

An Agile Approach to the Doctoral Dissertation Process

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Abstract—Dissertation is the most challenging phase of a Doctorate Program. Students engage in rigorous research with the ambition to contribute significantly to their field of study. To embark on this journey, admission is granted as Traditional Doctoral degree program, who admits recent graduates in residence full-time basis, opposed to Agile Doctorate program, who are full-time professional workers with many years of experience. Higher Education Institutions are impelled to consider new ways and processes of the doctoral work and to attract new cohorts; especially when looking to reduce the amount of time it takes to deliver the dissertation project; in particular when there is no need to go through a lengthy discovery phase to determine a topic of research; and when the candidate pursuing the doctoral degree has considerable years of professional experience ^[1].

I. INTRODUCTION

In this fast-paced modern society, universities are looking for innovative ways to meet the higher education challenges and adapt to demands educating those interested in research, especially those belonging to the workforce who don't have the luxury to enter the traditional research programs. The agile approach provides benefits which allow for a doctoral program that can be delivered in a short amount of time. This research paper presents an agile approach to the doctoral dissertation process as opposed to the traditional doctoral approach that is often followed to produce and complete the dissertation. In addition, this research compares and contrasts traditional and agile dissertation methods, as well as discusses core differences between the two programs types.

Agile development acknowledges the fact that requirement can change, and it is adaptive to the new changes. This concept seems to fit perfectly for a doctoral dissertation conducted by working professionals with practical working experience. Thus during the students' dissertation research, the student should be able to adapt to any new findings and/or ever changing technology in their subject area of research. In the traditional dissertation process, the student begins with a broad area of investigation that can include hundreds of possible dissertation topics. This can average out to be a lot of unnecessary time added to the dissertation process. With the traditional dissertation process, upon receiving satisfaction from the advisor, students then faces Examining Committee members, and only with satisfaction of Examining Committee members, students are allowed to face the final examination

which is usually an oral presentation open to public and the academia. The agile methodology creates a discipline in the dissertation process that encourages frequent reviews between the student and advisor which promotes adaptation, leadership, and accountability.

This study is organized as follows: Section 2 presents the non-agile doctoral dissertation process. Section 3 presents the agile doctoral dissertation process used at Pace University. The methodology used by a cohort of 13 Pace University Doctoral candidates is discussed in Section 4. Section 5 presents Traditional, Waterfall and Agile methodologies comparisons. Section 6 presents a weighted evaluation of several identifiable features for Traditional Ph.D. and the Agile DPS program at PACE – rendering statistical values for both programs.

II. OVERVIEW OF THE NON-AGILE APPROACH TO THE DOCTORAL DISSERTATION PROCESS

The Doctoral degree is awarded to a student that demonstrates mastery of a subject matter to the extent that the holder of the degree shows the temperament, knowledge, and skills needed to do original research that contributes to the body of knowledge about the subject. The demonstration of this mastery consists of coursework, writing a thesis and communication skills of the highest level in the defense of a dissertation before a faculty committee. This can take an average of six years, and this practice has been criticized for creating ivory towers unconnected to practical matters. ^[3]

A. Phases of the Non-Agile Process ^[4]

1. Plan of Study — Candidates are asked to prepare a plan of study for the research and course work to strengthen weaknesses with a timeline. Approval is from a committee of faculty whom the candidate selects.
2. Comprehensive examination — A qualifying exam is taken at the end of the courses to assess the extent of the candidates current knowledge and potential of success in conducting original research. This can occur from one to three years in the doctoral study.
3. Dissertation — A written thesis about original research in your area of study guided by an advisor and dissertation committee made up of faculty members.

This methodology reflects a step-by-step series propelled by the Waterfall and Software Development Life Cycle. In which progress is made as follow:

1. Conception
2. Initiation
3. Analysis
4. Design
5. Construction
6. Testing
7. Implementation
8. Maintenance

Moving down the latter within this methodology presents a particular weakness of this approach, it is not adaptable to change; which will increase the completion times and graduation rates for doctoral students.

B. Non-Agile Research Cycle ^[15]

1. Begin with the problem
2. Research defines the goals
3. Divide into sub-problems
4. Creating hypothesis as proposed solution(s)
5. Look for data directed by the hypotheses, collect and organize
6. Interpret the meaning of the data, resolve the problem, or create new ones
7. Start at [1]

III. OVERVIEW OF THE AGILE APPROACH TO THE DOCTORAL DISSERTATION PROCESS.

Agile comes from a counter-response to the inflexibility of software programming teams who use the Waterfall technique, in light of the productivity gains experienced by teams using Extreme Programming (XP) and Scrum techniques. The Agile software development approach is adaptive to change in requirements and is flexible enough to evolve solutions through collaboration and self-organizing team(s).

For each iteration, there is a planning session during which the dissertation short-term deliverables to be done are discussed and estimated. The stories are written by the student and/or the advisor. Every story has a written deliverable. These may be annotations of readings or parts of the final dissertation manuscript. Each iteration has a velocity, which is a measure of how much work that is completed and accepted can be done. The velocity of the next iteration is set to be the amount of work accepted in the prior iteration. This maintains a sustainable pace that the student is comfortable with and supports the continuous delivery of quality product. ^{[1][2]}

In the agile methodology, if the student determines that it will not be possible to complete all the stories for the iteration, then, together with the advisor, decide what to drop. Only completed and accepted work is integrated into the dissertation product. If the student finishes the stories before

the end of the iteration, more stories, based on their value and the velocity remaining in the iteration, are selected. Even though it might appear to be proscribed and overly structured, this process promotes creativity and helps many students finish in a shorter period. As a result, Agile approach can deliver a product that conforms precisely to the way people work, and in a fraction of the time compared to traditional methods. ^{[1][2]}

The Agile approach is outlined in the Agile Manifesto in the below section, and its spirit is captured in the expression “frequent delivery of quality products.”

A. Agile Manifesto ^[6]

“While there is value in the items on the right, we value the items on the left more.”

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

B. The Agile doctoral dissertation process

- Prepare through reading and research seminars for the dissertation
- Explore topics
- Write short and clear idea papers to help you converge on a topic
- Find an advisor
- Review the literature in your area of interest
- Write a dissertation proposal
- Work with your advisor on the formation of a committee
- Complete the research and structure the final dissertation
- Defense of the Dissertation

C. Agile Methodology

Similar to agile software development, it uses XP method of small releases and fast turnarounds (~2-week iterations). Agile methodology makes constant incremental advances in the dissertation work.

- Team and cohort groups
- Socratic method
- Dissertation notebook
- Writing emphasis and tools

D. Team and Cohort Groups ^[7]

Working in teams enhances learning by creating an active learning process, and is particularly effective when the team members actually need each other to complete a project. For instance class team, usually 3-4 teams per year group that enhances learning through teamwork, and cohort year group that contributes frequently through their extensive knowledge and experience by making helpful suggestions in the research seminar meetings and by helping to find relevant

literature/related materials. This promotes self-organizing teams. The power of the community is strong!

E. Socratic Method ^[7]

- Clarification through confrontational dialog
- Students must vigorously defend their position
- Works best if students adequately prepare for research seminar sessions
- Wikipedia definition: "...asking a series of questions surrounding a central issue, and answering questions of the others involved. This involves the defense of one point of view against another and is oppositional."

F. Dissertation Notebook ^[7]

Maintain a dissertation notebook as a repository of ideas, thoughts, and data. It is the only place that you write, diagram, scribble about your dissertation.

G. Traditional and Agile Doctorates Deviation

As of this research, there is no agile Ph.D. offered today in the United States. An agile doctorate as taught at Pace University incorporates a team approach to study and research but is distinct in name: Doctor of Professional Study (DPS) in Computing and it is specifically designed for computing and IT professionals. ^[5] This information is significantly different from a traditional Ph.D. Team work and cohorts are integral in undertaking the same work as a Ph.D. only with a different emphasis on viewpoint: the team as a whole is considered stronger and more knowledgeable than the individual. This effect on the program creates a course of study not easier for students but more comprehensive when their work is leverage by teammates. There is a learning component from collaborations for DPS students that a traditional Ph.D. student does not have. This approach permits a fast transition to research. The comprehensive exam is waived because the students are working professionals in the industry.

Agile takes reasonably-sized steps in multiple iterations with immediate feedback to give the most important requirements first (i.e. the high order numbers of the answer) and get feedback from the customer until the project is acceptable enough (i.e. high enough degree of accuracy) and you're done.

In the more traditional dissertation approach, students do not have the constant attention of an advisor and more importantly the agile methodology principles. As a result, focus and valuable resources are lost, and time upon completion of the doctoral program decreases. In an agile approach, every aspect of development requirements and design are continuously revisited and monitored throughout the completion of the program.

IV. METHODOLOGY USED IN THIS STUDY

Team organization, support, and cooperation are essential to an agile process, and those team dynamics were applied to this study. The cohort operated on the agile practice of "frequent delivery of quality product" by setting up a framework for the study paper and matrices, which were filled in as drafts of sections were completed. Teams 1, 2, and 3 in the cohort each made phone calls and emails to institutions, universities and searched websites to find programs descriptions and statistics for Computer Science and Information Technology Doctoral programs.

V. METHODOLOGIES COMPARISON

A. Comparison of Traditional vs Agile Doctoral Dissertation Process

Table 1 – Traditional vs Agile Doctoral Dissertation ^[7]

Process	Traditional	Agile
Collaboration	Researcher works in an intellectual or collegial vacuum	The ability of an agile researcher to interact and form a partnership and work with other colleagues at work place or Subject matter experts. Can leverage other processes and tools available at their own work environment or their colleagues.
Adapting to Discovery	A well-defined short and long term plans	Having well-defined short-term and long-term plans are vital, yet the vagaries of research require that the researcher be ready to change course as new discoveries are made.
Iterative approach	The approach is a "waterfall-like" with heavy upfront planning and little writing.	An iterative refinement approach that embraces frequent evaluation, regular meetings and explicit "backlog" of goals and tasks can be used for a research project in a positive way.
Team work – pairing	Traditional also embrace working closely with an advisor	The value of working in pairs such as another fellow student to be more productive, in addition to working together with advisor. Literature research can be done in pairs.
Face-to-face meeting	Student can meet more frequently with their advisors than the DPS students (who are mostly professionals with full-time jobs)	Student and faculty schedules are mostly divergent, constant communication can be done via email, phone calls, or spontaneous meetings. The weekly or regularly schedule, face-to-face research meeting is essential, but other forms of time-shifting communication can be

		equally effective at maintaining research progress, trading discoveries, answering questions and maintaining a solid collaboration.
Documentation	The traditional approach also uses wiki, etc.	Maintain research documentation on a wiki and updated log of research efforts as an important way to document discoveries, identify new avenues for research.
Conveying information	Academic research often is subject to grant funding organizations, yet it is quite possible for funded students to conduct research that supports the individual goals of a dissertation while supporting the larger goals of a project. Identifying projects that are interesting to the individuals involved can be the best way to maintain motivation over the course of a multi-year project.	Agile is an applied research; it can benefit and improve professional practice.
Dissertation methodology	Very structured. Normally it takes longer to complete (6 years average)	Mirroring agile methodologies. Normally it takes average 3.2 years to complete.
Dissertation contribution	Individually. Extra effort from individual is required.	Working in Teams. Every class is divided into teams to work on projects. By working in teams, it creates an active and effective learning environment for everyone to deliver successful projects together. Also, team members frequently contribute by making valuable suggestions to each other and helping to find relevant literature and related material for research. It is an important part of the agile dissertation process. During the process, everyone is expected to participate and help each other.

B. Agile Development Value Proposition

AGILE DEVELOPMENT VALUE PROPOSITION

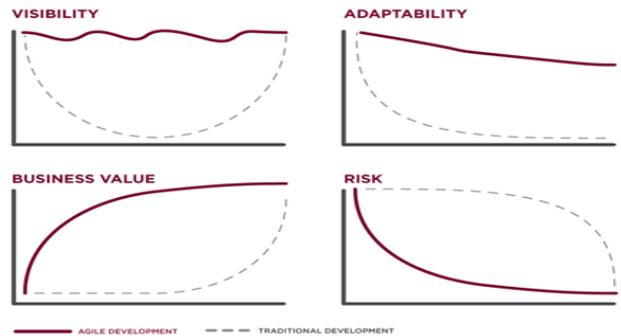


Figure 1 – Agile Development Value^[18]

C. Comparison of Waterfall Approach vs Agile Approach

Table 2 – Waterfall vs Agile Approach^[17]

Process	Traditional Approach	Agile Approach
Readings. Each paper, book, report, or dissertation that you read uses prior work as a foundation and, since a single work can't do it all, usually points to future work that might be pursued.	Collect and read numerous references in your area of interest. You follow all the reasonable leads from reading material and collect previous studies to read and refine your understanding without idea paper. The feedback part is there but it is more focused on the process of literature review and logistics of it than refining the idea paper	Select few authentic peer reviewed papers and skim through the main ideas and write down a draft idea paper. Read more and modify the paper. The basic idea is to select a limited number of reading artifacts and then improve the draft after every iteration of reading. Talk to your colleagues, teachers, other people about the ideas you are collecting and get their feedback
Select Potential Research Topics. For each possible topic, provide a title, a short description of what the work might entail, an indication of the source of the idea, relevant references, an annotated bibliography, and comments by faculty members or fellow students with whom you have discussed the idea. *Many students experience one or more false starts that result in a search for new topics. This also is not unusual	Categorize the literature to narrow down the research area and collect more material to refine your topic. But no idea paper is drafted yet. Again the focus is on this particular step of the process than the end product.	The result of each iteration of idea paper and literature review is actually more refined idea paper. This helps to further narrow down or change the topic as well as get the feedback on actual deliverable instead of one step of the process.
Search for a dissertation advisor. As a general rule, only full-time CSIS	Since there is no idea paper yet, you have to choose the supervisor much later in the	Since you already have a draft idea paper and would be talking to the teachers who are subject

faculty members or adjunct faculty who have taught you a course may serve as dissertation advisors. Exceptions must be approved by the program office. You should have selected an advisor by April 30 of the second year of study.	process and then you are pretty much stuck with the advisor	matter expert for the feedback. This will help to not only refine your idea paper but also select an advisor.
Write short and clear idea papers to help you converge on a topic. The goal is to find a possible dissertation area and to write a Dissertation Idea Paper.	You are still working in the initial steps in pretty much isolation or with limited feedback.	Based on the constant feedback from peers, family, friends, colleagues and teachers you already have few drafts of the idea paper
Write an Idea Paper. Write a Dissertation Idea Paper with approval from advisor	You may skip the idea paper and work on research proposal instead	After discussion with your advisor and your frequent iterations you can now write an idea paper
Write a dissertation proposal. There are two forms that must be kept up to date and filed with the doctoral program office once you begin work on your dissertation: Dissertation Tracking Form and Dissertation Approval Form	This will be probably first step where a tangible artifact resembling the final deliverable will be shaped again without much input from various sources	This will be a less anxious step and natural progression of previous step. Your will be expanding the idea paper to give it a shape of a dissertation proposal.
Work with your advisor on the formation of a committee. Your advisor or the program office will tell you when you should initiate the formation of a dissertation committee. This usually occurs between the time that the advisor approves the idea paper and approves the preliminary dissertation proposal.	Follow your institutions policy of selecting a committee	It will be pretty much dependent on the policy of the institution about the engagement, selection and composition of the committee. Based on previous iterations you will have many interactions with potential advisors and committee members. They will also have idea about your topic. You may change the committee members based on feedback from your advisor as well as those committee members.
Evaluation of Doctoral Students. You will be evaluated for idea paper(s) and the dissertation proposal as well as each semester of your dissertation work.	You are evaluated on coursework through the standard grading system. You are evaluated on the dissertation through a vigorous oral defense.	You are evaluated on coursework through the standard grading system. You are evaluated on the dissertation through a vigorous oral defense. Plus: You have multiple evaluations of the idea paper, the proposal, the

		research, and the dissertation as they progress.
The Dissertation Manuscript. Complete the research and structure the final dissertation	You will be gathering material for each section but may not give them final shape until you have all the material you think is necessary including outcomes of your analysis and surveys etc. You work section by section and try to finalize each each before moving to next chapter. The problem with this approach would be that you may think some sections are easier and you leave at the end or you may get stuck in one section for too long to concentrate on all the sections. Or you just simply get writers block.	In agile you are expanding from your idea paper into dissertation proposal and then into manuscript incrementally. You start work on different chapters simultaneously in small steps and then go through several iterations to improve each section. By now you have been constantly writing at a sustained pace and won't be overwhelmed by phenomenon such as writer's block.
Approval for Final Dissertation Manuscript	Since you are working in tradition waterfall method you won't have anything ready for review for the approvers till all the sections are complete. This can impact in two ways: It will take long time to get any feedback from the committee and if there is a major change suggested by committee, you will have to redo a lot of stuff.	You are continuously in contact with your advisor and committee. You will be constantly factoring in the feedback from them. So any change requests will not be a big issue.
Defense of dissertation	You have a heavy finalized deliverable without much feedback and a lot of anxiety	You will have a deliverable that has gone through a number of iterations and has already incorporated several changes based on review committee's comments.

VI. IDENTIFICATION OF FEATURES TRADITIONAL PH.D. AND THE AGILE DPS PROGRAM AT PACE

The following is a comparison of significant considerations for each of the two approaches by means of the following selected parameters. The selection of the parameters is heavily influenced by our common experiences in the DPS program and some literature review on the topic.

Table 3 – Agile DPS at PACE

Parameters	Traditional Approach – Agile Methodology (Heavyweight)	Agile Methodology (Lightweight)
P1. Average Time to	6 years	3.2 years

Complete ^[10]		
P2. Average Completion Rate ^{[10],[12]}	58%	52%
P3. Average Cost of Tuition ^[13]	\$30K / Yr.	\$22K / Yr.
P4. Learning Experience ^[10]	Higher Learning – More Academic and theoretical than practical	Somewhat newer doctoral experience
P5. Admissions Criteria ^[10]	Graduate Students with a Master degree	Senior computing professionals can join the DPS program
P6. Predictive approach ^[11]	Predictive and repeatable. Well established and mastered approach. Applicable to a wide selection of disciplines and subject matter. Typical Engineering approach. No, surprises.	Short planning sessions: As the dissertation process advances it is re-factored; parts can be discarded or changed, and new stories written.
P7. Comprehensive Documentation ^[11]	More	Less
P8. Collaboration ^[10]	Only when needed.	Very important. Emphasis is on the teamwork.

A. Assignment of Weight and Statistical Analysis

Since not all features have equal importance, it is natural to rate these parameters so that a realistic picture can be drawn for a reasonable comparison of the two approaches. To do so, we use a simple scale with two variables: Parameter Importance P(i) which measures the importance of a parameter and Parameter Value P(v) which measures the value of a parameter as experienced in the Agile DPS program at Pace University:

Parameter Importance

P(i) = 3- Very important, 2-Neutral, 1-Not very important

Parameter Value

P(v) = 3- Extremely Valuable, 2-Neutral, 1-Not very Valuable

The cumulative value of the Agile DPS program (Dv) by using the following equation:

$Dv = \sum P(i) * P(v) = 42$, this can be shown from the following table:

Parameter (Pn)	Importance P(i)	Value P(v)	P(i) * P(v)
P1	3	3	9
P2	3	3	9
P3	3	3	9
P4	3	1	3
P5	2	1	2
P6	2	3	6
P7	3	1	3

P8	1	1	1
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Now, we can find the value for the traditional methodology Tv simply by subtracting Dv from the maximum cumulative value Mv, as shown under:

$$Mv = P(n) * P(i)_{\max} * P(v)_{\max} = 8 * 3 * 3 = 72$$

$$\text{Hence, } Tv = Mv - Dv = 72 - 42 = 30$$

Thus, based on the above data in our experience the Agile DPS approach seems to be at least more valuable than the traditional approach.

Some other noteworthy statistical data that we discovered from the references cited in this paper is shown as under:

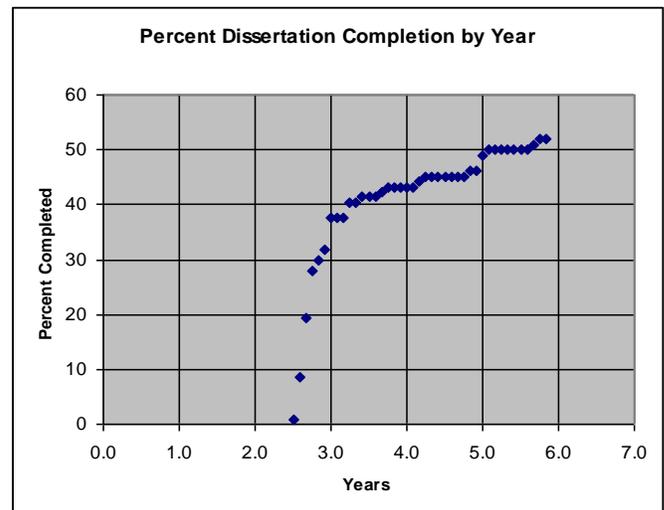
B. DPS vs. Traditional Completion Years

	DPS	Traditional
Average	3.2	5.5
Minimum	2.5	1
Maximum	5.8	10

C. DPS vs. Traditional Completion %

DPS	Traditional
52	40

D. Statistics for doctorate students using agile dissertation and Pace University is below, with the average completion rate at 3.2 years [1]:



VII. CONCLUSION

Both approaches “work”. It means doctoral candidates can complete their dissertation using either approach. The traditional “waterfall” has been the primary method to complete and receive a doctoral degree. The Agile approach, as is in use at Pace University, not only works, but it addresses some of the shortfalls of the waterfall approaches. These deficiencies cause some students to either take a long time to complete or never complete their dissertation, leaving the student with no doctorate, but an “ABD” (all but dissertation) status.

An advantage of the waterfall approach is that it is disciplined and repeatable. On the contrary, the traditional approach makes a “big bang” of the dissertation after much solitary work with little feedback. This is very stressful on students, and it could lead to a longer preparation without knowing when they are “done enough” to succeed. In addition, if the dissertation is not “done enough” the re-work can be substantial.

The agile approach inspires support to the doctoral candidate from others; advisors and other students in a similar situation. With multiple iterations for each step or section is reviewed and improved with feedback to determine if it has met the current state of requirements. This method gives the candidate steady progress of the dissertation and less to re-work if the most recent iteration created problems. Therefore, while the waterfall method might be used successfully and even preferred by some students, the agile method appears to create a greater success rate of doctoral candidates^[8] in less time.

The data in this research suggest that delivering batches of research and writing in smaller chunks “stories” would be a great improvement to the traditional program. But this can be hit or miss, depending on whether they actually get useful feedback about their work at the conference... Ideally, there should be a rough “roadmap” for development of ideas that are investigated and researched and written that receive feedback in a more predictable way. Get plenty of feedback. Have a backlog of research activities/tasks that are prioritized based on what you are learning and feedback from your advisors (product owners). Start small, get results, then build on them (and that is hard, too, because some of your ideas don't always pan out the way you had hoped).

Providing a superior doctoral experience for a diverse group of senior computing professionals for whom traditional programs are not possible or appropriate presents many challenges. While traditional doctoral study is a process of formation, the DPS in computing enhances and extends professionals who have already formed a professional identity, and empowers them to do greater things in their organizations and their future professional lives.^[1]

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