Managing Information Systems Projects within a Problem-Based Learning Environment

Abstract

The current approaches in managing student projects teams in Information Systems (IS) concentrate on project team issues such as composition of teams, group performance, peer evaluation and assessment (Scott & van der Merwe, 2003; Addison, 2005; Smith, 2005).

This paper examines the three dimensions of IS projects, namely: instructional strategies and learning modes, potential links with industries, and the influence of a marketing initiative on the students' project team performance.

The nature of this research required a qualitative research approach where observations, the focus group interview and document sources were used to gather data (Yin, 1994; Merriam, 1998). The views of 57 Information Systems final year students' at the institution for higher education were examined. Students at an institution of higher education were observed and their experiences were investigated through the focus group interview and documentation.

Findings revealed that multiple links with relevant businesses partners are necessary to the students understanding of project management. Findings indicated a need for project marketing and extended communication links between and within teams in a peer-based collaborative environment. Furthermore, findings showed that a variety of instructional strategies and learning modes nourish the problem-based learning in a project-based classroom.

Keywords: Information Systems, project-based classroom, learning modes, instructional strategies, user-centred Information Systems Design and Development

INTRODUCTION

In the relevant literature (for example, Scott & van der Merwe, 2002; Mantel, Meredith, Shafer & Sutton, 2001) there is a remarkable absence of discussion on issues in the Information Systems (IS) project-based classroom such as constructive project-related instructional strategies, learning modes, potential links with businesses and the influence of an marketing initiative on students' project team performance.

Information Systems graduates are expected to design and develop a business information system that solves a business problem, which provides students with real-life business experiences. Project coordinators have little understanding of a variety of constructivist instructional strategies and learning modes applicable in the project-based classroom.

Lack of understanding of a variety of constructivist approaches as well inefficient relationship with IS experts and related businesses could be described as a potential inhibitor to successful design and development of students' projects. In addition the marketing opportunities of IS projects have not been appropriately investigated in the present IS project-based environment (Mantel, Meredith, Shafer & Sutton, 2001; Steenkamp, 2002; Bahli & Buyukkurt, 2002). Thus the needs of students as IS designers and developers have been neglected.

The purpose of this article is to examine how utilising a variety of instructional strategies, learning modes and creating effective links with businesses could improve the design and development of business information systems. In addition, the study focuses on a marketing initiative and learning in a project-based classroom, where the students, divided in small teams, design and develop projects by finding a solution to a real-world business problem.
Within this context, the research questions were formulated as follows:

1. *What constructivist instructional strategies and learning modes should be used in managing Information Systems projects?*

2. *How the real-life nature of the problem and links with businesses contribute to the problem-based learning environment in a project-based classroom?*
3. *How project visibility and a marketing initiative influences IS students' team performance?*

FRAMEWORK FOR A PROBLEM-BASED LEARNING ENVIRONMENT IN THE IS CONTEXT

Constructivist learning theory a basis for real-world nature of IS projects

Winn (1990:53) states that educational designers should be driven by an understanding of theories of learning and instruction, rather than simply by a mastery of design techniques. Learning in a constructivist classroom came closer to real life environments (Jonassen, 1996). A project-based classroom is a constructivist classroom which supports real-world or natural learning by technology manipulation, which leaves room for problem solving, creative thinking and innovation (Jonassen, 1996). Students are able to reflect on new knowledge and have a chance to negotiate meaning with a mentor or via a small group in a cooperative environment (Mintzes & Wandersee, 1998:53). Constructivist classrooms provide the freedom for students to find alternative solutions and to reflect on learning (Zietsman, 1996). Learning in a constructivist classroom supports a variety of learning modes (for example, informal learning, problem solving, collaborative, situated and experiential learning) and constructivist instructional strategies (for example, group discussions, cognitive apprenticeship, brainstorming).

i) Informal learning in a project-based classroom

Design and technology tasks in schools and industry may have similar outcomes, but the purpose behind these outcomes is different (Elmer, 1998:237). In an industrial professional context the purpose is to achieve a workable product or system; whereas in an education context it is to achieve learning. In the project-based classroom the purpose is to achieve a workable system, which solves a business problem. Due to its purpose, the project-based classroom has little similarity with other classrooms, where learning is formal and highly structured, reflecting its poor influence on developing intellectual skills

(Johnson (1997:162,168). Thus, the learning in the project-based classroom moves towards informal education.

ii) Experiential learning in a project-based classroom

Henak (1995:14) notes that experiential learning helps students to personalise technical knowledge and to solve 'real-world' problems. Experiential learning with IS project work emphasises students' experience, knowledge base, interest, desires and students' involvement with authentic activities (Hill & Hopkins, 1997; Dick, 1991). When students are involved with IS web-based projects, they experience the effect of web design components such as graphics, charts, icons, video and sound, which increase the emotional and motivational appeal (Morris & Hinrichs, 1996; Barkhouse, 1997).

Students are involved in experiential learning through project work based on real-world problems (Hill, 1998; Barlex, 1995). They are involved in activity-based practice, which promotes creativity, motivation and problem solving skills (Johnson, 1997).

iii) Discovery learning in a project-based classroom

Discovery learning takes place when students are not presented with the subject matter in its final form, but rather are required to design and organise it themselves (Smallwood, 1995:5). An activity-based practice can be provided through discovery learning that engages learners in problem solving (Johnson, 1997; Jones, 1997). This idea particularly supports IS design as it encourages students in determining and creating their own learning routes.

iv) Situated learning in a project-based classroom

The way students solve problems depends on the situation in which the problem occurs (Winn, 1990; Bednar, Cunningham, Duffy & Perry, 1992). Learning is an interaction between the students and their physical and social context, rather than the manipulation of symbols or activities in an individual's mind

(Greeno, 1989; Hennessy & McCormick, 1994). Students use a variety of inventive and effective methods that depend on situations (Resnick, 1987; Rogoff & Lave, 1984; Bednar, *et al* 1992).

Rather than applying a formal procedure to solve a problem (for example, identify the problem, generate a solution etc.), students spontaneously invent a variety of their own procedures for solving problems in everyday situations (Hennessy & McCormick, 1994). Design and technology have the potential to be formulated in the context of authentic activities such as project work

v) The Problem-based learning environment in a project-based classroom

Problem-based learning includes interactions with the environment, reflection, handling cognitive conflict, knowledge that evolves social negotiation and the evaluation of the viability of individual understandings (Savery & Duffy, 1994:31). A project-based classroom provides an environment for handling multiple issues of problem-based learning.

While it is important to guide a project team forward, it is also crucial to make team members aware and willing to invest in their problem solving abilities through business collaboration. Students in a project-based classroom have opportunities to engage in a variety of problem solving activities found in real life in which teachers act as 'facilitators' and 'cognitive coaches' (Duffy & Cunningham, 1997).

vi) Reflective learning and strategic planning skills in a project-based classroom

Students construct their own knowledge, based on their experiences through collaboration and reflection (Lankard, 1996:1). "Self-knowledge requires reflection on what was learned and what needs to be learnt…" (Lankard, 1996:3). Before reflection can provide valuable insight, students should be encouraged to allow time to reflect upon the activities and record their 'feelings, impressions, and interests' (Jakovljevic, 2002). Reflection could help students to enhance their strategic planning skills.

vii) Peer-tutoring enhance collaborative mode of learning

"Collaborative learning means that students work together in groups, learn more from one another and are thus less dependent on the teacher" (Gunter, Estes, Schwab, 1995; cited by De Swardt, 1998). Vockell and Deusen (1989:24-28) state that peer tutoring and modelling are extremely effective for promoting higher-order thinking. In the process of sharing a problem situation in a collaborative learning environment, students develop problem solving abilities and thinking abilities in general (Wheatley, 1991:19; cited by De Swardt, 1998:51). Collaborative learning has been successful in teaching higher levels of thinking as well as interaction skills, and helping different racial and ethnic groups to work together (Slavin, 1990:22).

viii) Practical and cognitive apprenticeship in a project-based classroom

Cognitive apprenticeship is an expert-novice or peer-tutoring type of instruction, otherwise described as a higher achieving student assisting a less able student. It may involve verbal mediation through instruction, providing explanation, linking new ideas with previous knowledge (Jones & Carter, 1998:270). Cognitive apprenticeship gives students the opportunity to "observe, engage in, and invent or discover expert strategies in context" (Thomas, 1992). Learning through practical and cognitive apprenticeship reflects the collaboration of real-world problem solving (Bednar, *et at.* 1992). Arzarello, Chiappini, Lemut, Marara and Pellery (1993:292) mention that cognitive apprenticeship is not only aimed at practical abilities and processes, but also at cognitive and meta-cognitive abilities and processes.

RESEARCH METHODOLOGY

Research approach

This research can be described as a qualitative, single case study as the learning experience of IS students is investigated relating to a specific event in a bounded context (Creswell, 1994, Yin, 1994; Merriam,

1998). In particular, we used a case study method to follow up experiences of students in the IS project course held at an institution for tertiary education in South Africa. The case study method enables one to follow up interesting observations in a project-based classroom in great detail.

Profile of the students, and setting

The sample was composed of a group of 57 students enrolled for the final year of BCom degree in Information Systems Department at University of the Witwatersrand. Participants presented a purposive convenient sample, as they were available and inexpensive to this study (Merriam, 1998).

Students worked in groups of four to five members on real-world projects that they identified in various SME sectors. Teams had to find a client in an industry, to identify a business problem and propose an information system as a solution to the identified problem. Information systems were developed in VB.Net environment. Each team was guided by a mentor chosen from a postgraduate group of IS students. Participants were divided into 13 groups in which "individual students became experts on subsections of a topic and taught those subsections to others" (Eggen & Kauchak, 1996).

Data collecting methods

The data was collected by means of observations, the focus group interview with the eight students and documents analysis (project files and user documentations). Data was gathered through multiple data gathering methods which satisfy the criteria for triangulation (Creswell 1994; Yin 1994; Merriam 1998). Students' design teams were observed, and continuous assessment and monitoring of students' performance were established.

Analysis of data and the assessment of trustworthiness

Analysis of observational and interview data consisted of examining, categorising and tabulating to address the initial propositions of the study (Yin, 1994:102). A constant comparative method was applied to data within interviews and between interviews (Merriam, 1998:159).

Merriam's (1998:204, 205) strategies (peer/colleague examination, the statement of the researcher's biases, submerging the researcher in the study) and Yin's (1994: 33) conceptions about internal validity (making inferences, analytical pattern matching) were followed in this study, thus enhancing the internal validity of the findings. In addition, a rich description of the researched phenomenon, which was embedded in a theoretical framework, contributed to the external validity of this study (Merriam, 1998: 211).

Intervention in the project-based classroom

The project-coordinator who played the role of a participant-researcher recognised the need for constructivist approaches in a project-based classroom, in order to promote a problem-based learning environment. It was considered necessary to arrange the learning environment by promoting a variety of learning modes and instructional strategies (for example, individual discussion, cognitive apprenticeship and brainstorming) in order to improve the IS project outcomes.

Students were taught how to avoid and resolve conflicts. At least one technical person was allocated per team, as the lack of programming skills was a continuous problem in the project-based classroom. Regular team-coordinator meetings with the project-coordinator were organised aimed at more efficient communication of project-related tasks and feedback on each deliverable.

Project-related seminars were planned, organised and presented by industry experts during 2005. Additionally, a project exhibition day was organised, creating an opportunity for students to initiate a network of links with SME's. The project exhibition day was coordinated by a small project exhibition committee consisting of eight members, which was created from student volunteers. Furthermore, IT media was involved providing an exposure of the IS projects to community. This could have an influential impact in promoting team motivation and problem-based learning.

FINDINGS

Emerging from the interview, observations relating to the students' experience of the project work and documents analysis the following findings were recorded:

a) Project co-ordinators must be familiar with a variety of instructional strategies and learning modes in order to promote a problem-solving atmosphere in a project-based classroom

As an array of constructivist instructional approaches were evident in the project-based classroom (for example, group discussions, brainstorming, reflections, novice-expert interactions) the project coordinator was assured that students were immersed in the variety of constructivist learning modes (problem-based learning, collaborative learning, experiential and situated learning). Students were observed during the technical assessment of their systems and during the feedback of each deliverable. They were frequently involved in collaborative and problem-based learning modes reflecting on their experiences with clients. They were actively discussing strategically important tasks, producing ideas, providing critical remarks.

During the focus group interview one student commented "… *feedbacks and discussions with the project-coordinator were useful …"*
Another student noted … " *it was useful to visit clients…I was in a shop observing a sales manager … but we need more actual help from experts…"*

Team members were often interacting in a form of practical and cognitive apprenticeship during programming activities. It was observed that students were demanding explicit individual guidance from a project coordinator in a form of cognitive apprenticeship. Time was allocated during five project deliverables for reflection and explicit instructions on one-to-one basis in order to help students to form a vision and images of the project outcomes.

The fact that they were 'owners' of little companies and the responsibility to design a workable system to solve a real-world business problem was evident in their presentations of project-proposals and the quality of the documentation.

b) Project initiation stage demands exceptional planning

Materials supporting the project, explanations and brainstorming sessions were aimed to create a vision, images, enthusiasm and energetic approach helping students in the initiation stage of the project. However, the project initiation stage need more time, explanation and was not sufficient as students commented "*…project initiation stage must be planned … students don't see the worth of their projects … what is the expectation …communication must be more often on line…we want to see the whole picture …*" Observations revealed that, at the initial stage, students had a very unclear vision of what will happen during and at the end of the project journey.

c) Collaboration with the project-coordinator and collaboration between and within groups are necessary in a project-based classroom

Observations revealed that team members were involved in continuous collaborative learning. Analytical discussions during collaborative learning were observed in multicultural groups of students. As these teams organised their own 'company' simulating a real-life business environment, students were motivated and determined to help each other with sharing of knowledge and skills. There were few conflicts reported within teams, these conflicts perhaps being due to a lack of communication and negotiation skills as well as a lack of time for team adjustment.

Students reported that, "*we shared skills within our group…we help in knowledge sharing…we helped other groups as well…*" Students' project files revealed the evidence of regular group meetings and on line communications in the form of e-mails, faxes and agendas. " Team members discussed their tasks and roles in advance and allocated them to the different members taking into consideration their respective skills, preferences, feelings, and interests…" (it was recorded in the observation notes).

d) Informal nature of IS projects provides the opportunity for experiential and situated learning

Students commented that, "*…with client must be ongoing communication…lecturers must meet a client on Friday … develop relationships …they [clients] will develop commitment…we have a problem to establish a continuous link with clients…we met client only once…clients are too busy…if lectures meet clients they will be more committed to help us…lectures should build a relationship…"*

It was observed during the project-exhibition day that clients were happy with the system and the relationship established with team members. One client reported that*" I am happy …I would like to cooperate next year… perhaps a bigger system could be developed…'* Another client with an exciting tone of voice approached the project coordinator saying*, " they [students] developed exactly what we wanted… we created a mutual relationship…we would like a more complex system next year"…*
Some team members joined the discussion and they said *" it was a valuable for us…we learned a lot…we are part of their IT team…"*

Interaction between students and their physical and social context situated in a business was documented from their project files. It was evident in project files that a network of communication links were created with their client, through e-mails, phone calls, faxes and interview protocols and transcripts. This served as evidence that they were fully engaged in experiential learning as well as situated learning.

e) Creating links with industries promote apprenticeship and problem-based learning

In addition to the major task of finding a company for which they have to find a solution to their business problem, students were exposed to project-related seminars. They had the opportunity to meet experts in the project related fields. Seminars were well attended and the students commented, "*… we liked guest lectures, lectures from experts in industry…it was interesting…it was valuable experience…they [students] were not coming in normal lectures but every Friday the classroom was full…lectures helped for our project deliverables…"*

During the technical assessment of the systems, team members clearly shared their client-based business experience and knowledge they learnt in the real-world business environment. The project-coordinator observed the students' dedication to their project work and their excitement in finding a solution to a real-world business problem. It was observed that having links with the real-life environment, students could exchange ideas, ask questions, observe and use some business documentations. These could be promoting factors for productive thinking, creativity and problem-based learning.

It was evident in their project files (the fact finding section) that meetings with clients were crucial where students could investigate real-life business problems. Thus, there were opportunities and time to question and reflect the latter.

f) Visibility and the marketing of students' projects provide a motivation and positively influence team performance

Students realised that they contributed to the visibility of IS projects in general as they exhibited their projects at the project exhibition day with high responsibility and pride. The marketing initiative had motivational effects on the students. This was visible during the project-exhibition day in their project presentation, professionalism, and dress and how they approached potential employers and clients. Each little cubicle was organised and decorated in an original way with a company colours, business cards and posters. Each team presented a company. Students commented, *" marketing, it is a good idea… really, we are involved in profit sharing* [they said with doubt but with happy surprise on their faces].

They were excited by the fact that IT media was involved taking photos of the various teams. Students were busy answering questions and seeing the worth in their effort in producing a marketable and valuable product for the community. They reported that *" it went well …we need a networking with businesses …we need knowledge sharing …"*
It was observed that, that students created links with the businesses during the project exhibition day.

DISCUSSION

Findings revealed that a variety of constructivist instructional strategies (group work, cognitive and practical apprenticeship, individual discussion, discussions with team-coordinators,) were promoting multiple learning modes (for example, collaborative, situated learning, experiential learning) and setting an appropriate environment for problem-based learning. (as an answer to research question 1)

Furthermore, findings revealed that practical and cognitive apprenticeship accessible to individual students and teams could substantially improve project team performance. Having observed students in various stages of mastery of a cognitive task, researchers have noted that students help each other, and explain instructional strategies to each other, using their own words (Stevens, Slavin & Farnish, 1991). A cognitive and practical apprenticeship atmosphere with its deep engagement gave students the opportunity to discover expert strategies in the IS context (Thomas, 1992).

Roth (1995; cited by Jones & Carter, 1998:269) described the tasks of scaffolding as providing support for any part of an assignment that students are unable to carry out on their own. Students were able to reflect on business processes guided by mentors in a cooperative environment (Mintzes & Wandersee, 1998; Roth 1995; Jones & Carter, 1998) and to find alternative solutions for a business problem (Zietsman, 1996). “Collaborative activities require students to reflect on their knowledge to make generalisations and elaboration that they can convey to their peers” (Stevens, Slavin & Farnish, 1991:10).

Developing projects in a real-life environment helped students to enhance their strategic planning skills. This can be aided by a visual representation of the project deliverables at the initiation stage of the project development. Learning is facilitated when students are occupied with solving real-world problems (Jonassen, 1996), which resulted in experiential and situated learning.

Findings indicated that the real-world nature of IS projects developed problem-based and productive thinking, which involves structured understanding of properties and also relations of the ideas in a business problem. With the link to social and physical context students had the opportunity to practice

productive thinking and procedural knowledge (McCormick, 1997). (as an answer to the second research question).

Findings indicated that the visibility and marketing of IS projects within different SME sectors was an effective initiative which had a remarkable influence in promoting a teams creativity, technical and abstract skills. This opportunity empowered students' enthusiasm and energetic preparation for the project exhibition day (as an answer to research question 3). The tendency to extend links with industry in terms of expert guidance in design and technology features was evident. However, diverse marketing strategies and media involvement need to be explored.

CONCLUSIONS

Based on the findings, the researcher of this study believes that the most significant further improvements of IS projects will come from intensified links with external businesses and the initiation of project marketing within SME sectors. Some aspects need to be emphasised when creating a problem-based learning environment in a project-based classroom:

- Projects should be developed in a constructivist classroom where multiple instructional strategies and learning modes are nurtured.
- Missing links with industry in terms of business analysis and design, as well as in programming need to be established at an early stage of the project design and development.
- Attention should be given to diverse marketing strategies in order to promote students' enthusiasm and overall team performance.
- To have a marketable product students must have a clear vision of their project destination and they must be guided by clear expectations at the project initiation stage.
- Students must visualize each deliverable through monitoring, encouragement, knowledge and skills transfer during practical and cognitive apprenticeship offered by a mentor, project-coordinator and peers.
- The problem-based learning experience must be guided and motivated through the experiential and situated mode of learning in cooperation with businesses.

The students' internal power of self-direction, the impact of their vision and directions with caring and knowledgeable guidance of an expert (for example, the mentor, project coordinator a business expert) acts as a vehicle in IS project design.

In conclusion, an insight into the management of IS projects within a problem-based learning environment derived form this study can be used as a base for further investigations in this field. Further research should answer the following question: how to develop links with various sectors and industries in order to create marketing initiatives for IS projects?

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