Agile Preparation Within a Traditional Project Management Course

Jeffrey P. Landry
jlandry@southalabama.edu

Rachel McDaniel
rachelmcdaniel47@gmail.com

School of Computing
University of South Alabama
Mobile, Alabama 36688

Abstract

Agile software approaches have seen a steady rise over a decade and a half, but agile's place in the information systems (IS) undergraduate curriculum is far from settled. While agile concepts may arguably be taught in multiple places in the IS curriculum, this paper argues for its inclusion in a project management course. This paper builds on work by Schwalbe and the Project Management Institute (PMI) to define a set of topics for undergraduates. The co-authors, a professor and a senior student at a public, four-year university, consulted four sources: an industry partner, the PMI, the Schwalbe textbook, and published literature. The authors created course content, including a glossary of terms, individual and team assignments, and assessment items. Our thesis is that agile can be taught alongside traditional project management topics and broadly across PMBOK® areas. Results from the spring semester indicate that students demonstrated a sufficient level of mastery of outcomes.

Keywords: agile, curriculum, project management

1. INTRODUCTION

The use of agile practices is becoming more and more prevalent. Since the publication of the Agile Manifesto (Beck et al., 2001), agile has gained in popularity. PMI's research has shown that the use of agile has tripled from December 2008 to May 2011 (Schwalbe 2012) and has grown even more since 2011. According to the VersionOne (2014) State of Agile Survey, approximately 88% of respondents are practicing agile in the workplace.

As agile gains ground in industry, it is important to consider its place in the IS curriculum. As it was formulated as a better way for developing software, it makes sense to include agile in courses that cover software development. The IS 2010 model curriculum (Topi, et al., 2010) mentions "agile methods" in the topics list for the IS 2010.6 Systems Analysis & Design course. Programming and project management are two other courses that may incorporate agile methods, although the IS 2010 is silent in this regard. Schwalbe (Schwalbe, 2014, 2012) has incorporated agile into her project management textbook, however, and the Project Management Institute (PMI) has adopted agile concepts in its framework, offering an Agile Certified Practitioner (PMI-ACP®) certification (Project Management Institute, 2011).

Motivated by the values that drove the originators of the Agile Manifesto, namely that agile methods are a better way, the authors set out to define course content and pedagogy to

prepare students for an increasing agile world. The lead author is a professor teaching project manager to seniors in the information systems (IS), information technology (IT), and health informatics (HI) majors at a midsize, southern, four-year, accredited, public university. The co-author was a senior IS major who had previously taken the course and was assisting the professor in a locally funded research project. In accordance with their responsibilities and common area of interest, the co-authors limited their focus to the project management course. The research question for the paper is, therefore,

What is a best set of agile concepts and practices appropriate for an IS project management course?

The expected contribution is to provide faculty members teaching PM courses with helpful guidance in putting together an effective agile component.

2. APPROACH

Several early decisions were made on the approach. The first was to not radically redesign the PM course, but to teach agile alongside traditional project management. The authors did not wish to risk being foolish by touting agile as a "silver bullet" (Brooks, 1987), and also recognized that not all situations are suitable for a completely agile approach. The approach enables comparison as well. The second decision was to teach agile throughout the course, and not just as a single topic, as agile provides for many different methods. Eventually, it was decided to use the well-accepted Project Management Body of Knowledge (PMBOK®) areas as a content framework for achieving coverage breadth. A third decision, as a result of the singular focus on the project management course, was to focus broadly on agile *project management*, rather than on agile *software development*, or developing a specific type of product. Our approach, in summary, is principally: 1-agile alongside, 2-agile throughout, and 3-project not product.

We chose topics for each area and created content. Four sets of presentation slides were created and presented:

- An introduction to agile
- Is agile right for my project?
- Agile in industry
- Agile human resource management

We also created a glossary, assignments and assessment items. A glossary of 40 vocabulary terms resulted, with at least one term falling into each of ten PMBOK areas. A ten-item multiple choice quiz was created and given to individuals and teams as part of a team-based pedagogy (Michaelsen, Knight, and Fink, 2004) used in the class. A total of 25 multiple choice items were created overall, with others used on the midterm and final exams. Three individual assignments were given:

- Financial evaluation methods problems (same as for traditional)
- An online discussion forum on an *Is agile right for my project?* Case
- A soft skills writing assignment on *Am I ready for agile?*

The latter assignment requires students to take an emotional intelligence self-assessment "quiz" and write about their results. Student teams took part in an active learning assignment on planning poker, where individuals iteratively estimated task times using a Delphi-like technique. The final exam had an essay question on agile soft skills, and a burndown chart problem. These assignments and items were given in addition to the assignments, items, and activities already in place for traditional project management practices.

3. AGILE ACROSS THE PMBOK AREAS

For each of the ten PMBOK areas, we have defined one or more key topics for coverage in the project management course. In selecting these key topics, the key criteria were to identify something in every area and to select the more important topics within each area. We considered what already was covered in the Schwalbe text, as well as the emphasis of project over product. As for Schwalbe's coverage, she provides an extensive example case in an early chapter, done in both traditional and agile approaches. Many of the terms and concepts we used as agile were present in her text as well. See Table 1 that follows for a list of topics by PMBOK area. What was taught in the course was actually more than what is in the list, but the list in Table 1 represents a post hoc reflection on what is most important.

Integration

Project Integration Management is the area that incorporates and coordinates multiple areas at once. For Agile, it is the core values and principles that encapsulate all practices. Thus, the Agile Manifesto (Beck et al., 2001) is the critical coverage area. In the manifesto,

which can be accessed at agilemanifesto.org, the signatories assert that a better way of developing software is to value the following:

Individuals and interactions over processes and tools
Working software over comprehensive documentation
Customer collaboration over contract negotiation
Responding to change over following a plan

Agile practices may change, but the practices should remain consistent with core values.

We first introduce agile (Rajamanickam, 2005; Conforto and Amaral, 2010) with the discussion of the manifesto, and with a contrast between traditional and agile project management (Fernandez & Fernandez, 2008; Lipika & Sanjeev, 2013), and, finally a discussion of conditions that are right for agile to be used (Augustine, Payne, Sencindiver & Woodcock, 2005; Nerur, Mahapatra & Mangalaraj, 2005). Agile is right for a project when:

1. Project exhibits high variability in requirements
2. Team members have a high knowledge base and can learn quickly
3. Team members are willing to adapt to change
4. Resources for project are easily accessible
5. Customer is highly involved and in close proximity
6. Value of the product to be delivered is very important to the customer
7. Manager is comfortable with a facilitator role

The *planning game* of eXtreme programming (Lindstrom and Jeffries, 2004), one of the popular agile approaches, calls for the customer-involved identification and prioritization of features, broken down into work tasks, then completed in a test-driven manner, iteratively throughout the project. This agile approach to planning is at the heart of agile project management and integrates the areas of scope, time, quality, and stakeholders, and more.

Scope

Project Scope Management covers all of the work needed to complete the project. Agile scope management revolves around the iterative identification of requirements, or features, called *user stories*, expressed in the terms the user can understand. The collection of prioritized stories and the work into which the stories are broken is called the *backlog*. The management of agile scope is iterative and customer-involved, and addressed by project integration management processes described above. In contrast to traditional project management, in which scope is fairly rigid, scope is highly variable in agile projects. Agile practitioners prefer responding to change over following a plan. Scope change is a part of every project iteration, called sprints in Scrum (Shojaee, 2012), one of the two most popular agile approaches.

Time

It is difficult to define a singularly important agile concept in the area of Project Time Management. Perhaps it is the concept of *timeboxing*. Project schedules in agile are timeboxed, or fixed, into typically two to four week intervals called *sprints*. Rather than estimating how long work is going to take and trying to meet that estimate on a task-by-task basis, an agile project team breaks down and estimates stories using a technique such as *planning poker*, a Delphi like method. The team then picks the number of stories that can be completed in a sprint. The idea is to complete a cycle of activities in a sprint, including testing and user acceptance, allowing for variations in scope rather than time. A burndown chart is used to show progress and estimate project or sprint completion. With the *Kanban* approach, estimates are not even made. Instead, tasks are written on sticky notes and placed on a white board in one of three columns: to do, doing, and done, with notes moved from left to right as tasks change state.

PMBOK area	Key Agile Topics
Integration	Agile manifesto values & planning game
Scope	User stories/backlog
Time	Timeboxing, sprints, planning poker, burndown chart, Kanban board
Cost	Financial evaluation methods (NPV, ROI)
Quality	Acceptance testing, definition of done, escaped defects
Human Resources	Emotional intelligence, Scrum Team
Communication	Co-location, Daily Scrum, empathic
Risk	Progressive elaboration, risk-adjusted backlog
Procurement	Agile contracting methods
Stakeholder	Scrum Master, Product Owner, servant leadership

Table 1 - Agile topics by PMBOK area

It is interesting to make a three-way comparison between traditional Gantt charts to burndown charts to Kanban boards. Gantt charts provide for the most complexity with relationship among tasks that are all estimated. Burndown charts show task estimates, but no task relationships.

Kanban displays task status without relationships nor estimates.

Cost
Project Cost Management deals with the financial resources of projects. All students should understand the interrelationships between project scope, cost, and time. However, it is interesting that scope is the area that varies in agile projects, while cost and time are relatively fixed. Cost concepts emphasized in the PMI-ACP are the traditional financial evaluation methods of net present value (NPV) and return on investment (ROI).

Quality
Project Quality Management for agile projects in particular is concerned with the need-satisfying aspect of a project's unique purpose. Essential to project quality management is satisfying key stakeholder needs or expectations. *User acceptance testing* involves independent testing by users of working software at the end of each iteration. Agile projects need an agreed upon *definition of done* that includes a quality criterion. *Escaped defects* is a measure of agile software quality. The goal is zero escaped defects, meaning that all defects are detected and corrected by testing during development.

Human Resource
Project Human Resource Management is the area that seeks balance between the needs of people and the needs of the project. The *Scrum Team* is the primary human resource needed to complete an agile project. A project manager, or Scrum Master, needs to develop soft skills, such as *emotional intelligence* to effectively work with other people in the project. Emotional intelligence the ability to identify, use, understand, and manage feelings in positive ways to relieve stress, communicate effectively, empathize with others, overcome challenges, and defuse conflict (managedagile.com).

Communication
Project Communication Management covers all activities related to project information. A key idea here is to keep project stakeholders informed. Until recently, project stakeholder management was covered in this area but now has come the tenth and newest PMBOK area. Now, the emphasis is not only to keep them informed but engaged. Key among stakeholders are users. In an agile project, they are engaged by their *co-location* with the project team and through *empathic* or active listening. Another critical stakeholder-related communication in agile projects occurs among team members in daily standup meetings. In Scrum, the *Daily Scrum* communicates three pieces of information—what was recently completed, what is to be done today, and what obstacles are being faced.

Risk
Project Risk Management deals with addressing areas of positive or negative uncertainty that can affect a project. Schwalbe identifies *progressive elaboration* as one of the attributes of a project. Progressive elaboration is that property that concerns how uncertainty is reduced as a project becomes clearer in more detail as it proceeds forward. Furthermore, effective risk management can help reduce uncertainty faster and more effectively. *Risk-adjusted backlog* is an agile approach to prioritizing user stories (Senevirathne, 2014) that is identified as a risk management topic in the Tools and Techniques section of the PMI-ACP exam. It adopts the principle of addressing riskiest items first.

Procurement
Project Procurement Management concerns the use of project resources outside the organization. Usually, contracts are used to enforce agreements. Agile projects are highly non-traditional. When establishing contracts for agile development, non-traditional contracts are needed or else the project will be in danger of failing to reap the benefits of agile approaches (Arbogast, Larman, & Vodde, 2012). For example, agile contracts should codify that scope changes during a project be handled in a way that corresponds to agile's value of responding to change. *Agile contracting methods* is identified in the PMI-ACP as a knowledge and skill, along with vendor management, as the only two procurement topics.

Stakeholder
Project Stakeholder Management is the newest PMBOK area, being separated from Communications. See *Communication* above. In agile Scrum projects, there is no project manager in the traditional sense (Hunton 2012). Instead there is a *Scrum Master* who facilitates the Daily Scrum, and a *Product Owner*, who ensures business value by overseeing the scope prioritization process. *Servant leadership* is listed as a concept in the soft skills negotiation section of the PMI-ACP exam. Stakeholders are the beneficiaries when project managers serve by putting others first.

3. STUDENT LEARNING OUTCOMES

During this year's first delivery of the project management course that included agile concepts, and afterwards, we developed and refined a set of course objects for what we are arguing is a best set of agile project management concepts.

1. Evaluate the suitability of agile methods for use in a given project and organization context
2. Analyze project proposals using multiple techniques
3. Compare and contrast traditional versus agile project management
4. Demonstrate an awareness of agile project management basic terminology and concepts across multiple PMBOK areas.
5. Apply agile PM principles and techniques for managing in multiple PMBOK areas
6. Discuss the soft skills and abilities of project managers
7. Complete team-based work applying the principles and tools of project management

4. ASSESSING STUDENT PERFORMANCE

As with other topics in the course, student performance on agile topics varied. Towards the end of the course, students were given a Readiness Assurance Test (RAT) on agile project management. A RAT is a type of quiz given in the Team-Based Learning (TBL) pedagogy (Michaelsen et al., 2004). First, individuals are quizzed (iRAT) typically with ten multiple choice questions on a topic area worth four points each. The same quiz is then taken by the permanent teams (tRAT), using a scratch-off-the-answer card called an IF-AT (Immediate Feedback Assessment Technique).

RAT #4 - Agile (max score=40)					
	Team 1	Team 2	Team 3	Team 4	Team 5
iRATs	34 32 30 24 19	36 33 26 25 24	32 31 30 30 28 22	29 28 24 20	36 36 34 32 28
tRAT	38	36	36	36	38

Table 2 - Agile RAT results

On the iRAT, 17 of 25 students received a passing score of 70% (28 of 40 points). The mean was 73%. The tRAT scores were all at 96% or above. See Table 2. These RAT scores were consistent with how students typically perform on iRATs and tRATs. The grand means for iRATs (n=4) in that semester was 72% and the grand mean for tRATs was 94%. These results indicate that students mastered the agile PM material similarly to other course content.

However, performance on the midterm and final exams was lower than historical averages in the project management course. The midterm average was 68% compared to 78% over the previous three semesters. The final exam average was 71% compared to 80% historically. The students performed similarly on both traditional and agile PM content, and with the agile PM content making up less than 20% of exam content. We are uncertain as to why exam performance trended lower during a semester when RAT performance remained stable. Could the additional agile content have made the course too content heavy? We believe not. As part of the review for the final exam, the students were given a surprise, review quiz—a comprehensive RAT consisting of all questions from prior RATs. The overall performance, a mean score of 76%, was only slightly above the 72% grand mean of the original iRATs, and far below the 94% tRAT performance. Because students had collaborated and were exposed to correct answers, their performance on the re-take would have been better, we thought. One Team-Based Learning instructor (Goodson, 2004) reported that her surprise RAT retakes usually average 80%+. Due to the somewhat low recall, and below average performance on exams, more review and reflection is needed during the semester.

5. CONCLUSIONS

In addressing the research question on identifying the best set of agile concepts and practices appropriate for an IS project management course, we surmised that these concepts and practices could be taught alongside traditional project management topics, that the these topics could fit broadly across project management knowledge areas, and that these topics should emphasize project over product knowledge.

Agile Alongside

While adding agile content throughout the course, we continued to teach traditional approaches, such as the critical path method, while adding agile topics like the burndown chart on the same knowledge area. It is important to point out, however, that we do cover the entire

Schwalbe text, and in each knowledge area, we did not try to juxtapose both a traditional and an agile concept. We simply added agile topics. The issue with adding agile topics is that the course could become topic-heavy. Students in our class were able to master agile concepts similarly to other topics, given our results in the RAT. But, student performance on the midterm and final exams was lower than historical averages.

Agile Across
We were easily able to find important agile topics in each knowledge area. All topics came from either the Scwhalbe text, the PMI-ACP exam content guide, or a literature source. The toughest area to find something was procurement, but we did find an important concept (agile contracts) that received mention in the PMI-ACP exam content guide and for which there was literature.

Project Not Product
The topics we chose were project management topics. We did not have to resort to teaching non-project management topics like programming. However, in the case of the planning poker estimation exercise, we realized that students in this case were not expert enough to be able to make confident estimates for (programming) tasks, given the lack of information in the case. In the future, we might stick to the burndown chart and Kanban exercises, or tweak the planning poker exercise to avoid this problem.

6. RECOMMENDATIONS

We make the following recommendations to faculty members considering adding agile PM coverage in their project management course. First, choose at least one learning outcome related to agile PM for focusing your effort. We suggest that the lowest level outcome would be at the awareness level, and that this one would be outcome 4—demonstrate an awareness of agile project management basic terminology and concepts across multiple PMBOK areas. Second, we recommend that you emphasize agile project management concepts across multiple PMBOK areas, and without dropping traditional PM content. Third, we recommend that you assess agile PM so that you can isolate student mastery independent of the rest of the content, so that your intervention can be evaluated. Fourth, we recommend review of material prior to comprehensive testing. Fifth, we recommend additional literature review for discovery of concepts, methods, and approaches to teaching agile PM that may be informative but fell outside of the reach of this study.

7. FUTURE WORK

Our future work begins with getting the learning outcomes right. We believe we are close, now. What's important is that students have some awareness and appreciation of agile so that they can converse intelligently with other professionals, i.e. in a job interview, and are prepared to hit the ground running when thrust into an agile environment. So, a set of low-level outcomes that reflect fundamentals mixed in with some application is warranted. The compare and contrast outcome may be the most important one, not so much to differentiate approaches, but to be able to evaluate effectiveness. It is important to educate students so that they may innovate in order to improve.

Once outcomes are revised, then the task is to adjust content accordingly. We will remove any content not necessary to make sure the course is not becoming content-heavy. We will then adjust assessments accordingly, so that each outcome is effectively assessed. An effective set of assessments can then be used to "certify" that students are agile-ready. We will also look at midterm and final exam results,, making sure students are performing at expected levels.

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