
Characterising a capstone within a foundation learning programme

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Abstract

This paper uses a framework for considering projects in computing education to describe a “foundation capstone” within an introductory sub-degree computing programme. The intention is to provide a framework for considering whether the prior research into capstone projects in computing degrees can be used to inform pedagogy in this “foundation capstone”. The paper concludes that while many aspects align, the primary difference is in the nature and amount of academic supervision required in this programme.

Keywords

Capstone, project, certificate, framework.

Introduction

This paper contributes to the body of knowledge regarding capstone projects in Information Technology. In particular we consider the characteristics of “foundation capstone” within a sub-degree certificate programme.

Capstone underpinnings

Many authors have described aspects of capstone – or final year projects in computing degrees. Much has been learnt about different aspects of the pedagogy of such courses

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To give a flavour of the research into capstone projects: Clear *et al.* (2001) provided a set of resources for capstone educators; Goold (2003) raised questions of process, as did Strode and Clark (2007); in a series of papers Mann and Smith (2004, 2005, 2006) described the development of an integrated process combining agile and structured methodologies; Conn (2004) and others discuss the relationship between the capstone and software engineering; a value proposition model was proposed by Mann and Smith (2006) that Goodwin and Mann (2007) used as a basis for understanding the perspectives of different stakeholders; Herbert (2007) developed processes for peer assessment within the capstone and with Wang, developed a timesheet approach for considering student effort and workload; (Herbert and Wang, 2007); Smith and Mann (2005) described the culture of the "project room"; Stein (2002) studied group size effects; and Von Kinsky and Ivins (2008) considered the capability and maturity of projects.

Around the edges of the capstone experience can be found variations on the approach. Skelton and McLay (2006), for example describe a structured work placement approach.

Research questions

In developing a pre-degree foundation level course (Level 3 on the New Zealand Qualification Authority Framework), the authors wanted to replicate the success of the capstone project with an integrated course of study. The question then arises, to what extent can this be considered a capstone? – can we appropriate the capstone literature to inform this lower level course?

The most complete work on projects in computing education remains the book "Computer Science Project Work: Principles and Pragmatics" edited by Sally Fincher, Marian Petre and Martyn Clark (2001). In this book they provide a framework for considering different approaches to the project experience in computing. Fincher *et al.* use "composite case studies" to introduce different approaches and provide a context for discussing mechanisms. The composite case studies include various project models including: research, product development; software engineering; application based; team projects; process focused projects and integrative capstone projects. Fincher *et al.* do not have a category that neatly fits the "foundation capstone".

In the next section, we describe the "foundation capstone" using the framework developed by Fincher *et al.* (2001). The intention is to highlight aspects of the foundation capstone that align with a traditional capstone, and those areas of divergence. Fincher *et al.*'s template begins with a summary table (Table 1) and covers: Size and Duration; Context; Objectives/Aims/Pedagogic Focus; Topics (Allocation); Supervision; Student Process; Deliverables; Assessment; and Keys to Success. This provides a context for the later reflection and discussion.

Size and Duration

The project is four weeks, full-time. Student work consists of 33 hours per week, of which 18 hours is supervised, and approximately 15 hours per week unsupervised. Note: in this case this distinction is not equivalent to teacher/student directed learning.

Table 1: Foundation Capstone

Individual or group?	Group, 4 max
Year	Level 3 (Degree minus one year)
Assessment	Summative but continuous
Pedagogic focus	To integrate and demonstrate the skills and knowledge acquired previously
Special characteristics	Not just using information learned in disparate courses/modules, but also putting it together in a coherent body
Key problem	Topic selection – within the limited capability of the students, yet of sufficient complexity to maintain student interest. Needs to be of computing in nature. Ownership – needs to promote student ownership of the project

Context

The capstone foundation project is the cumulating project, demonstrating knowledge and skills acquired during the programme. It aims both to culminate the IT foundational programme with a practical demonstration by the student confirming their ability in the domain, and to make learning “real” by integrating theory and practice through authentic problems, processes and deliverables.

Objectives/Aims/Pedagogic Focus

- To integrate, consolidate and demonstrate technical knowledge and skills acquired over the whole of the programme (and thereby potentially acquire new knowledge)
- To apply computer science theory and methods to solving authentic problems and making engineering decisions
- To confirm the student’s IT foundational knowledge and ability
- To demonstrate both constituent and self management skills
- To bring home to students that their formal education is incomplete without an ability to put their knowledge into use in solving problems

Topics (Allocation)

The topic is assigned by the supervisors. The topic choice must provide scope for a range of knowledge and skills, emphasised in the programme, to be demonstrated, and should encourage student

- Required Gantt Charts uploaded into the "Gantt Charts" area of Moodle (assessed as a group)
- Letter requesting information for presentation venue correctly completed and uploaded into the "Moodle Mail" area of Moodle (assessed individually)
- All files that relate to the application, archived into a single compressed file and uploaded into the "Software" area of Moodle (assessed both individually and as a group)
- Final presentation to lecturers (assessed both individually and as a group)
- PowerPoint for presentation uploaded into the "Portfolio" area of Moodle (assessed both individually and as a group)

The project brief gives only a high level overview of the Project Structure and list all the deliverables but not actually define what they are required to do to meet the deliverables. This approach allows the students to look at the Project Scenario and look at the deliverables and then make decisions on how they are going to get there.

Assessment

Assessment is integrated throughout the project. The project itself does not have any learning outcomes, rather the four courses of study that are integrated into the project provide the learning outcomes. Assessment criteria are specified both through instruction given to students during the project and through provided

marking schedules. The project deliverables are assessed against the appropriate learning outcomes, and are measured for completeness, correctness and quality. Students are mainly assessed individually against the learning outcomes.

Keys to Success

In Fincher's composite case studies these are "cited keys to success". Here we identify elements that the authors believe were keys to success of our students. In most cases these align with elements identified by Fincher, but from a range of her categories. These are identified in parentheses below.

- Success comes when students have real knowledge and skills to bring to the project from their previous education
- Rich enough project topic, which requires students to draw on material from the different courses, and which allow both "vanilla" demonstration of skills and also admit exceptional or insightful solutions which exceed previous teaching.
- Students devoting the required time to the project (First Year Individual)
- Insisting that students keep the project moving at a steady pace (First Year Individual)
- Engagement of staff (Research -type)
- Getting the scope of the project right (Design and Build)

- Having more students on a team than is strictly necessary (to accommodate attrition)(Project with a client)
- Good time management by students(Project with a client)
- An intensive period of project work (Process based)

Reflection

Role of project based learning in the programme

Learners in the Certificate in Information Technology (Level 3) are currently predominantly young males. At this level they have already been identified as needing IT Foundational Learning and may have struggled with learning in their past. The CIT (Level 3) is a feeder into both the CIT (Level 4) and the Bachelor of Information Technology degree programme.

The intention in developing a foundation project as the conclusion for the Certificate in Information Technology (Level 3) programme was to bring the various threads of learning together into an experiential learning environment to meet the graduate profile.

Project-Based Learning is a key philosophy in the entire programme. Thomas (2000) describes Project-Based Learning as being "a model that organizes learning around projects". This is a student-centred learning technique and is comparatively different to the traditional teaching method of "chalk and talk" (Thomas, 2000). In order to further understand PBL and to better appreciate how projects should be used to enhance learning, Thomas(2000) goes on to describe

five criteria that answer the question of "what must a project have to be considered an instance of PBL?"

- PBL projects are central, not peripheral to the curriculum.
- PBL projects are focused on questions or problems that "drive" students to encounter (and struggle with) the central concepts and principles of a discipline.
- Projects involve students in a constructive investigation.
- Projects are student-driven to some significant degree.
- Projects are realistic, not school-like.

(Thomas, 2000)

The "Foundation Capstone" is not actually a prescribed course, rather, it is really a four week project event that combines learning outcomes from three distinct courses. This project does, however, meet the five criteria above and can be described as a "capstone" event that allows the students to apply what they learnt in the previous twelve weeks of the programme, while still being central to the curriculum itself and combining learning and assessment.

PBL fits into an enhanced learning methodology which is referred to as criterion based. Biggs (1999) describes the difference between criterion based and more traditional methods as being, "The curriculum is stated in the form of clear objectives which state the

level of understanding required rather than simply listing the topics to be covered". The learning is driven by the criteria (learning outcomes) that have to be met and the project allows students to encounter and struggle with learning that assists them to meet these learning outcomes. Even though these learning outcomes belong to three different courses within the programme; the use of a portfolio of submitted documents/publications, minutes, agendas, charts provide a collection of evidence that can be assessed across different courses. One particular deliverable (assessment item), can be assessed by two different lecturers for different learning outcomes within different courses.

By students knowing what is required of them, and then being given the freedom to work in a project environment that simulates a real life situation, they are able to drive their learning and "they focus on the application, and possibly the integration of previously acquired knowledge" (AAEE, 2003). Through utilising Moodle as a central point of collection for the Project deliverables, and through providing students with a number of resources that they have control over, this creates an experiential learning experience for the student.

Facilitation

The role that the lecturers take on in the four weeks of scheduled class time is very much a facilitator role. The students have meetings where they set the work that they are going to do for the next couple of days. They utilise Gantt Charts to plan the milestones and how they are going to meet the deliverables. The control appears to very much be in the students' hands and through various resources they can plan their

learning and how they are going to meet the assessment requirements.

No lesson plans exist, however there is an overall timetable that specifies some set meeting times and the final presentation details. The biggest challenge around this is that we are taking three different courses classes and combining them into a single project class timetable. The various lecturers that up to that point in time were teaching different topics are now all involved in a single project. The common factor of these classes are the student project groups.

To give an example of the type of project, in 2010, the project for each student group was to prepare for a software release event for an "Asteroid" style game that they have been designing the graphics and multimedia for in one of their courses.

In the real world a project group would be responsible to somebody who would regularly communicate with the group and dynamically give instructions and directions. It was decided to give the mock business that the project groups are working for, a mock manager. Hence the creation of "Iam Manager". Iam corresponded with the group through the Learning Management System.

Portfolio Based Submission

The project deliverables are submitted within a portfolio of documents/publications (on Moodle). Each item submitted is automatically attached to the gradebook. One particular deliverable might have two different lecturers marking it with two different marking schedules from different perspectives. All these

marking schedules are available to the students within Moodle.

Rationale

In looking at our past experience with the Certificate in Information Technology (Level 4) programme, and because this new CIT (Level 3) programme is a pathway into the Level 4 and the BIT Degree programmes; we wanted to create an experience at the end of the programme that applied the skills that the students had learnt and better prepared the students for further studies at the higher levels.

Within all the IT programmes we have found that students have more enjoyment and achieve more if they are actually applying their learning. Just having lectures and discussing topic after topic after topic, has not worked in the past with these certificate level students, and therefore over a number of years a lot of hands on activities have been incorporated which make the learning more experiential and applied.

In the same way just having online material for these students and allowing them to manage their learning remotely does not work either as they fail to achieve. We have made increasing use of firstly Blackboard and then Moodle over the years, and we have found that if students are left to work on an activity online from home they seldom manage to complete the activity because of other distractions and the lack of instant feedback and support. The ability for students to utilise the same online resource in the face-to-face classroom and then continue on working at home is the best combination.

The project-based learning approach to these four weeks allowed these learners to experience the learning in a hands-on manner which encouraged learning in a less threatening environment. They are able to relate the learning to real life and therefore apply the learning in a manner which is relevant to each individual. The group work involved provided support for each learner and the joint responsibility provided extra motivation for the learner.

The use of the graphics and multimedia content within the project creates interesting content for students who are interested in Information Technology. The use of Moodle as a tool for collaboration, submission, and communication, utilises online resources in an environment which is relevant to IT students.

By simulating a real life industry situation, it is building the students towards their further studies and further project/group work in the future which they will be utilising in the BIT environment. This will enhance their chances of being successful in the BIT and eventually participating within the IT Industry.

The majority of the learners are males between the ages of 17 and 20 years old. They have various levels of IT experience, but in general would have a good level of digital literacy. They have grown up around computers. We then have a smaller group of more mature students who often have less computer exposure than the younger students, but generally have more life experience and often possess more self discipline.

Because of our high 17 – 20 year old ratio in the class, there is a need to encourage engagement within the

courses through progressive success strategies (as in building success on success), as well as consequences for non-participation. A big part of this engagement is the feedback that students will receive in all parts of the course as this is what regulates future performance. Nicol (2006) suggests: "that feedback messages are invariably complex and difficult to decipher and that students require opportunities to construct actively an understanding of them (e.g. through discussion) before they can be used to regulate performance." We find this with our 17 – 20 year olds and therefore there is a high need for one to one conversations both within and outside the classroom.

Conclusion

The Foundation Capstone meets institutional goals of being a "learner centred organisation" that "inspires and builds capability" The Foundation Capstone approaches the learner with this vision at the core. Through students having control of their learning and through their utilisation of computers and online resources, they will learn through experiential processes and will be encouraged to record their learning and pass this onto others. This concept of "doing what you are learning" is central to the learner's experience.

The "Foundation Capstone" is certainly an example of project based learning in computing. It is also a capstone in that it pulls together material learnt in other courses at the end of the programme. The fundamental difference between the Foundation Capstone and a traditional capstone as described by Fincher *et al.* (2001) is the level of supervision required of lower level students.

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