practices have not been incorporated fully into university IT degree programs when planning their project management teaching.

Do IT Students Apply PMBOK Guide Practices?

Awareness of project management guidelines is not enough; project management guidelines have to be applied to obtain benefits, and the study investigated whether IT students are applying PMBOK Guide practices. The investigation of the application of project management guidelines showed that not all IT students followed the PMBOK Guide practices. Table 2 shows the number of students that applied each of the PMBOK Guide practices. The project management principles are ranked from most used to least used.

Table 2 shows that there was a wide range in the application of project management practices. The most frequently used project management practice was the use of Microsoft Project to develop project management schedules, which was done by 97% of the participants. The second most used project management practices were the use of templates and the creation

Table 1. IT students' awareness of project management and PMBOK practices

		Mean	Max	Min	Std. Dev.	Diff.	Sign.
General PM	Before Project	3.33	5	1	0.971		
	After Project	4.34	5	3	0.656	1.01	0.000
PMBOK	Before Project	2.17	5	1	1.138		
	After Project	2.93	5	1	1.233	0.76	0.000

Table 2. Project management practices that IT students applied

PM Practices	PM Knowledge Areas	Yes		No	
		Count	%	Count	%
Use Microsoft Project to develop schedule	Project Time Management	40	97.6	1	2.4
Use template to create project management plan	Project Integration Management	38	92.7	3	7.3
Created scope statement	Project Scope Management	38	92.7	3	7.3
Regularly distributed project information	Project Communication Management	34	82.9	7	17.1
Discuss project's progress	Project Communication Management	33	80.5	8	19.5
Created scope management plan	Project Scope Management	26	63.4	15	36.6
Monitored project results	Project Quality Management	26	63.4	15	36.6
Created risk management plan	Project Risk Management	24	58.5	17	41.5
Created communications plan	Project Communication Management	21	51.2	20	48.8
Use skills matrix	Human Resource Management	20	50.0	20	50.0
Created quality plan	Project Quality Management	20	48.8	21	51.2
Follow project plan (WBS, Gantt Chart)	Project Time Management	19	46.3	22	53.7
Monitor risks	Project Risk Management	18	46.2	21	53.8

of scope statements, both done by 92% of the participants. The third most frequently used project management practice was regularly distributing project information to other group members, which was done by 82% of the students. The least used project management practices were following the project plan (46.3%) and monitoring risks, which was done by only 46% of the participants.

Table 2 also shows which project management knowledge area each practice

is from. Several of the project management knowledge areas were represented by several practices in the questionnaire, and there were differences in the number of participants who used the various project management practices within the areas. For example, while 97% of the participants used Microsoft Project to develop the project management schedule, only 46% followed that schedule. This project management practice is part of Project Time Management. Similarly, while 58.5% of participants

Table 3. Usefulness of the project management (PM) knowledge areas to student projects

Project Management Practices	Mean	Std. Dev.	Max	Min
Usefulness of communications plans	4.10	1.081	5	2
Are templates useful?	3.85	0.910	5	2
Usefulness of risk management plans	3.56	1.026	5	1
Usefulness of project time management	3.54	0.869	5	1
Usefulness of scope statements	3.18	1.048	5	1
Usefulness of quality plan	3.15	0.988	5	1
Usefulness of skills matrixes	3.10	1.215	5	1

said that they created a risk management plan, only 46.2% said they monitored risks. In addition, most students used Project Communication Management practices to distribute project information (82.9%) and to discuss the project's progress (80.5%), but only half of the participants (51.2%) created communication plans.

These results also suggest that IT students are more likely to produce the initial documentation associated with some of the project management knowledge areas than to make use of it throughout the project in order to monitor the project's progress. Students were much more likely to create both project management schedules and risk management schedules than to follow them. One reason for this might be that the project management plans are too hard for students to follow, because they may not have a full grasp of how to use them. Another reason might be that following project management plans was not part of the assessment for the project course, and students might be more encouraged to use project management plans if they are awarded points or grades for following them. Therefore, if instructors want IT students to apply more of these guidelines, then the course's content and assessments should be aligned with PMBOK Guide practices.

What are IT Students' Perceptions of the Usefulness of PMBOK Guide Practices?

The third research question relates to students' perceptions of the usefulness of PMBOK Guide practices. Table 3 presents ratings of the perceived usefulness of each of the project management practices ranked from most useful to least useful. In general, IT students did find project management practices useful as they rated the usefulness of all project management practices above the middle of the scale. Even the project management practices that were ranked in the bottom half still were perceived to be relatively useful. Therefore, students do believe that project management practices help them in their projects.

The results showed that communication plans were perceived as the most useful practice with a mean usefulness rating of 4.10. By using these plans, IT students learned to plan how they could distribute project information among group members and report their project performance to verify how well the project was moving toward meeting its goals.

The project management practice that students perceived as second most useful was the use of templates, which had an average usefulness rating of 3.85. IT students used templates as a starting point to

create a project management plan for their projects. They had to identify the sections of the template that were appropriate for their project, as not all the sections are relevant to a given project. The outcome of following templates was that students produced project management plans to coordinate project activities and guide project execution and control. Participants commented how valuable it was to use a template to create the project management plan for their projects.

The project management practices that were perceived as least useful were scope statements (mean=3.18), quality plans (mean=3.15), and skills matrixes (mean=3.10). These project management practices were not part of the course assessment, and as a result, it appears that only a few students applied them. Another possible reason for these results is that not all IT students within a student group were involved in completing a particular task. Therefore, some participants who answered that skills matrices are not useful may not have been involved in that project activity and, hence, may not have realized their value.

Does the Application of Project Management Principles Increase the Chances of Completing Student IT Projects Successfully?

Previous research (Gowan & Mathieu, 2003; The Standish Group, 2001) has provided evidence that the use of project management increases the likelihood of project success in industry projects, and this study investigated whether this is also the case for student projects. The fourth research question was considered in two ways. To address the first hypothesis, the number of project management practices used was correlated with the IT project success score. The results of this indicate

that there was no relationship between the IT project success score and the number of project management practices that were applied ($r=0.090$, $p=0.761$). Thus, the first hypothesis was not accepted. It appears that the key to project success in IT student projects is not based on how many project management principles that student groups use.

In order to test the second hypothesis, the quality score for each group's project management plan was correlated with the IT project success score. The results indicated that there is a strong relationship between the quality of the project plan and the IT project success score ($r=0.710$, $p=0.004$); thus, the second hypothesis was accepted. This result indicates that having a good project plan is associated with obtaining a good software product from the student project. This is consistent with the results of research into the success of industry projects (Aladwani, 2002; Gowan & Mathieu, 2003; Pinto & Slevin, 1988; The Standish Group, 2001).

These results imply that student IT project success is not based on how many project management principles are applied but on how well they are used. Therefore, the quality of project management practices plays a big part in how successful the project is going to be.

CONCLUSION

The main focus of this study was to investigate the role of project management in student projects. The major limitations of this research are the small sample size and the fact that the study was conducted only at one university. Future research should explore further the issues raised in this study in other universities and with larger groups.

The research revealed that students' awareness of general project management and PMBOK Guide practices was higher after completing an IT project course. However, IT students were more aware of general project management than the specifics of the PMBOK Guide. As the PMBOK Guide is so widely used in industry (Freedman, 2002), the level of awareness and the use of the PMBOK practices should be raised.

The study also showed that there was a wide range in the project management guidelines that IT students applied in their projects. The study identified the project management practices that were used the most (e.g., use of Microsoft Project to develop a project schedule, using templates to create project management plans, creation of a scope statement) and those that were the least used (e.g., creation of a quality plan, following the work breakdown structure, and monitoring of risks). The results also suggest that creating documentation appears to be easier for students than using it to monitor project progress. Therefore, it is recommended that assessment is aligned with PMBOK Guide practices to encourage students to apply more project management guidelines to their student projects.

The study also investigated whether the application of project management guidelines increases the chances of completing IT projects successfully. The results showed that the number of project management guidelines applied was not associated with IT project success. However, there was a strong relationship between having a good project management plan and obtaining a good software product.

Grundy (1997) suggested that IT students need to be immersed in a project situation in order to put into practice what they have learned about project manage-

ment in previous courses, and many authors have argued that the project activities have to mirror the real world in order for IT students to learn what needs to be done in industry projects (Bickerstaff, 1985; Carver, 1985; Farkas, 1988; Heinrichs, 1987; Lowe, 2000; Nance, 1998). The findings of this study support the importance of enabling students to practice their project management skills in a software development project and suggest that if maximum value is to be obtained, skill use should be linked to assessment.

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APPENDIX A. Questionnaire Used in the Study

What is your gender?

- Female
- Male

1. How old are you?

_____ yrs old

2. What is your major(s)? Check all that apply.

- Computer Science
- Applied Information Technology
- Multimedia Information Systems
- Business Information Systems
- Information Systems Development
- Internet Computing
- Games Technology
- Internetworking and Security

3. What is your project group's name?

4. How aware were you of project management practices *before* ICT333?

Very little				A lot
1	2	3	4	5

5. How aware are you of project management practices *now*?

Very little				A lot
1	2	3	4	5

6. How aware were you of Project Management Body of Knowledge (PMBOK) practices *before* ICT333?

Very little				A lot
1	2	3	4	5

7. How aware are you of Project Management Body of Knowledge (PMBOK) practices *now*?

Very little				A lot
1	2	3	4	5

8. Where did you learn project management?

9. How did you learn project management?

Project Integration Management

10. Did your group use the template provided by the course coordinator (or any other template) to create the project management plan?

- Yes No

11. Was it easy to follow the template(s)?

- | | | | | |
|------------------|---|---|---|------------------|
| Difficult to use | | | | Very easy to use |
| 1 | 2 | 3 | 4 | 5 |

Why?

12. How useful do you see templates when applying them to IT projects?

- | | | | | |
|------------|---|---|---|-------------|
| Not useful | | | | Very useful |
| 1 | 2 | 3 | 4 | 5 |

13. Would it be better for a group to create its own documents rather than following existing generic templates?

- Yes No

Why?

Project Scope Management

15. Did your group create a scope statement to define the scope of your project?

- Yes No

16. Did your group create a scope management plan to manage the scope and integrate changes to it?

- Yes No

17. How useful are scope statements and scope management plans to manage your project's scope?

- | | | | | |
|------------|---|---|---|-------------|
| Not useful | | | | Very useful |
| 1 | 2 | 3 | 4 | 5 |

Project Time Management

18. Did your group use Microsoft Project to assist the development of the project's schedule?

- Yes No

19. Did your group follow the project plan closely (Work Break Structure, Gantt Chart) to check the deadline of tasks?

- Yes No

