The Value of Agile in Experiential Learning of Software Development

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Abstract
A primary measure of success in both student and commercial software development projects is the value delivered to the client. Of equal instructional importance is to what extent the student perceives value in the process used to achieve this goal: is it a support or an impediment? Previous experience with heavy weight processes produced anecdotal evidence that students perceived them as onerous and irrelevant. To determine student perceptions of the relevancy of agile principles, we conducted a year long study during senior student software development projects in which they applied agile principles working with industry clients under minimal supervision. Results indicate a strong relationship between student perception of value delivered to the client and their perception of the value of utilizing agile principles to achieve their goal. This paper describes our study and supports the validity of using agile principles in student experiential learning of software development.

1. Introduction
Our experience and observations, teaching software development to higher education senior students using agile in an experiential project [5], has suggested that agile encourages successful software development. Our experience also suggests agile provides an environment that encourages learning and acquiring the knowledge and skills necessary to produce software. In agreement with others, we see value in teaching agile [7] and in bringing the agile principles to the learning activity [2]. We also see evidence that students find it relevant and supportive.

Some connections between agile software development and learning are readily observed:
• Short iterations provide opportunity for frequent reflection on the product and the process utilized to produce the product. This reflection allows for changes in the next release. In a learning environment, this reflection allows for changes in the approach the students use in producing their software during the next release or reflection on software development and how they go about developing an understanding of the concepts being learned[1,6].
• Frequent feedback from the client drives the direction the development takes for the next release. In parallel, frequent evaluation and feedback from the instructor as mentor or coach, allows the student opportunity to change their effort to become more productive and effective. Providing assessment with the releases allows the student to align their goal of producing software for the client with that of achieving ever greater success academically.

There is a need to present the learner with opportunities to exercise and acquire the soft skills necessary in software development like teamwork, client interaction and good communication [8,9]. We believe the experiential nature [4] of the 30 week projects with industry clients combined with agile values and principles [10,11], allows the students to experience this complexity without being overwhelmed by it. In part we believe this is achieved through frequent feedback, reflection and high levels of interactivity with client, instructor and peers. Thus the students can manage the complexity of the tasks by applying agile principles, while contributing to the completion of the overall complex software development project. In parallel the students learn the complex skills and knowledge necessary to develop software. It should be noted the students have not been introduced to any other software development methodologies when they begin the project course.

Perhaps more importantly in a project based course, research indicates that affective motivational states rely on relevance and reality [3]. Our observed student success, and therefore the skills and knowledge they develop through the course, can be attributed to the reality of the projects and a software development
process students perceive as relevant. Our initial queries of this assertion test the following:

- That our projects exhibit and were perceived by students to exhibit the characteristics for which agile is appropriate:
  - Requirements are in a continuing state of change over time.
  - It is difficult to define a complete set of requirements at any point in time.
- That face to face communication, as supported by agile, contributes to student discovery of product and process.
- That the students perceived a positive outcome in the product produced.
- That perceived positive outcomes were attributable to the students applying the principles of agile.

In other words, we will show that the projects are as we expect them to be, students perceive themselves to be successful, students applied the principles to the production of their software and that a correlation exists between their perceived success and the application of those principles.

2. How we proceeded

To test our observations, we surveyed five project groups averaging six members operating over 30 weeks through five releases. The survey was composed of a five choice Likert-scale testing respondents agreement with thirteen statements (Appendix A). The survey was given to both client and student members of the project teams. Each statement was one of either:

- Premise (P) - a belief upon which the agile principle is built; the statement measures the amount to which students believe the premise holds
- Outcome (O) – a statement that tests student perception of positive results that are in concert with agile principle(s)

Two premises are assumed by our study and are tested directly in the survey:

- “We identified or encountered changes in the business requirements as a result of this release.”
- “I believe that face-to-face conversation was the best method of acquiring information by the project team during this release.”

These statements were drawn from the following statements of the manifesto [10]:
- Individuals and interactions over processes and tools.
- Customer collaboration over contract negotiation.
- Responding to change over following a plan.

The two premise statements capture the basic characteristics of our software development process and what we believe to be characteristics of the project as experienced by students. The first statement captures the reality of software development in today’s industry. The second statement captures the importance of effective client communication best achieved face-to-face, made relevant by a real client. This has been recognized by others [8] as one of the most important aspects of bringing a project to a successful conclusion.

All statements provided space for comments. The client survey statements were reworded slightly, where necessary, to make them appropriate to the clients, but were essentially the same as statements for the students.

The survey was delivered as a repeated measure at the end of each of the five releases. Students and clients were made aware that all results would remain anonymous and would be collected by a third party. The results were collated so that client and student responses would remain associated with the appropriate project and release, but project identity was anonymous. Participation was optional and no assessment advantage was offered for participation. Respondent numbers remained fairly consistent between measures ranging from 28 to 30 respondents per survey.

3. Survey results

The following sections describe the results obtained from analyzing the survey data. Client surveys were only used for comparison to student responses.

3.1. Student perception of project and process

The first premise statement to be evaluated by the survey was:
- We identified or encountered changes in the business requirements as a result of this release.

Agreement with this statement indicates that the students have developed awareness that changes become evident as the software evolves and an understanding that defining all requirements before beginning software development is difficult if not impossible. In parallel, as students learn software development and participate in other classes, they become cognizant of new concepts and considerations that can be brought to bear on the process, activities and product. Their responses also indicate our projects
are suitable for the use of agile. Figure 1 demonstrates the responses to our statement.

![Figure 1: Student perception of encountering change with each release (“no response” is indicated on the far right).]

During the first release the students have no context and few skills upon which to base their opinion. Thus a number of students did not form an opinion or actually disagreed with the statement. However, a significant number appear already aware that changes became evident because of the release and the working software they provided to the client. As we work towards the end of the project we expect the amount of changes to begin to reduce in number. Thus we see a leveling of the perception of change. Release five is special in that the project is over and therefore the final meeting with the client did not include a discussion of future requirements and leaving the statement with an ambiguous context.

The second premise statement to be evaluated by the survey was:
- I believe that face-to-face conversation was the best method of acquiring information to the project team during this release.

Figure 2 indicates that students appear to agree with the premise and have developed an understanding that communicating with the client face-to-face provides a better mechanism for exchanging information regarding requirements and task priorities than does any other form of communication. Interacting with a real client provides a depth of experience not possible through other approaches. This interaction underlines the importance of developing soft-skills in software production.

![Figure 2: Overall student perception of the value of face-to-face communication.]

Clearly, the value of face-to-face communication is identified by the students early on. This perception varies little throughout the releases. It is most strongly held at the close of the project which is what we would expect if in fact they hold the premise valid upon reflection over the whole project.

### 3.2. Student implementation of principles (AP)

We surveyed the students using a series of statements on how well they applied certain principles of agile.

Two statements tested agile principles that are product oriented:
- Working technology (hardware, software, networking, etc.) was the primary goal of this release.
- The team focused on value to the business during this release.

As with most projects, even more so for students, there exists an initial period of chaos while an understanding of the project is developed. This is evident in the disagreement with the application of the product oriented principles for the first release. Later releases follow a trend that moves towards agreement that the team applied the principles (Figures 3 and 4).
Four statements of the survey tested process-oriented principles:

- Team members worked with the client and members of the business staff during this release
- At the completion of this release, the team reflected on accomplishments and shortfalls, and identified changes to our approach for the next release
- At the completion of this release, the team spent time with the client identifying and prioritizing future goals for the next release
- The team was willing to accept changes for the next release

Students seem to find process-oriented concepts easier to apply, possibly because of their prescriptive nature. This appears evident by virtually no disagreement in any of the statements and a strong trend towards agreement by the last release (Figures 5 to 8). The one statement that appears different is the one regarding working with the client and staff (Figure 8). The difference may be attributable to variability in the availability of some clients for the high degree of interaction expected by the students.
3.3. Student perception of outcome (O)

Students were asked to rate their agreement with four statements about successful product outcome for their client:

- The project team delivered significant business value to the company during this release.
- The team delivered functioning technology (hardware, software, networking, etc.) to the company during this release.
- The team created good business value for the amount of effort invested.
- The delivered technology satisfied our expectations of functionality for this release.

They also rated one statement indicating their success communicating within the team:

- During this release, my communication with the team was effective.

The student responses to successful product outcome statements were similar in trend over the five measures (Figures 9 to 13). The results seem to indicate students were initially unsure of their success in software production (split between agreement and disagreement), but became more confident over time. The communication statement had the most initial and subsequent agreement (Figure 13). Small fluctuations could be attributed to individual student responses to current team dynamics. In all cases strong disagreement disappeared over the course of the projects and tended towards agreement demonstrating that the students perceived themselves to be increasingly successful in achieving their goals with each subsequent release.
3.4 Comparison of applied principle to outcome

Included in the survey were two paired statements, one an applied principle and one an outcome, that relate to each other:

- The team focused on value to the business during this release (AP), and, the project team delivered significant business value to the company during this release (O).
- Working technology (hardware, software, networking, etc.) was the primary goal of this release (AP), and, the team delivered functioning technology (hardware, software, networking, etc.) to the company during this release. (O)

If the students perceived the principle to be relevant we would expect to see an increase in its application over time. With this increase we would expect to see a corresponding increase in success. The results shown in Figures 14, 15 indicate that, over time, the application of the principle increased indicating students came to recognize its relevancy. A similar change in the outcomes indicates that the students perceived a positive benefit from applying the principle.
Figure 17: The team delivered functioning technology to the company during this release (O).

4. Conclusions

From the results above we draw the following conclusions.

- Based on the survey results regarding our premise statements, our projects exhibit the characteristics of software development projects in general except for scale. The interaction with real clients deepens the student experience of the projects to include the requirement for soft skills. The projects are of the type that lend themselves to agile development. These results support both the reality of the projects and the relevancy of applying the principles.

- Analysis of the survey results regarding the application of principles and the outcomes indicates the relevancy of the principle to obtaining a successful outcome. Over releases, the students increasingly applied the principles suggesting they saw relevancy in their application. In turn students perceived increasing success in the outcomes.

These results reinforce our observations that using agile in an experiential project course promotes successful software development and provides an environment that encourages learning and acquiring the knowledge and skills necessary to produce software. We continue to see value in bringing agile principles to the learning activity which the study indicates the students find relevant and supportive.

5. References


6. Appendix A: Group survey

1. The project team delivered significant business value to the company during this release. (O)
2. We identified or encountered changes in the business requirements as a result of this release. (P)
3. The team delivered functioning technology (hardware, software, networking, etc.) to the company during this release. (O)
4. Team members worked with the client and members of the business staff during this release. (AP)
5. I believe that face-to-face conversation was the best method of acquiring information to the project team during this release. (P)
6. Working technology (hardware, software, networking, etc.) was the primary goal of this release. (AP)
7. At the completion of this release, the team reflected on accomplishments and shortfalls, and identified changes to our approach for the next release. (AP)
8. At the completion of this release, the team spent time with the client identifying and prioritizing future goals for the next release. (AP)
9. The team focused on value to the business during this release. (AP)
10. The team created good business value for the amount of effort invested. (O)
11. The team was willing to accept changes for the next release. (AP)
12. The delivered technology satisfied our expectations of functionality for this release. (O)
13. During this release, my communication with the team was effective. (O)