ISSN: 2473-4901
v10 n6196

Using Agile Methods for Course and Curriculum Development in Higher Education

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Abstract

Making data-driven decisions is becoming more critical for organizations, and academic institutions are increasingly tasked with graduating students with a quantitatively oriented mindset. This research explores the ability and effectiveness of using agile development concepts in curriculum and course design. using continuous improvement and collaboration to advance analytics education within the colleges of business of two regional public universities with significant international student populations. The application of agile methodologies allowed the organizations to complete curriculum and course design changes that better addressed market changes, improved faculty buy in, minimized the number of additional course preparation requirements, while minimizing disruptions to schedules and student achievement.

Keywords: Agile Development, Agile Methodologies, Analytics, Artificial Intelligence Curriculum, Curriculum Development, Process Improvement

1. INTRODUCTION

Academia is facing significant challenges recently, resulting in at least forty-four public or nonprofit colleges closing, merging, or announcing closures

ISSN: 2473-4901
v10 n6196

or mergers since March 2020 (BestColleges.com, 2023). Perhaps part of the reason is that universities are often slow to respond to the needs of their stakeholders and the environment, often forcing colleges to address gaps between offered programs and the market.

Agile development is one potential way to address the turbulent nature of academia. The agile methodology involves a collaborative approach in which team members follow a cycle of planning, executing, and evaluating. Agile development involves a commitment to continuous improvement and assurance of learning to match the needs of the marketplace. Open communication, collaboration, and adaptation are at the very core of agile development (Atlassian, 2023).

Curriculum improvement has many challenges. The primary goal in curriculum development is to improve student outcomes. While that goal cannot change, additional stakeholders, such as faculty, who may see this as an increase in workload have been understudied (Millidonis *et al.*, 2023; Sturman, 1994). Resources may constrain institutions, so the development models must account for this. By using smaller, more agile teams that view students, other faculty, and the institution as stakeholders and potential customers of the system, better outcomes for all can be achieved. This manuscript details how one academic department, within the business school at two regional universities located in the southeastern United States, is gravitating towards using agile development in curriculum design and improvement.

Academia is not immune to the accelerating pace of change introduced by pervasive digitalization (Fornes and Altimira, 2023). Moving from a world where linear thinking and responses to change has been common and ingrained, even for traditionally agile organizations, bureaucracies are at a severe disadvantage when change transitions from linear to exponential. Artificial Intelligence (AI) is rushing the challenges faced by curriculum designers, increasing the exponential rate of change and, thus, shortening the time to react.

The next section provides a review of the literature on teaching analytics and agile curriculum development, followed by a section that discusses the implementation of agile methodologies at two universities. Results, as well as a discussion of the results are subsequently presented. The next to last section discusses the study's key limitations and addresses avenues for future research projects in this arena. The concluding section provides some concluding remarks as well as the study's implications.

2. LITERATURE REVIEW

When discussing curriculum development, there are a few considerations. Requirements from external accreditation agencies, students, and the needs of other stakeholders, and assessment of learning outcomes, to name a few. The following sections will examine related research connected to this project, including the need for continuous improvement in higher education, the pace of change, and how engaging with students has changed with the invasion of smart technologies into the classroom. We will also review research on how the needs of employers are changing and how data analytics is making a difference in decision-making. To conclude we provide a brief reminder about the system development life cycle (SDLC), agile methodologies, and the use of agile in academia. This foundation will enable everyone to engage with this research with a common perspective. We begin with a review of continuous improvement.

Continuous Improvement

Continuous improvement is essential in higher education, underscored by the importance of the assurance of the learning process to earning and keeping Association to Advance Collegiate Schools of Business (AACSB) accreditation (Vander Weerdt, 2023). The AACSB was established to promote continuous quality improvement in management education; as such, the emphasis on continuous improvement is reflected in the rigorous standards set by the AACSB, which focus on key areas such as a clear mission, well-qualified faculty, faculty participation, a high-quality curriculum, and resource requirement planning. Scholarship of Teaching and Learning research needs to be a focus at AACSB schools (Siddqui and Lento, 2024). Through continuous improvement, higher education institutions can identify areas of improvement, implement effective strategies and processes, and monitor their progress toward meeting AACSB standards.

The Pace of Technological Innovation and Its Impact on Education

Higher education (HE) faces many issues caused by the volatility, uncertainty, complexity, and ambiguity (VUCA) of the current environment. HE organization could better respond to these challenges by adding agility to their curricula (Audunsson et al., 2024). Perhaps one way to add

ISSN: 2473-4901
v10 n6196

agility would be to include agile curriculum development to the faculty's toolbox. Teaching analytics, technical fields such as AI, and critical thinking skills can present several challenges related to VUCA that educators must address to effectively prepare students for the demands of data-driven decision-making (Saputra *et al*., 2023). One of the challenges in teaching analytics and critical thinking is the pace of technological change. As technology advances at an unprecedented rate, educators must keep up with the latest tools and techniques in data analysis. They must stay updated on emerging technologies and be able to incorporate them into the curriculum to provide students with relevant skills and knowledge (Akçay *et al.,* 2021; McGuinness & Vlachopoulos, 2019), while avoiding overhyped frameworks and tools that are just the "flavor of the month"

The emergence of AI and large language models has sparked debates about their effects on various sectors of society, including education (Yu and Guo, 2023). The integration of AI technology in education has been a topic of interest for educators as they explore how to incorporate advancements into teaching and learning processes. AI-based tools have shown the potential to reduce the time required for manuscript preparation and aid researchers in their tasks. Furthermore, the development of AI technology has led to its adoption in solving critical educational issues, such as creating systems equally effective as human-to-human tutoring. However, using AI tools to cheat on assignments and avoid plagiarism detection complicates existing instructional methods. Educators must develop new methods to assess learning, especially in remote, online, and/or distance learning environments.

Student Learning

The pervasiveness of smartphone use in the modern classroom can be a challenge for many instructors, as it may affect student attitudes toward learning and classroom engagement dynamics. Students have become accustomed to instant gratification and quick answers, which can hinder their ability to think critically and engage in data-driven decision-making (Marks *et al.*, 2021). Adapting to the changing landscape of student expectations is crucial in teaching analytics and critical thinking. As technology advances and shapes how we live and work, students' expectations of their educational experience also evolve (McGuinness & Vlachopoulos, 2019).

Additionally, engaging students in real-world data analytics applications and critical thinking is essential. Students must see the practical relevance and impact of the application of data analysis and critical thinking skills in various professional fields. Therefore, educators need to develop and implement case studies, projects, and examples that demonstrate the practical applications of data analytics and critical thinking in real-world scenarios, thus fostering a deeper understanding and motivation among students. (Tapis & Priya, 2019)

Evolving Employer Demands

Employers' increased needs and demands for knowledgeable and skilled employees in using data analysis to improve organizational decision-making have presented instructors with challenges on how to teach analytics and critical thinking best. Employers expect today's job candidates to possess strong analytical and critical thinking skills to effectively analyze data, make sound decisions, and solve complex problems. Therefore, educators must adapt their teaching strategies and methods to meet these changing employer expectations and equip students with the necessary skills for success in a data-driven world. At the same time, students may have different learning preferences and expect more hands-on, interactive, and experiential learning opportunities (Isnainiyah & Fitriah, 2022). Furthermore, the increased availability and accessibility of data requires students to develop strong analytical skills to process and interpret large volumes of information effectively (Sedkaoui, 2018). Thus, students must have practice using analytical skills to better meet evolving employer needs.

Analytics Implementation in Business Schools

Previous research addresses the challenge of implementing data analytics in business school curricula at the undergraduate and graduate levels with challenges in defining terms and finding common needs across disciplines (Gerhart et al., 2024). For example, Jeyaraj (2019) and Nestorov *et al*. (2019) discuss specific case studies involving analytics implementation at the undergraduate level. Jeyaraj (2019) discusses an undergraduate curriculum that developed a pedagogical framework encompassing multiple data stages: acquisition, preparation, analysis, visualization, and interpretation. Jeyaraj also emphasizes that prospective employers increasingly demand such skills. Nestorov *et al*. (2019) describe a new data visualization class that includes a real-world project component in the information systems undergraduate program

 ISSN: 2473-4901
v10 n6196

at Loyola University Chicago Quinlan School of Business. Their study also describes a class project undertaken with GE Transportation that discusses potential career implications for graduating students using real-world data and scenarios. In addition, Wilder and Ozgur (2015) propose a curricular model that Valparaiso University adopted during the 2014-15 academic year. Their proposed model includes courses in data visualization, data mining, spreadsheet models, and an analytics practicum.

At the graduate level, Wang and Wang (2019) discuss implementing an MBA business analytics program. Their article states that business schools increasingly establish MBA business analytics programs in response to industry demands and stresses the significant database knowledge for MBA business analytics students. They present a pedagogical model for MBA students that includes key database concepts for business analytics, a tutorial on database-centric OLAP (online analytical process), and a database-centric OLAP exercise assignment.

Several articles address university responses to industry needs. For instance, Parks *et al.* (2018) state that companies increasingly collect data more quickly than ever, observing that the need for data analysts has never been higher, with demand expected to reach 1.5 million within the next two years. As the demand for data analysts grows, colleges and universities will rush to offer programs to equip their graduates with the necessary analytical skills to meet today's data-centric workplace. Ceccucci *et al.* (2020) confirmed that conclusion by observing that as companies continue to put data and business analytics as their top priority, universities will need to supply students with the appropriate skill sets that meet this demand.

The academic literature on this topic includes studies that draw conclusions based on studying 100+ business school offerings across the United States. According to Mamanov *et al.* (2015), more than 130 Business analytics programs at undergraduate and graduate levels were launched in the past five years. Their study found that the programs vary in the coverage of analytics and analytical methods. The study concludes that this inconsistency and emerging trends in analytics provide opportunities for academic institutions which is a sentiment echoed by Turel and Kapoor (2016). Their study examined the gap between industry needs and academic offerings concerning data analytics. After examining business analytics offerings at 104 top-ranked business schools, their study concluded that higher education still needs to do more to meet expected industry needs for data analytics.
The growth of Artificial Intelligence (AI) and Machine Learning (ML), initially in the realm of predictive algorithms, and more recently around Generative AI (GenAI), are constant reminders of the impact these technologies are having on the economy and as examples of exponential growth. Adding the use of such technologies in analytics education has benefits but they are limited (Cribben and Zeinali, 2023, Wang et al., 2023).

As such, educators will be faced with exponential pressure to adjust curricula to meet the research and teaching demands. Planning, gaining approval, gathering resources, teaching, and evaluating learning impacts requires a highly agile effort (Staat, 2021).

Meeting industry and academic challenges will mean that schools of business must produce research, programs, and leaders with relevant skillsets. Thus equipped, organizations will be able to better adapt rapidly to market challenges and opportunities driven by emerging technologies, and have the moral compass to manage ethically, with a foundation in theory. (Staat, 2021)

Systems Development Lifecycle (SDLC)

The system development lifecycle is a systematic approach to develop and maintain a system. While various systems or software development models exist, the stages are similar. The usual stages include planning, analyzing, testing, deploying, and finally maintaining the system (Ruparelia, 2010). Traditionally, the waterfall methodology was a popular structured method. Waterfall utilizes the steps in a sequence, with very few changes occurring in prior steps as the project progresses toward completion.

As software development matured and even large enterprise systems became more customized and modular, there was a movement away from only using the traditional waterfall to the implementation of hybrid and agile development methodologies allowing for more flexibility (Ahituv *et al.,* 2002).

Agile Development Methodologies

In 2001, guidelines provided a clear understanding of the desires of agile development were collected into a manifesto which was meant to cross multiple agile methodologies and unite them by providing a focus (Agile Alliance, n.d.). For this research, Scrum and Extreme Programming methodologies were used. A brief

 ISSN: 2473-4901
v10 n6196

description of these concepts is provided below, but more detail is provided when discussing the implementation, Section 3.
Scrum is a methodology that utilizes iterative development using brief sprints, and extreme programming, which pairs programmers with customers to achieve predefined user stories and acceptance criteria. There has been research published using agile development methodologies in academia, which will be discussed next.

Agile Development and Academia
Agile development emphasizes early and rapid development by interacting with the stakeholders continuously through the development process, stresses simplicity and welcomes change (Agile Alliance, n.d.). The idea of agile development has had traction in the academic world, and an adaptation of the agile manifesto was drafted, placing students and learning outcomes as the focus (Krehbiel *et al.,* 2017).

While their manifesto preaches focusing on students and the continuous need for improvement, this focus on students differs from the original methodology, which did not define a customer group and can be applied to several systems that various stakeholders use, which is evident in the fact that there are numerous implementations in teaching individual courses (Sharp *et al.,* 2020).

We found little implementation of agile methodologies by administrators in our search for academic research. Education and business school students' needs are rapidly changing, and analytics curriculum guidelines suggest emphasizing real-world data and computing (Tarpey *et al.,* 2002; Schwab-McCoy *et al.,* 2021).

The rise of Big Data and AI has shown that available data and computing capabilities are rapidly changing. These topics may be dismissed by business schools as being in the fields of engineering and computer science (Locke and Rainer, 2024). However, two powerful forces: 1) the speed of digital product development and, 2) the exponential development of computing capacity of Graphical Processing Units (GPU) are causing organizations to question Moore's Law.

These high-growth capabilities are resulting in rapidly evolving high-level language development and the ability to develop systems without having to code. Coding will always be required, at some level, to deploy new systems. But those functions are often concentrated with highly specialized vendors, freeing up developers to use high-level tools such as low-code and no-code for deploying systems. The shift to low-code and no-code means that business processes are filling the gaps left to fill the development and deployment roles previously occupied by engineering functions (Yan, 2021). Application proliferation is based on opportunities for organizations to capitalize on these modern technologies. Whether engineering or business, the growth is real (Aggarwal et al., 2022). It will fall to business decision makers to manage growth and lead organizations through the challenges of hyper-growth and hyper-change. The results of any online search for data analysis and AI innovations will be primary concerned about the business uses of technology, not computer science.

While curricula need to have a foundation, these changes also suggest that there need to be mechanisms to respond to a rapidly changing environment. Based on a review of previous research, we should not only use these business practices in our response to industry, but also use them to become more agile when meeting student needs and managing the limited resources that institutions require.

Research shows limited implementation of agile techniques in administration, such as in course design (Woszczynski *et al.,* 2021). Evidence of agile curriculum design exists, such as its utilization for creative industries (Palmer *et al*., 2016) and the rapid redesign of innovative programs (Bojorque & Pesántez, 2018). There is also a need to consider other stakeholder's perspectives (e.g., adding micro credentials to a program (Raj *et al.,* 2023). Although research has been done on the effects of leadership style on faculty (Feng and Adams, 2023), a gap still exists in the application of agile development in the continuous improvement of curriculum which considers students, administrators, employers, and faculty, all as potential customers.

3. IMPLEMENTATION

This section addresses our implementation of agile methodologies at two different institutions. We selected a Scrum / Extreme Programming model for our development processes. We will first discuss how we implemented these models in the development of an undergraduate business analytics curriculum at one institution, and then we discuss an implementation of agile curriculum development of a graduate artificial intelligence program at a second institution. To conclude this section, the selection process for determining the development type, and the types of projects that the implementation of agile methods utilized is addressed.

ISSN: 2473-4901
v10 n6196

Scrum Development
Scrum allows for direct interaction with customers and calls for regular brief meetings that discuss progress towards an iteration of the project (Scrum Alliance, ND). Additional meetings are formally held to review the completion of an iteration. Scrum development has a suggested size of 5-11 members, including the Scrum master and the product owner. This model also helps to break down larger projects into manageable portions or sprints. Using Scrum also allows for more formal project management, implying that more significant projects with more organizational stakeholders and a more structured project management approach were better served using a Scrum-like methodology versus Extreme Programming (XP). The Scrum master helps facilitate the meeting, lead the team, champions agile development, and works with the project owner to organize the order of development or backlog while maximizing value.

For our implementations, this was either the chair of the department or the chair of the committee in charge of the curriculum change. The product owner needs to define the objectives and goals, set the order of the backlog, get feedback from the end users, and determine how the success of the implementation may be measured. As appropriate, the department or committee chair developed the initial user stories and expanded them with input from other faculty members.

An example of prioritizing the backlog in curriculum improvement is provided in Table 1 in the appendix. Committee chairs, department chairs, or deans represented the product owners for our implementations. The developers are the remaining members who are empowered to accomplish the tasks within the project and are represented by the faculty members working on the project.

Scrum usually utilizes daily meetings, but this is only sometimes practical in an academic setting, so these meetings were substituted with weekly or biweekly meetings to allow for the equivalent level of work to be accomplished.

Extreme Programming
Extreme Programming (XP) is the most specific of agile methodologies utilized and while it may not be used in its entirety many practices may be taken and used depending on the context (Agile Alliance, ND). XP calls for the use of paired programmers who utilize stories to create short-term iterative development whose goals and priorities may change within the iteration (Agile Alliance, ND). These paired programmers are partnered with a customer to speed up the interactions and unit testing as the system is developed (Wells, N.D.). The goals are controlled through general metaphors or user stories with acceptance criteria and are tested in real-time by the programmers and the customer representative.

Table 2 in the appendix provides an example of a user story and acceptance criteria for improvements to a single course. Utilization of user stories are a key component of XP.

The paired programmers in our implementation of XP were typically two faculty members who worked together to develop the project. Additional faculty members represented the customers with a vested interest in the product and the department chair driving the initiative.
Selection aspects were examined to facilitate system selection (Table 3 in the appendix). First is the iteration length or time when some aspects must be implemented. While Scrum can be quick, the smaller team size in XP can allow for a much faster turnaround. XP with a smaller team size may also be more appropriate for smaller projects measured by the number of stakeholders and changes. Finally, XP allows for quicker changes within the iteration as the smaller team with the customer embedded can quickly change the goals within an iteration.

To examine the selection aspects of the implementation, we divided the tasks by the general goals we intended to achieve. These goals are Curriculum Improvement, Course Redesign, New Program Development, and Shared Resources. Additionally, it was essential to identify whether the extent of the project was exclusive to a course, the department, the college, or the university. Determining the goal and extent of the reach helped to determine the approximate size of the project and the number of potential stakeholders.

Curriculum Improvement
This first goal is curriculum improvement, which covers the continuous improvement of a curriculum or the overall education plan that may stretch across an entire degree at a university level, core aspects within a college, or specific aspects within a department. However, even if the aspects of the curriculum only directly affect courses in a department, the approval process may include either the college or the university to approve any potential changes. Table 4 in the

ISSN: 2473-4901
v10 n6196

appendix provides examples of curriculum improvement.

Course Redesign
Course redesign pertains to continuous improvements within a course, which may include adding additional assignments or redesigning the course. While this usually has stakeholders at the course level, a complete redesign of a service-level course may have stakeholders at the college or university level. It may be triggered by overall curriculum improvement, such as when data analytics was added throughout the college curriculum. Individual course redesign often builds upon emerging curriculum issues. For course re-design, a hybrid approach was used to infuse various data analytics skills across courses (Dzuranin *et al.,* 2018). The hybrid approach teaches the base material in one course, and a second course with major or program-specific content (or case studies) analyzed with the skills learned in the first course (Dzuranin *et al.,* 2018).

This means that even individual course design often has additional stakeholders. However, using XP with partnered instructors who also incorporate other faculty as customers for the design fits well with the design concept. Table 5 in the appendix provides examples of course redesign.

New Program Development
Creating innovative programs pertains to the process of adding new degrees, minors, and certification programs that involve creating a new curriculum or education plan. The initial idea to create a new academic program is a creative task but is a highly structured process in higher education. It involves collecting data, analyzing the data, and making informed decisions about what the program can add to the university's academic profile. Once the program is created, it is passed through the college and university administration ranks for evaluation. It often must also pass through the university's state commission of higher education, which has an additional approval process. However, while there are layers of authorization, planning, and organizing, the material may be limited to the departmental level. Therefore, a smaller agile team may complete the initial design. XP was used in these cases, limiting the faculty members working directly on the program and having the remaining faculty members function as customers reacting to updates (see Table 6 in the appendix).

Shared Resources
Teaching institutions must be sensitive to overworking faculty (Jacobs & Winslow, 2004). While this can be offset by hiring additional faculty, including adjuncts, institutions must be aware that adjuncts may also be overworked and must be appropriately managed to ensure that the learning outcomes are unaffected (Nica, 2018). Faculty workload has been growing post-pandemic, with additional time being spent on teaching (Swacha, 2022). Overwork will lead to burnout with several adverse impacts that should be addressed through proper administrative decisions (Hall *et al.,* 2019). Part of the solution to this issue is creating and adopting tools and resources that can be shared across several courses or sections. This could potentially reduce prep work for instructors while at the same time looking to provide similar learning experiences and improved learning outcomes. In most cases, with shared resources, the projects were limited to courses with many sections; however, the resources may sometimes stretch across multiple courses. Table 7 details projects in which we unitized agile methodologies to create resources that could be shared among multiple faculty members.

4. RESULTS AND DISSCUSSION

The results of our work have been mostly positive. Working in smaller groups following agile processes facilitated achievement of our goals efficiently. This section details some of the results and challenges encountered, consistent with other organizations that have utilized agile methodologies in course improvement but unique in that not all our goals were strictly related to student outcomes, as students are not the only stakeholders.
In terms of curriculum improvement, we added data analytics throughout the curriculum through agile methodology to include all the departments to create buy-in to the need and to make the various departments aware of the topics to be covered. One of our key performance indicators (KPIs) regarding student outcomes is how we score relative to the national average in the Undergraduate Business Major Field Test (MFT) exams. Our most recent results showed a 15% increase above the national average in quantitative business, indicating that our improvement measures are keeping us ahead of peer institutions regarding data analytics in the business school. These efforts have also reduced prerequisites and provided students with certification options. However, this initiative comes with a cost as we identified which skills needed to be covered; where this meant that courses were required to be modified, we also managed using agile methodologies.

ISSN: 2473-4901
v10 n6196

While academic freedom in teaching is encouraged in most areas, increased standardization is required, especially in service-level courses that are prerequisites for other courses. We found that the increase in stakeholders did not mean that we had to have more members responsible for developing the courses. Utilizing XP to have multiple faculty members work on the design allowed for an improvement in the materials that were initially developed while at the same time providing flexibility for faculty members to work quickly as a larger committee was not involved. Our use of committees of other faculty as customers to evaluate the projects periodically allowed for both buy-in and flexibility, which allowed for the curriculum changes to be operationally implemented and for additional projects such as filling in gaps in project-based courses to be filled. This allowed for improved student outcomes on the capstone exams and our overall MFT scores. This process sometimes identified gaps that needed to be filled by adding additional programs.

Regarding innovative programs, we successfully created a new undergraduate data analytics degree and a graduate AI degree. While the process involves multiple steps and stages, utilizing smaller teams using agile methodology can be an advantage. One challenge that academia is facing is that the marketplace is rapidly changing. Developing a new degree will present challenges throughout the process. Higher education faces threats from changing technology, enrollments, and other market conditions, which may mean that the initial ideal model for the curriculum may face constraints to ensure that it does not overlap with other organizations and meets resource constraints that may be provided to reduce the risks of launching a new program. A smaller team using agile methodologies with goals set by the customers can more readily change the required documentation to meet these conditions and ensure that approval of the program is obtained as new hurdles are presented. Other faculty can review the developed program to act as customers and testers of the ideas. However, with both new and improved programs, faculty may find that their workload has increased as new assignments are added to their courses, or they may have to prepare for a new course. Part of the process must facilitate shared resources that reduce preparation time and standardize the material while making it unique to the institution.

The development of a master's degree in AI was conceived, designed, developed, and approved in less than six months using Scrum-like methodology. With a ripe market, interest among current students, enthusiasm among faculty, and support from administrators, ten courses were designed to the level of syllabus and course assignment detail, along with course descriptions and marketing materials, ready for consideration by the university board of trustees. The process began with a general concept and progressed through brief weekly meetings where the courses were defined, syllabi created and refined, and materials for student exercises were developed by a small team of four faculty. Nearing the board of trustees meeting a few months later, the associate dean and graduate school coordinator joined the effort to assist with getting course and program approval by the university graduate curriculum committee. The new degree program was approved by the board with full support.

In terms of shared resources, we succeeded in developing cases, assignments, and a video library, which reduced the time for individual faculty members to prepare the material themselves. By using agile methodologies, we were able to have multiple members of the faculty work on creating resources that could be used across multiple courses while engaging other faculty members as customers which did seem to help overall buy-in of the new material as it allowed the other faculty to feel involved as customers. However, this does not necessarily mean that the overall workload was reduced. Hence, a few concerns were raised about class time and grading requirements, as it pertained to some of the changes; however, the creation of shared resources allowed for these concerns to be somewhat ameliorated.

Limitations and Future Research

The cases presented above are in the college of business of regional universities located in the southeastern United States. While we were able to assess that program objectives were accomplished within our required timelines, additional research should be conducted to evaluate development timelines compared to other methodologies. Additionally, while our implementation of agile methodologies achieved better buy-in of the projects, there was no formal mechanism, and there is little research on faculty buy-in to use as a baseline. A model to measure the acceptance and desire to implement curriculum changes and meta-analyses of the use of agile methodologies in curriculum improvement or design could be avenues for future research projects. Future research projects should also examine student outcomes with the institution's administration and faculty as vital stakeholders.

ISSN: 2473-4901
v10 n6196

Conclusions and Implications

Agile methodologies can be used for curriculum design and improvement. While often the goal of the process is student outcomes, all stakeholders, including the administration and faculty, need to be considered. One key takeaway is that committee usage is integral and essential for successfully implementing an agile development program. Acting as customers or product owners, they can interact with smaller, more agile teams to respond quicker to changing requirements. Although agile development was initially developed in the context of software development, it has since been expanded to include other fields. Although the literature does not support extensive usage of this tool in higher education, there have been some implementations that show improved student outcomes. However, the research often only includes other stakeholders in the post-COVID environment. Instructors are spending more time on teaching, which needs to be addressed, and more time should be spent not only on student outcomes but also on institutional and faculty outcomes. If appropriately applied, agile development practices should be integral to curriculum implementation while considering all stakeholders.

This study has presented a case study involving two colleges of business at two universities. The primary contribution of this study is that the results, as well as lessons learned and potential pitfalls, can serve as a blueprint for other institutions of higher education that are considering implementing an agile methodology for curriculum and program development.

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ISSN: 2473-4901
v10 n6196

APPENDIX A

Scrum and XP Methodology Artifacts and Explanations

Priority	Story	Outcome
1	As a curriculum designer, I must determine the techniques and software to be introduced.	The need to include Excel in the curriculum and introduce additional basic statistics and an introductory statistics package was identified. There was a need for all students to do some fundamental analysis and to be able to communicate results in writing and orally. Two options for statistics software were identified for exploration in SAS and SPSS.
2	As a curriculum designer, I need to determine the potential certifications and requirements that must be accomplished for the certifications.	The university already offered Excel courses that had essential Excel Certifications. SAS had an advantage over SPSS as it had a program where students could earn a Joint Academic Certification and had an accessible cloud-based interface. There was a requirement of exposure to SAS in at least two courses and two courses where additional practice was conducted in the communication of analytics.
3	As a curriculum designer, I must determine appropriate courses for inclusion in the certification programs.	It was determined to maintain the current Excel Certification courses. SAS was added to an "Introduction to Information Systems and Business Analytics" course and an "Introduction to Operation Management" course. Analytics communication was selected to be emphasized in a business communications course and the capstone to the upper-level business core. However, the courses would not be overly impacted as some assignments were already related to the requirements. Implementation of the requirements was passed to two instructors to develop assignments and training as a team of paired programmers to add the SAS material to the two new courses.

Table 1. Priority Backlog Order Example for Curriculum Improvement

User Story: As an instructor in a project-based course, I need to identify gaps in skills utilized in projects efficiently and have an efficient mechanism to fill the gaps and provide exposure to students.	
Acceptance Criteria:	
1.	Clear communication of the skills that are required to be taught during the course.
2.	Manageable assignments that can be added to fill concept exposure gaps.
3.	Maintain or improve the capstone exam results related to the filled gaps.

Table 2. User Story Example for Continuous Improvement for One Course

 ISSN: 2473-4901
v10 n6196

Aspects	Practices	XP	Scrum
Iteration Length	How quickly goals need to be met	Preferable for rapid turnaround projects.	Allows for quick turnaround but typically longer than XP.
Iteration Size	Size of the project	Smaller projects can be divided into a brief story.	More significant iterations have more requirements.
Project Influence	Number of stakeholders affected	Typically, it is smaller, where a team of paired individuals can interact with very few customer representatives.	The larger team allows more members to be directly involved in developing the result.
Handle Changes within an Iteration	Whether changes can be made in the goals in between iterations	Changes can be made within the iteration.	Changes are not made during the iteration.

Table 3. Project Selection Aspects

Project	Method	Level	Notes	Outcome
Adding analytics throughout the undergraduate business curriculum.	Scrum	College	A cross-department working group was created to work as a central team. A more traditional waterfall method was utilized for the overall program construction, with implementation broken down to allow for agile methodology.	Developed SAS Partnership and repeated exposure to analytics topics.
Skill identification	XP	Dept.	Develop a technical and soft skills map that allowed the department to determine skills coverages within assignments in the curriculum.	Created a degree map; Identified potential certifications; Identified potential reductions to prerequisites.

Table 4. Examples of Curriculum Improvement

 ISSN: 2473-4901
v10 n6196

Project	Method	Level	Notes	Outcome
Identifying gaps and adding tutorials to provide repeated exposure in a capstone course.	XP	Course	Two individuals worked to identify needed skills and where students received exposure. The project for the course was evaluated, and then tutorials were selected based on instructor feedback.	Improved capstone exam results for the subjects covered within the tutorials.
Reducing/Removing prerequisites from data analytics and information systems courses.	XP	Dept.	Two individuals worked to create the skill requirements for data analytics students and to identify the level of skills needed in the area for the course. Modules were created to supplement knowledge gaps to allow students to catch up or to meet requirements to take the course.	Identified concepts and are creating modules to ensure necessary skills for projects or certifications.

Table 5. Examples of Course Redesign Projects

Project	Method	Level	Notes	Outcome
Creating a Data Analytics Degree	XP	Dept.	Two individuals worked to identify courses that could better utilize faculty and facilities.	Created an undergraduate data analytics degree.
Creating a Masters in AI Degree	Scrum	Dept.	One individual faculty member outlined curriculum, three additional faculty joined to produce syllabi and course descriptions.	Created a graduate AI degree in business.
Identifying analytics needs for protentional certifications	XP	Dept.	Two individuals worked on examining analytics needed for accounting by researching job descriptions.	Identified skills for accountants to add a certification.
Creating a Data Mining course sequence that will train students toward a SAS certification.	XP	Dept.	Two individuals worked to identify a certification and the skills needed. They then worked to coordinate course design to ensure coverage of the material spread between the courses.	Identified the software and certification and will soon implement the sequence.

Table 6. Creating New Programs

 ISSN: 2473-4901
v10 n6196

Project	Method	Level	Notes	Outcome
Create ANOVA and linear regression assignments with provided SAS datasets	XP	Course	Course Coordinator and primary instructors collaborated on exercises and data sets and solicited feedback from other instructors and DAWG members.	Standardized assignments and assessment rubrics were created and shared among instructors.
Creating case study for Capstone Course.	XP	Course	Two individuals worked to create the scenario. Other instructors were involved in providing input and formalizing the final case.	A case study was created, and a greater understanding of the desired result from coursework was gained.
Creating case studies for undergraduate courses to expose students to analytics.	XP	Course	Two individuals worked to create the scenario. Other instructors were involved in providing input and formalizing the final case.	Assignments were shared across multiple sections, with edits managed centrally. SAS Studio was utilized as the primary tool that required training videos to be created to familiarize students and faculty.
Creating a Video Library for undergraduate curriculum cases and SAS training.	XP	Course, Dept., and College	Two individuals worked to create the videos detailing instruction and interpretation for descriptive statistics, ANOVA, and linear regression. Committees were used to build awareness and to obtain feedback.	Videos were shared across multiple sections and used in additional courses with edits managed centrally.

Table 7. Shared Resources

