Defining Projects to Integrate Evolving Team Fundamentals and Project Management Skills

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ABSTRACT

Industry has indicated the desire for academic programs to produce graduates that are well-versed in collaborative problem solving and general project management concepts in addition to technical skills. The primary focus of a curriculum is typically centered on the technical training with minimal attention given to coalescing team and project knowledge. In this article, we present an evolutionary approach to defining projects for the duration of a student's tenure that integrates the development of team competencies and project knowledge. The approach uses the project management processes defined in the Project Management Institute's Project Management Body of Knowledge as a standard collection of project knowledge and identifies different levels of expertise that should be exhibited by students at different points through the curriculum. We also provide a collection of example projects to illustrate the differences between projects at each of the freshman, sophomore, junior and senior levels.

Keywords: Project Management, Team Fundamentals, Problem-Based Learning, Competency Matrix, Project Scaffolding

1. INTRODUCTION

A goal of undergraduate curriculums such as Information Sciences/Information Technology and Business is to prepare students for entry into the workforce. In addition to technical skills, industry is demanding entry level workers who have the ability to work on teams and execute projects (Peterson, et al., 2003; Woratschek and Lenox, 2002). Project management practices must focus concurrently on people, processes, and technology and shift emphasis from project management to project leadership (Nidiffer and Dolan, 2005).

1.1 Motivation and Objective

Students are often provided satisfactory exposure to the technical details of a domain in an evolving style but the team and project skills are typically provided in a disconnected manner. That is, while curriculums strive to define a set of structured courses to address students' technical skills over the span of the program, team fundamentals and project knowledge concepts receive minor focus (Hogan and Thomas, 2005).

In order for graduates to complete a degree program and meet the expectations of future employers, students must be provided an environment in which to learn, apply and evolve their team and project knowledge. Students should have an opportunity to learn, practice and develop team and project management skills, in a near-commercial environment, with opportunities for reflection and interaction with real-world clients (Jones and McMaster, 2004; Rawlings et al, 2005). To educate successful young IT professionals, teamwork fundamentals and project management concepts should be integrated into the curriculum (Schneider et al., 2005). The goal of this paper is to define an approach to project selection that spans the four years of a traditional baccalaureate curriculum. The approach is rooted in the Project Management Institute's (PMI) Project Management Body of Knowledge (PMBOK) (Project Management

Institute, 2004), and is integrated with a competency matrix for team assessment, which define how students' team competency is expected to mature as they progress through the curriculum (Smith and Smarkusky, 2005).

1.2 Background and Related Work

The human engineering factor is often the most important, but frequently overlooked, aspect of IT project management (Laplante, 2003). In order for students to both practice and exhibit desired team skills, projects need to be defined in a way to provide such opportunities. As it is unrealistic for students to both simultaneously learn and demonstrate mastery of team fundamentals and project knowledge, an approach that enables students to evolve independently in both dimensions is required. Within the literature there is significant discussion on the merits on various team-oriented learning such as problem-based learning and service learning (Cameron et al., 2005; Duch et al., 2001; Eyler and Giles, 1999). Further, discussions of projects that address the needs of specific courses, such as for introductory courses in a given discipline, are numerous. However, the literature is vacant with respect to defining evolving projects over significant time spans that focus on integration and enhancement of project knowledge and team fundamentals. This article serves to fill that void by merging a competency matrix approach to evolving team skills, scaffolding and problem-based contextual learning.

To address the need to provide an approach that gradually evolves a student's team skills, Smith and Smarkusky (Smith and Smarkusky, 2005) employed a competency matrix that defines the expected maturity of various team skills for each student level (i.e., freshman, sophomore, junior or senior). The approach also abstractly describes the evolving nature of the projects for each student level. The projects can be described in two dimensions: the formality of the project structure and the explicitness of the project objectives. In order for freshman students to focus on practicing team skills, freshman projects are highly structured and have very well-defined objectives. In this case, the instructor provides both significant guidance throughout the project lifecycle and explicitly defines the scope and deliverables. By contrast, senior projects are loosely structured and have open-ended problem statements. Seniors are expected to work efficiently as a team with minimal involvement of the instructor and must work to understand the nature of the problem and negotiate the scope and schedule of the project. While the simple, two-dimensional characterization of the problem is sufficient for defining the competency matrix, it does not provide guidance to an instructor who has to define a project for a given student level.

The dimensions of structure formality and objective definition really address the specification, planning and execution of a project and can be summarized as "project knowledge". That is, freshmen are expected to exhibit minimal project knowledge whereas seniors are expected to have varying levels of mastery of different aspects of the project life cycle. An accepted standard for project knowledge is defined by the PMBOK. Using the project management processes, organized by the nine PMBOK project management knowledge areas, we are able to define an evolving set of criteria that serve as a guideline for defining student projects at each level. Further, by selecting problem-based learning opportunities that simulate real-world problems encountered by corporations, students are provided an opportunity practice relevant skills in an appropriate context as prescribed by Brown, Collins and Dugid (Brown et al., 1989).

With an increased focus on project-based learning, the "notion of scaffolding is now increasingly being used to describe the prompts and hints provided in tools to support learning" (Putambekar and Hubscher, 2005). Scaffolding through human and/or computer guidance is provided when and where necessary and is removed when evidence of learning is present (Lajoie, 2005). Scaffolding is applied across the student levels to provide for a "hierarchical program in which component skills are combined into "higher skills" by appropriate orchestration to meet new, more complex tasks requirements" (Wood et al. 1976). Scaffolding is realized by the level of involvement of the instructor with respect to the formality of the project structure and the explicitness of the project objectives.

The remaining sections provide the details of this integrated approach to evolving both team competency and project knowledge. Section 2 provides the team and project fundamentals. Specifically we discuss what is meant by team competency and the use of the matrix as a roadmap for team training. We also provide the details of how the processes defined for the nine project management knowledge areas are used to characterize the projects from the freshman level to senior level. Section 3 describes concrete examples of projects at each of the four levels and discusses how such a project definition addresses the defined characteristics. Lastly, we provide a discussion and future research in Section 4.

2. ROADMAPS FOR TEAM AND PROJECT FUNDAMENTALS

For students to achieve an integrated competency in both team and project fundamentals, students must be provided an opportunity to learn, practice and demonstrate such competencies (Leong, 2005). The traditional student will enter the program with no or minimal team competency and project knowledge. Since projects by their nature are typically team-based, it is reasonable to assume that before we can expect students to excel in project knowledge, they first must learn how to work in a team environment. To this end, the nature of the projects that correspond to the freshman year are focused and evaluated relative to students exercising team fundamentals rather than project fundamentals. On the other end of the spectrum, senior projects are significantly focused on exercising project fundamentals with team fundamentals implicitly expected.

2.1 Team Competency Roadmap

The team competency roadmap is defined by the matrix introduced by Smith and Smarkusky (Smith and Smarkusky, 2005). The matrix has five main team competency categories, summarized in Table 2-1. Each of the categories is further refined by a collection of aspects. The expected

proficiency for each student level, freshman through senior, is defined per aspect.

Team Competency Category	Definition
Process	The abstract understanding of the steps required to complete a project
Communication	The ability to share information both internally amongst the team and externally amongst all stakeholders
Interaction	The social and interpersonal skills and includes things such as conflict resolution and understanding the value of diversity
Contribution	The way students can be an integral part of the success of the project via collective problem solving and decision making
Responsibility	The commitment to and ownership of the project success which includes timely completion of tasks, equity in duties and general good citizenship

Table 2-1. Definition of the Five Team Competency Categories (Smith and Smarkusky, 2005, p. 156)

The general idea in defining the proficiencies for each aspect of the matrix is that freshman are expected to exhibit awareness of self and take responsibility for their own actions. Conversely, the seasoned senior should be attempting to continuously improve the team's performance, mentor peers who exhibit deficiencies in certain aspects and embrace a proactive, rather than reactive, approach to potential problems in team dynamics. The competency matrix also defines the nature of the projects at each student level: highly structured with well defined objectives to unstructured with undefined objectives. This progression affords students the opportunity to demonstrate more mature knowledge as time progresses.

Team competency training occurs at the beginning of the progression. Freshman students will receive focused team training, such as the modular approach defined by Smarkusky et al. (Smarkusky et al., 2005), and they will be expected to implement these team fundamentals for their projects. The evaluation of students for the project is centered on their team competency with lesser emphasis placed on the quality of the specific deliverables. The role of the instructor is as a trainer.

The sophomore training consists, at most, of abbreviated refreshers of the original team training. Ideally, sophomores will be able to reflect on the freshman experiences and identify weaknesses and strengths in their approaches. The result is that sophomores are expected to begin a transition from the application of specific techniques to the selection, justification and application of the most appropriate technique. The instructor plays the role of coach rather than trainer.

During the junior year, students no longer receive any focused team training and begin to transition to viewing the team from a management perspective rather than a member perspective. The instructor begins to transition from the role of coach to the role of mentor.

As seniors, students are expected to be self-sufficient with respect to team dynamics. The instructor plays the role of a mentor and students consult with the instructor to resolve extreme difficulties in team dynamics. As students progress through the curriculum, they use the competency matrix as a roadmap for team competency expectations and a peer assessment tool for team projects (Smith and Smarkusky, 2005).

2.2 Project Knowledge Roadmap

Student projects may involve system analysis, development or academic research, and should expose them to ideas and concepts beyond the classroom and textbook (Mustafa, 2004). The project knowledge expectation roadmap evolves in a similar manner as that for team competency with minimal expectations of the mastery of formal project concepts early in the students' careers with rather demanding expectations at the end (Hogan and Thomas, 2005; McRobb, 2006).

As it is considered an industry standard, we adopt the use of the PMBOK to define the expected project management knowledge of the graduating students. The PMBOK defines nine project management knowledge areas, each of which has associated processes (Project Management Institute, 2004).

In the freshman and sophomore year, a student's understanding of processes is not immersed explicitly in the context of project management. Rather, students are introduced to purpose and necessity of various processes and their relationship to the project lifecycle. The processes are explained with minimal project management terminology initially and may be more formally defined in a project management course taken later in the curriculum.

The freshman level defines only conceptual expertise of a handful of processes. Students are exposed to the monitoring of the project schedule, sequencing of activities to complete a task, and project quality based on expected outcomes. Team competency training focuses on the fundamentals within the Project Human Resource Management and Project Communication Management areas.

Sophomore students will be expected to take some initiative by transitioning from the conceptual to practicing level of expertise in most of the process tasks associated with freshman projects. Since sophomores are to begin accepting ownership of the project's success rather than just their individual success, they are exposed to project management areas such directing and managing execution, creating Work Breakdown Structures, activity duration estimating, schedule development, and managing a project team. Students are responsible for proper team dynamics, and ensuring projects stay on task and meet the defined requirements.

The greatest increase in project knowledge expectations is in upper-level courses, when students learn the majority of formal project management terms and concepts. Juniors are expected to have mastered the activities that relate to basic

team skills, to practice the skills that relate to owning the success of the project, and to demonstrate the conceptual understanding of all processes relating to project management. By the time students become seniors they will be expected to have acquired the project skills necessary to independently execute a successful project. Ideally seniors would demonstrate a practicing or mastery level expertise for most of the processes but projects will rarely afford such opportunities. Processes relating to Project Procurement Management will be difficult to exercise as students will not be in a position to establish and execute legal agreements with vendors and consultants. Since the projects are confined typically to a semester, many of the control and risk related tasks are not applicable since there will be limited time for students to measure, assess and modify their current approach.

In addition, the PMBOK defines five project process groups: Initiation, Planning, Execution, Control and Closing (Project Management Institute, 2004) as well as provides a mapping of the project management processes to the project management process groups. The mapping is described in Table 2-2.

2.3 Relating Project Levels to Project Management Process Groups

Using the notion of scaffolding, we introduce a conceptual framework for enhancing project management skills. In the last section we briefly discussed the relationship between project management processes and the level of expertise expected by students based on where they are in the curriculum.

Within each project management knowledge area, we identify if an expertise is expected and, if so, to what degree at each project level. We define three levels of expertise: *conceptual*, *practicing* and *mastery*. A *conceptual* level indicates that the student demonstrates an understanding of the process and performs the tasks under the guidance of an instructor (i.e., the teams are explicitly instructed to perform a process and given clear indications of the expected outcome). A *practicing* level of expertise indicates that the students will be implicitly instructed to perform a process and the expected outcomes are not necessarily explicitly defined. It is at this level that students learn the formal project management terminology, and are given an opportunity to practice formal project management processes. The level of *mastery* means that students are independently expected to perform a process without supervision or specifically being asked, and inherently understand how to produce a quality outcome. Table 2-3 identifies each project management knowledge area, the associated processes and the specification at each level of the expected expertise.

The mapping of the project management knowledge area activities to project levels combined with the mapping in Table 2-2 illustrates the relative involvement that student level projects will have with each process group and is shown in Figure 2-2. Each identified process group shows a collection of four histograms which represent from left-to-right the freshman (f), sophomore (s), junior (j) and senior

Process Group	Processes	
Initiating	• Develop Project Charter • Develop Preliminary Project Scope Statement	
Planning	• Develop Project Management Plan • Scope Planning • Scope Definition • Create Work Breakdown Structure • Activity Definition • Activity Sequencing • Activity Resource Estimating • Activity Duration Estimating • Schedule Development • Cost Estimating • Cost Budgeting	• Quality Planning • Human Resource Planning • Communications Planning • Risk Management Planning • Risk Identification • Qualitative Risk Analysis • Quantitative Risk Analysis • Risk Response Planning • Plan Purchases and Acquisitions • Plan Contracting
Executing	• Direct and Manage Project Execution • Perform Quality Assurance • Acquire Project Team • Develop Project Team	• Information Distribution • Request Seller Responses • Select Sellers
Controlling	• Monitor and Control Project Work • Integrated Change Control • Scope Verification • Scope Control • Schedule Control • Cost Control	• Perform Quality Control • Manage Project Team • Performance Reporting • Manage Stakeholders • Risk Monitoring and Control • Contract Administration
Closing	• Close Project • Contract Closure	

Table 2-2. Project Management Processes Organized by Project Management Process Groups (Project Management Institute, 2004)

Project Integration Management	Freshman	Sophomore	Junior	Senior
Develop Project Charter			C	P
Develop Preliminary Project Scope Statement			C	P
Develop Project Management Plan			C	P
Direct and Manage Execution		C	P	M
Monitor and Control Project Work	C	P	M	M
Integrated Change Control			C	P
Close Project	C	C	P	M
Scope Planning			C	P
Scope Definition			C	P
Creating Work Breakdown Structure		C	P	M
Scope Verification			C	P
Scope Control			C	P
Activity Definition			C	P
Activity Sequencing	C	P	M	M
Activity Resource Estimating			C	P
Activity Duration Estimating	C	C	P	M
Schedule Development		C	P	M
Schedule Control			C	P
Cost Estimating			C	P
Cost Budgeting			C	P
Cost Control			C	P
Quality Planning			C	P
Quality Assurance	C	P	P	M
Perform Quality Control			C	C
Human Resource Planning	C	P	M	M
Acquiring the Project Team			C	C
Developing the Project Team	C	P	M	M
Managing the Project Team	C	C	P	M
Communications Planning	C	C	P	M
Information Distribution	C	P	M	M
Performance Reporting	C	C	P	M
Managing Stakeholders			C	P
Risk Management Planning			C	P
Risk Identification		C	P	P
Qualitative Risk Analysis			C	P
Quantitative Risk Analysis			C	C
Risk Response Planning		C	C	P
Risk Monitoring and Control			C	C
Plan Purchases and Acquisitions			C	C
Plan Contracting			C	C
Request Seller Responses			C	C
Select Sellers			C	C
Contract Administration			C	C
Contract Closure			C	C

Table 2-3. Expected Student Expertise Defined by Level for Each Project Management Process (Project Management Institute, 2004). Table Entries Have the Following Interpretations: C – Concept, P – Practicing, M – Mastery.

(n) project levels. Each open square in the histogram represents a process for which a student should exhibit a conceptual level of expertise, a gray box represents a practice level and a black box denotes a mastery level.

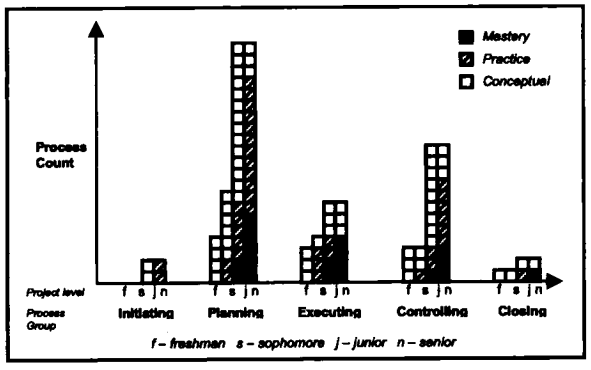

Figure 2-2. Process Counts per Project Level and Expected Expertise for Each Project Management Process Group.

An analysis of Figure 2-2 shows that students are initially exposed to project management concepts in the freshman year, and continue to learn, practice and enhance their project management skills throughout the curriculum. Each of the nine project management knowledge areas are included with the expertise level in each of the project management process areas increasing each year. Although one would expect mastery to be more frequent at the senior level, we argue that while students have the practicing knowledge, most have not been independently responsible for these tasks, but instead have participated as part of a supervised team. Thus, we cannot afford them the ranking of mastery in these areas.

3. PROJECT SPECIFICATIONS AND EVALUATION

With the understanding of the project knowledge roadmap, we now present a collection of example projects that span the four project levels. As stated previously, the general idea is that freshman projects are highly-structured and require well-defined objectives whereas senior projects are primarily open-ended problems that students must first understand and then define, plan and execute the project plan.

3.1 Freshman Level Project

Much of the preparation for the freshman level team project is incorporated in team skills training, such as that described by Smarkusky et al. (Smarkusky et al., 2005). After the training is complete, project teams are established and activities to reinforce the use of team skills are performed. These include the use of ice breaker activities, establishing team member availability and a common team meeting time as well as each individual's technical strengths and weaknesses. This initial interaction should take place before the project is described to the teams. As the project progresses, informal reflection activities (such as in-class free-writing or journaling) that require students to associate elements of the initial team training to the assigned team project provide reinforcement of the concepts and skills as well as provide the instructor an opportunity to detect and correct deficiencies.

At this level, students are also introduced to several project management concepts. The monitoring and controlling aspect of project integration are built into the project, which requires weekly reports and milestone assignments. Closing the project is accomplished when teams turn in their written report, present their findings to the class and submit their individual lessons learned narratives. The activity sequencing and duration estimation aspect of time management are incorporated into the required milestones. Instructor feedback on milestones provides feedback (quality assurance) and a chance to make mid-project corrections. Human resources planning is accomplished by instructor team assignments based on skills, team development by team building activities and team management by weekly status reports and milestone assignments. Communications planning, information distribution and performance reporting have been structured by requiring use of the groupware, weekly status reports, and milestone assignments.

3.1.1 Example Freshman Project: Chamber of Commerce Team Project: The goal of the project for each team is to develop criteria and associated weights for evaluating various Chamber of Commerce web sites. Each team will develop 8-10 criteria for each of three separate audiences - a company considering relocating to the area, a family of four transferring to the area by the wife's company, and a young college graduate considering a move to the area to seek employment. In addition to the local Chamber of Commerce, teams should choose five other Chamber web sites from similar-sized cities located anywhere in the US and evaluate each of the sites for each of the three audiences according to the criteria the team developed. Each team will produce a written report and present their results to the class. The project milestones and deliverables are defined in Table 3-1.

In addition to achieving the milestones and producing the deliverables, each team will meet with the instructor weekly to give a progress report. Each week a different student should provide a global progress report for the team which will include a brief, but specific, review of what each team member has done that week. The instructor should ask questions of each team member to ensure the report accurately reflects the current situation as well as to help identify and resolve and current team issues.

3.1.2 Evaluation of Example Freshman Project: The most important characteristic in the evaluation of freshman level projects is the significant emphasis placed on team competency. This is accomplished by defining an evaluation system that weights equally the student's participation as a team member and the quality of the deliverables themselves. The equal weighting reduces the concern students have about

the quality of a team generated deliverable but does not deemphasize it to a degree such that a team ignores quality all together. The evaluation of the project deliverables depends on the style of the instructor but typically addresses content, attention to style and adherence to any specific requirements.

Week	Milestone/Deliverable	Description
1	Team Contract	Includes team member responsibilities and expectations, communication and meeting plans and other norms needing explicit statements. All members must sign the contract and a copy is to be provided to the instructor.
2	Create Criteria / Weighting	Teams identify the criteria for the three separate audiences and the weighting scheme.
3	Identify Websites	A list of Chamber of Commerce websites is to be provided. Students should justify the inclusion of each site into the evaluation.
4	Process and Peer/Self Assessments	The team should reflect on how the project is progressing and make any changes necessary for improvements. Students should also perform a peer assessment for each team member as well as themselves.
5	Evaluation Spreadsheet	Teams produce and submit the initial weighted evaluation of the websites.
6	Process and Peer/Self Assessments	The team should again reflect on how the project is progressing and make any changes necessary for improvements. Students should also perform a peer assessment for each team member as well as themselves.
7	Written Report	The formal, written summary of the website evaluation.
9	Presentations	Each team presents the findings in class.
10	Peer/Self Assessments and Lessons Learned Narrative	Students should perform a peer assessment for each team member as well as themselves. Students will also write a brief reflection on the lessons learned during the project, identifying opportunities for improvement.

Table 3-1. Project Milestones and Deliverables for the Freshman Project.

The evaluation of team competency is driven by three main components: peer and self assessment of team skills, instructor assessment of team skills, and timely completion of assigned tasks. The assessments would be completed using the competency matrix defined by Smith and Smarkusky (Smith and Smarkusky, 2005). Assessments occur at three different times during the project. The first two assessments are informational, providing feedback to the student and an opportunity to correct for deficiencies. The last assessment will be utilized to differentiate the individual contribution from the group contribution to determine the student's project grade.

With respect to preserving the integrity of the individual grade in the team project, the level of contribution of an individual is assessed via the weekly meetings with the instructor as well as the peer assessments that are performed multiple times throughout the project lifecycle. These provide adequate inputs for fairly assessing an individual (Hayes et al, 2003).

3.2 Sophomore Level Project

Students at this level should be familiar with team building and the creation of team contracts. Students will receive refreshers of the formal team skills training at this level, when needed, and will continue to practice and enhance their team fundamentals that were introduced at the previous level. As with the Freshman Level Project, instructors can use reflection tools to detect potential deficiencies. This regular observation enables the instructor to intervene with teams before significant dysfunctions occur. Ultimately, students are responsible for assigning team roles and responsibilities amongst themselves to ensure that each deliverable is completed according to the requirements and submitted on time.

In a sophomore level project, students are introduced to a process and need to be aware that there are different tasks that need to be completed in a predefined order to complete a project. Students also begin to realize that the output of one phase may be the input to the next phase and system development is an iterative process. The descriptions of the deliverables are more general than for the freshman project requiring students to refine high-level tasks into subtasks as well as sequence all activities to ensure the team completes each milestone on time. During this level of development, students should be informed of the risks and challenges that they may face when completing this project, such as requirement changes, computer failures, student illness or family emergencies, and what are some measures they can take to avoid or resolve these issues when they arise. Students are expected to demonstrate a stronger commitment to the project and will demonstrate this commitment by taking independent ownership of assigned tasks. Where weekly meetings with the instructor at the freshman level forced students to stay on task, biweekly status checks at the sophomore level provide students with more independence.

3.2.1 Example Sophomore Project: Virtual Golf Course Locator and Player Project: For this project, teams are asked to investigate, design and implement an object-oriented software application using the Java programming language. The project summary is as follows: "PA Recreation, Inc." (PAR.com) has an interest in attracting visitors to the region and desires a Golf Course Locator and Simulator for their website. Each team is to create a system

Week	Milestone/Deliverable	Description
1	Team Contract	Teams are to establish a team contract.
2	Initial Analysis Review and Project Schedule	The team should investigate 10 area golf courses. Identify the information that will be included in the course summaries. Identify signature holes for each course. Identify significant challenges to completing this project. In addition, the team should provide a rough sketch of the tasks to be completed, the assigned individual(s) responsible for their completion and a sequencing that enables the timely completion of the project.
4	Design Review	The team is to produce a detailed design document that identifies how the required functionality is to be incorporated into the system. It also describes the design of the database and how interaction between the software application and the database will occur.
5	Process and Peer/Self Assessments	The team should reflect on how the project is progressing and make any changes necessary for improvements. Students should also perform a peer assessment for each team member as well as themselves.
6	Application Prototype Demonstration	Teams will present the design of the graphical user interface to the class as well as demonstrate its current functionality. Classmates will be able to ask questions regarding the design – both to learn as well as to ensure the system requirements are being met.
9	Project Submission and Presentation	Teams submit completed projects and present their final projects to the class. Students should be fully prepared to answer any questions from the class.
10	Peer/Self Assessments and Lessons Learned Narrative	Students should perform a peer assessment for each team member as well as themselves. Students will also write a brief reflection on the lessons learned during the project, identifying opportunities for improvement.

Table 3-2. Project Milestones for the Example Sophomore Project

that maintains information for area golf courses as well as enables visitors to virtually play a "signature hole" for each course. The system should be designed to handle ten golf courses and associated selected signature holes. The system must make use of a database (such as Oracle or MySQL) and provide an interface that includes operations both site managers and visitors are likely to perform. The initial data should be input into the system via a file but thereafter all additions, deletions and modifications should be entered via a Graphical User Interface. Once initialized, your system should allow for the following user activities: displaying the information and picture of the signature hole for each course, iterating through all courses and viewing the information for one course at a time, searching for a course by name, sorting and displaying golf course information by total yardage or course name and simulated play of at least one signature hole for each course. In addition site managers, and only site managers, should be able to create, modify, and delete course information. The project milestones and deliverables are identified in Table 3-2.

3.2.2 Evaluation of Example Sophomore Project: At the sophomore level, team skills still have a significant impact in the evaluation. However, the timeliness and quality of project deliverables plays a more significant role. Rather than weighting the team skills and the quality of deliverables equally we give the team skills one-third of the weight and the deliverables two-thirds. The evaluation of team skills is again driven by three main components: peer and self assessment of team skills, instructor assessment of team skills and timely completion of assigned tasks. The difference at this level is that the weighting of the team skills in the overall evaluation, coupled with the limited feedback (having moved from two mid-project peer assessments to one) and the less frequent instructor involvement, requires students to exercise their learned team skills independently to achieve project success. The evaluation of the project deliverables depends on the style of the instructor and the intention of the course but a key observation with respect to project knowledge is that students are still being guided through the project lifecycle.

3.3 Junior Level Project

At this level, student training moves completely from team to project management fundamentals. During lectures, students are learning about the different phases of a project and the key knowledge areas related to project management.

During the junior level project, students are exposed to the formal project management processes. Because students will need guidance while learning to perform many new processes, process outputs, such as scope statements and project schedules, will be reviewed by the instructor to ensure a consistent and fair workload among teams. Students will also gain a better understanding of quality assurance by having regular status meetings with the client. Because students will have a variety of tasks and roles throughout the

project, they will gain a better understanding of the different functions and decision making processes that occur within a formal project.

Student teams are expected to meet with the instructor biweekly to discuss the project status and handle any project management issues. Here, the instructor takes a mild hands-on approach to help coach the students through the project lifecycle in the context of project management.

3.3.1 Example Junior Project: E-Commerce Proposal: Each team will identify and investigate the information systems and business processes of a local corporation and then propose an E-Commerce extension to the existing information system (e.g., providing an on-line ordering system, adding an automatic inventory ordering system, etc.) to increase profitability and/or marketability of their corporation. The contact at the organization should be provided by the instructor to ensure the organizations understand the nature of the project and are willing to participate. The final deliverable to the sponsor will be a complete business case that defines and justifies the E-Commerce extension. Teams will also summarize their proposal in a formal presentation to the sponsor. The project milestones and deliverables are defined in Table 3-3.

3.3.2 Evaluation of the Example Junior Project: Students at the junior level are expected to be competent in team skills. Evaluation of the students at this level is related primarily to the success of the project. The project success can only be achieved by demonstrating sufficient project knowledge. The influence of team skills on the student's evaluation is reduced to only twenty percent of the grade. Further, self and peer assessments are performed only at the end of the project.

Project knowledge is demonstrated in two ways with this project. First, students must understand how to execute a project in order to complete the project itself. Second, the business case that serves as the final deliverable requires students to have a significant understanding of project management. The difference between the two is that the project is small enough and controlled enough that the need to actually manage the project is minimal. Much of management is in cooperation with the faculty at the biweekly status meetings. However, the business case requires a detailed understanding of many project management concepts.

3.4 Senior Level Project

Senior level projects represent an opportunity for student teams to demonstrate their ability to successfully complete a project on their own. Instructors at this point largely remain hands-off from the project, typically meeting with student teams for progress and risk reporting. Projects at this level ideally are in the form of service learning where external organizations sponsor problems to be solved by student teams. There is no formal project specification to be done by the instructor. Student teams take full responsibility for working with the sponsoring organization to define all aspects of the project, ultimately negotiating scope and schedule. As organizations volunteer to participate and accept significant risk with service learning projects, there is no formal budget associated with the project. However, students can utilize their effort estimations in their project schedule as a baseline for the project cost and, keeping track of their total effort, can assess their progress with respect to the project cost.

Instructors of courses with senior level service learning projects obtain the external sponsors, help the sponsors identify candidate projects and organize the project kick-off meeting. However, once the initial introduction of the sponsor and student team has occurred, the instructor plays the role of a mentor and meets regularly for progress and risk reporting to help enable the success of the student team but the student team is solely responsible for the success of the project. The progress report will provide the instructor visibility to the team's conformance to and management of scope and schedule as well as their adherence to their overall project management plan.

The evaluation of the senior level projects is primarily driven by the satisfaction of the sponsor. At the completion of the project, the instructor solicits sponsor feedback on the project which includes a grade that should reflect the grading scheme of the institution. The sponsor's grade may be adjusted by the instructor based on the instructor's

Week	Milestone/Deliverable	Description
1	Project Kick-Off	
2	Project Plan	Teams will submit a detailed project plan inclusive of a work breakdown structure, schedule and task assignments. Initial project risks should be identified.
4	Initial Analysis Complete	The team will submit to the instructor a summary of the corporation's current information systems infrastructure and business processes. This provides an opportunity for the instructor to provide feedback on the analysis to ensure students have not omitted anything substantial.
6	Detailed Analysis Complete	The team will submit to the instructor a detailed summary of the corporation's current information system infrastructure and business processes.
8	E-Commerce Extension Proposal	Teams will submit their business cases to both the instructor and the sponsor. Teams will schedule a date for their final presentation to the sponsor.
9	Presentation to Sponsor	Teams present their proposal to the sponsor.

10	Peer/Self Assessments and Lessons Learned Narrative	Students should perform a peer assessment for each team member as well as themselves. Students will also write a brief reflection on the lessons learned during the project, identifying opportunities for improvement.

Table 3-3. Project Milestones for the Example Junior Project

observation of the project execution. For example, if the sponsor proved to be a difficult customer that the student team did an excellent job in managing, the instructor may opt to increase the team grade. On the other hand, an instructor with a team requiring a significant amount of coaching to resolve team conflict or failing to produce satisfactory progress and risk reports may opt to lower the team grade.

As with the other project levels, individual grades for students are determined using a combination of the team grade, peer assessments, through the use of the competency matrix, and the instructor's observation of how an individual student. At the senior level, this evaluation may be rather holistic and could simply be cast as how close an instructor feels a student is to be promoted or fired.

3.4.1 Experience and Example Projects

The senior capstone course offers a service learning experience. These types of projects have a "number of important advantages including: realism, the ability to interact with clients, and the potential to produce a system that is useful to an organization" (Cappel, 2002). In practice these projects tend to be trade studies resulting in a business case that recommends a product to meet a specific need of the sponsoring organization. Other example projects may include the assessment of a modernization of a legacy technology (for example, migrating from IBM RPG to J2EE), evaluation of Linux as an enterprise desktop solution, and designing a computer lab for an assisted-living community home with associated training. Sponsoring organizations vary widely from large for-profit corporations to small, non-profit organizations.

During the past three years, 24 service learning projects were completed. Student teams were given an opportunity to work with clients to complete the required project management tasks. Some student teams had the opportunity to experience risk and change management (i.e. a sponsor's point of contact changing midway through the project and with the new leadership came a significant change in the requirements). The final outcomes and deliverables of the projects have been well-received with student teams often exceeding the expectations of the sponsors, and as a result, many sponsors remain regular participants.

4. DISCUSSION AND FUTURE RESEARCH

We have provided an approach to course project definition that enables students to evolve independently in both team and project knowledge throughout the curriculum. The team competency evolution is based on the team competency roadmap and competency matrix for team assessment. The project knowledge evolution is defined in terms of the PMBOK, an accepted standard for project management. A collection of project examples that support the integrated evolution of team and project knowledge were provided. The relative relationship between team and project management training versus knowledge expectations from the freshman to senior levels is shown in Figure 4-1.

Student training combined with project definition and evaluation should be focused on team competency during the freshman and sophomore years and project management knowledge during the junior and senior years. Students should experience the greatest increase in team fundamental knowledge during the freshman and sophomore years, with similar increases in project management knowledge during their junior and senior years.

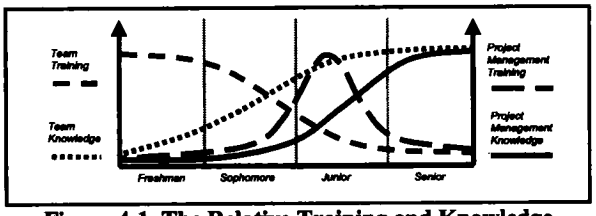

Figure 4-1. The Relative Training and Knowledge Perspectives for Team and Project Management.

It is worth observing that while we have defined a roadmap that spans a traditional four year baccalaureate program, this approach may be tailored to fit shorter time frames. For example, in curriculums where core courses for the major do not begin until a students' junior year, perhaps due to students taking required courses that are not under direct control of program department, the four year levels could be replaced with the four semesters that span a student's junior and senior year. In this case, the project management concepts may be formally introduced in courses that were taken during the first semester of the senior year. Since this approach uses a scaffolding method of learning, it is important that students take courses in a prescribed sequence with the appropriately defined team and project management objectives and projects.

Since this approach is currently theoretical, we plan to execute a comprehensive review to test this model over time. We need assess the appropriateness and effectiveness of both the mapping of processes to expected mastery at each of the levels that appeared in Table 2-2 and the time at which a formal project management course occurs. We also need to independently test the outcomes in team and project knowledge when applying this approach over four years and four contiguous semesters. After this technique is applied in both environments, a comparison of the skills acquired by the students is of interest. Understanding any differences is important, as the commitment and coordination required for a four year or four semester evolutionary approach is significant.

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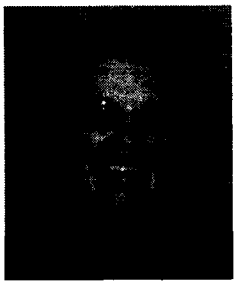

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