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Implementation Of Agile Project Management In The Classroom

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IMPLEMENTATION OF AGILE PROJECT MANAGEMENT IN THE CLASSROOM

by

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ABSTRACT

The world of engineering and engineering practices is advancing rapidly. In response to this rapid change, engineering education practices have to advance to ensure students are properly trained for the workforce. The purpose of this report is to address and substantiate the hypothesis that if engineering instruction incorporated Agile project management methods, then students will be challenged by professors to accomplish course objectives with a systematic and timely approach that will improve assessment performance metrics and present the framework of how agile methods of project management can be integrated into the classroom. The agile methods incorporated will also encourage the use of industry-related soft skills; emphasizing accountability, resourcefulness, team building, and interpersonal skills. From this framework, the idea that instructors have the ability to manage their students and accomplish course objectives in a timely manner, similar to the engineering industry practices, even when presented with impromptu absentees or cancellations, is plausible. The proposed method to substantiate this hypothesis was the implementation of a flipped classroom and using scrumban agile methods within a General and Honors classroom setting. Due to design and time limitations, only the Kanban Board was implemented into the Honors section for study. The results of the study showed the Honors section performance metrics decrease. With the limitations of the experiment, the hypothesis was rendered inconclusive. In moving forward, obstacles that were present (hurricane cancellations

and guest instructors) are still believed to be mitigated with full experiment implementation.

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CHAPTER 1: INTRODUCTION

The world of engineering and engineering practices is advancing rapidly. In response to this rapid change, engineering education practices have to advance to ensure students are properly trained for the workforce. Engineering schools play a huge role in molding this shifting landscape as they prepare students to operate within engineering industry. Pursuant to the American Society for Engineering Education (ASEE) Executive Director, Don L. Millard, “Engineering schools are heavily influenced by academic traditions that don’t always support the profession’s needs. Students abandon engineering in part due to a lack of connection between what is studied and perceived as exciting practice.” [1]. To improve the connection between the theory and the application, engineering professors can adjust instructional approaches that better relate theoretical knowledge to practical application.

The National Society of Professional Engineers (NSPE), in accordance with ABET's Engineering Criteria 2000, stated, “…all U.S. engineering departments will have to demonstrate that besides having a firm grasp of science, mathematics and engineering fundamentals, their graduates possess communication, multidisciplinary teamwork, and lifelong learning skills and awareness of social and ethical considerations associated with the engineering profession,” [2]. Recurring conversations about the balance of educational fundamentals and industry-related soft skills have encouraged university administrators and professors to investigate and adjust aspects of traditional instructional methods for engineering education. These conversations present a level of uncertainty for transforming instructional approaches. It is plausible that instructors may feel that commitment to implementing new instructional approaches will leave them with insufficient time to pursue other academic responsibilities. Pursuant to Professional Policy No. 14 of the NSPE, "engineering education is considered to be the foundation of the engineering profession. The NSPE believes engineering educational programs must prepare graduates for the practice of engineering at a professional level."

The NSPE holds consistent values and belief in what engineering education and instruction should encompass, including:

- Encouraging schools to develop creative and imaginative programs as new approaches to engineering education.
- Strong belief that engineering curricula should incorporate instruction designed to instill engineering students with professional concepts.
- Instruction should emphasize the primary purpose of the profession as being the pursuit of a learned art in the spirit of public service.
- Professional concepts brought to the attention of the student should be the responsibility of all engineering faculty [2].

In instilling these values and beliefs, an opportunity exists to apply agile methods of project management (adaptive and iterative processes) to engineering instruction to promote student analytical learning. The hypothesis being addressed is if engineering instruction incorporated Agile project management methods, then students will be challenged by professors to accomplish course objectives with a systematic and timely approach that will improve assessment performance metrics. The agile methods incorporated will also encourage the use of industry-related soft skills; emphasizing accountability, resourcefulness, team building, and interpersonal skills. This emphasis will help in leading to the improvement of student learning, engineering application, and career readiness. The goal of this thesis is to substantiate the hypothesis and present a framework of how agile methods of project management can be integrated into the classroom. From this framework, the idea that instructors have the ability to manage their students and accomplish course objectives in a timely manner, even when presented with impromptu absentees or cancellations, is plausible. From the Project Management Institute (PMI) (2013a) *Pulse of the Profession* report, "organizations with developed project management practices, benefits realization processes, portfolio management practices and program management practices and those with high organizational agility all have significantly better project outcomes than their counterparts who are less advanced in their project management practices" (p.11) [3]. In order to understand how agile methods can be used effectively within the classroom, project management practices must first be properly and thoroughly understood for readers.

CHAPTER 2: BACKGROUND

2.1 What is Project Management?

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. It is accomplished through the appropriate application and integration of five process groups:

1. Initiating
    a. Selection of the best project given resource limits
    b. Recognizing the benefits of the project
    c. Preparation of the documents to sanction the project
    d. Assigning of the project manager
2. Planning
    a. Definition of the work requirements
    b. Definition of the quality and quantity of work
    c. Definition of the resources needed
    d. Scheduling the activities
    e. Evaluation of the various tasks
3. Executing
    a. Negotiating for the project team members
    b. Directing and managing the work
    c. Working with the team members to help them improve

4. Monitoring and Controlling
    a. Tracking progress
    b. Comparing actual outcome to predicted outcome
    c. Analyzing variances and impacts
    d. Making adjustments
5. Closing
    a. Verifying that all of the work has been accomplished [4]

Managing a project includes:

- Identifying requirements
- Addressing the various needs, concerns, and expectations of the stakeholders in planning and executing the project.
- Setting up, maintaining, and carrying out communications among stakeholders that are active, effective, and collaborative in nature.
- Managing stakeholders towards meeting project requirements and creating project deliverables
- Balancing the competing project constraints

The project team works to assess the situation, balance the demands, and maintain proactive communication to deliver a successful project. Iterations develop the product through a series of repeated cycles, while increments successfully add to the functionality of the product. These iterations lead to the life cycle of the project to become adaptive or agile and incremental. Adaptive life cycles are intended to respond to high levels of change and ongoing stakeholder involvement [5]. Within the engineering environment, these changes may include new research techniques, new engineering instruments, common industry-related practices, and impromptu changes in class meeting times, ranging from cancellations to additional study sessions organized by instructors.

2.2 Standard Instructional Approach

Project Management methods and ideologies can be related to current instructional approaches in education. A standard instructional approach within the classroom resembles (*see Appendix A)*:

1. Anticipatory Set – the instructor reviews prior knowledge and begins introducing a new concept.
2. Instruction – the instructor explains the new concept/skill and demonstrates.
3. Guided Practice – these are practice problems or scenarios in which corrective feedback for understanding is immediate.
4. Closure – This is the review section of the lesson and provides clarity.
5. Independent Practice – this step includes homework and take-home projects.
6. Results Survey – this step provides feedback on the lesson, including material questions and instructional approach.

This instruction style is incremental in the development of the information but relating lessons to the complete outcome of the course can be difficult when learned skills and instructional approach are not audited frequently through feedback sessions. A model without auditing and feedback session is shown in *Figure 1*.

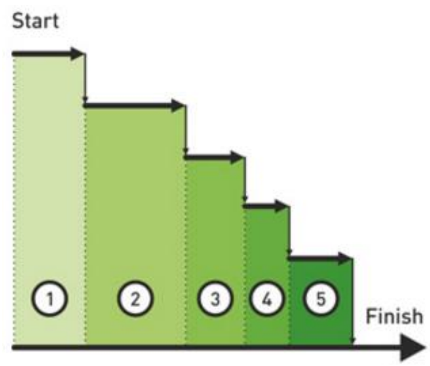

Figure 2.1: Incremental Project Development

The x-axis of *Figure 2.1* is the time of completion for the project [12]. The y-axis denotes the total amount of work that needs to be completed at the beginning. As time goes on, the work decreases incrementally but the work decrease is dependent upon the previous stage of work. This one-way model is similar to the Waterfall approach to project management. The waterfall approach to project management is a non-iterative design process in which progress is seen as flowing steadily downwards through the phases of discovery, design, development, and testing. In the Waterfall approach, each step is incremental but does not provide a flexible approach to the material being presented if a change to objectives were to be made. A graphical representation is shown below in *Figure 2.2* [12].

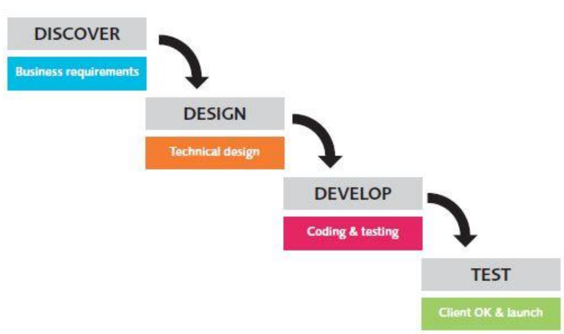

Figure 2.2: Waterfall Project Management Flowchart

The Anticipatory Set relates to the Discover and Design stages, planning the approach and methods that are to be used in instruction. The Instruction and Guided Practice Steps correlate with the Develop stage to build and develop the skill that is being taught. The Test stage encompasses the Closure and Independent Practice steps as the information or skill should be ready for practical use. With the standard instructional approach relating to the Waterfall method, planning instruction is mainstreamed. However, what if there is a change (i.e. an added day of instruction) or lack of production (i.e. below average test scores) in one of those stages? How would the project team react to help solve the issue immediately? The waterfall method does not provide recourse for unexpected changes. The use of Bloom's Taxonomy helps identify where agile methods come into play.

2.3 Bloom's Taxonomy

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition – i.e., thinking, learning, and understanding. The framework consists of six major categories: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. In 2001, the categories were revised into six new categories with knowledge as the foundational basis (*Figure 2.3)*: Remember, Understand, Apply, Analyze, Evaluate, and Create [13].

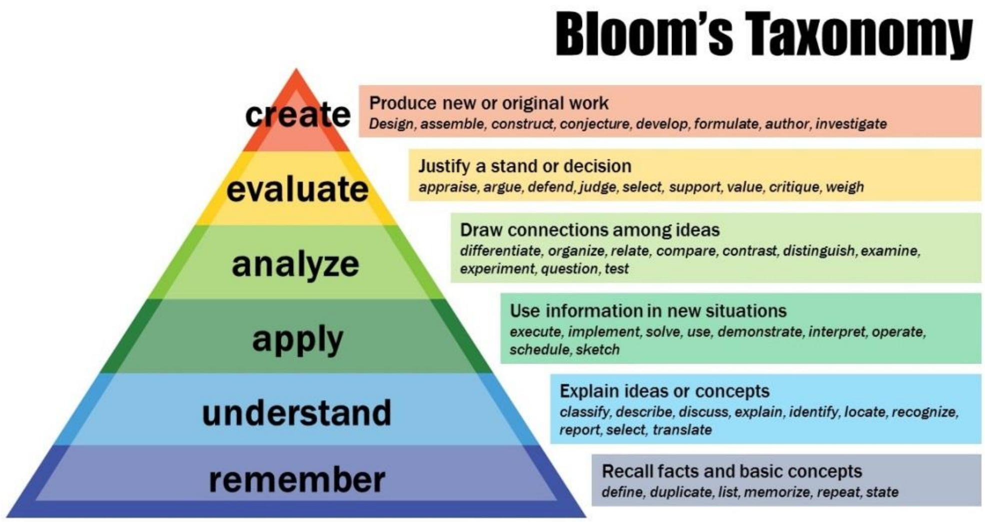

Figure 2.3: Bloom's Taxonomy

Within education, there are four main uses for Bloom's Taxonomy:

1. Objectives (learning goals) are important to establish in a pedagogical interchange so that teachers and students alike understand the purpose of that interchange.
2. Teachers can benefit from using frameworks to organize objectives
3. Organizing objectives helps to clarify objectives for themselves and for students.
4. Having an organized set of objectives helps teachers to:
    a. Plan and deliver appropriate instruction
    b. Design valid assessment tasks and strategies
    c. Ensure that instruction and assessment are aligned with the objectives [14].

Using Bloom's Taxonomy helps educators establish objectives for instructional purposes, organize those objectives to helps provide a clear roadmap for themselves and students, and achieve those objectives through valid assessment tasks, and strategies. Utilizing Bloom's Taxonomy has resulted in the Flipped Classroom.

2.4 The Flipped Classroom

A Flipped Classroom insists that students gain first exposure to new material outside of class, usually via reading or videos. The students and professor use class time to focus on the assimilation of that knowledge through problem-solving, discussion, or debates. In regards to Bloom's revised taxonomy, students are performing the lower levels of cognitive work (remember and understand) outside of the classroom, and focusing on the higher levels of cognitive work (apply, analyze, evaluate, and create) in class, where they have the resources of their peers and instructor. The Flipped Classroom consists of and provides four key elements:

1. Provide an opportunity for students to gain first exposure prior to class.
2. Provide an incentive for students to prepare for class.
3. Provide a mechanism to assess student understanding.
4. Provide in-class activities that focus on higher level cognitive activities.

These four elements of the flipped classroom compliment the use of agile project management and agile feedback methods [13].

2.5 What is AGILE Project Management?

Agile project management is an adaptive, iterative process that focuses on customer value first, team interaction over tasks, and adapting to current business reality rather than following a prescriptive plan. Agile uses facilitated work sessions, called sprints, to establish a shared understanding of the problem, the solution, and the plan. Agile methods are useful in constantly relating the work completed during sprints to the completion of the project, as seen in *Figure 2.4* below.

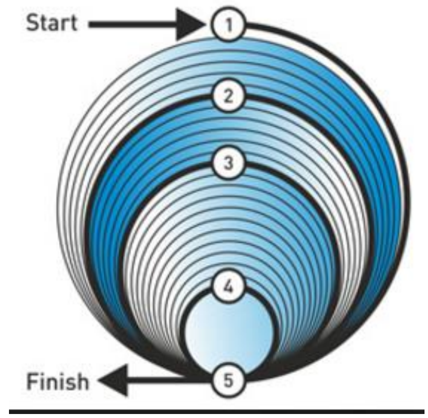

Figure 2.4: Circular Project Development

In *Figure 2.4*, the circular development of a project through agile methods indicate that from each cycle that is conducted, the final product deliverable is considered finish at some level and ready to deployment [12]. After the first cycle, the product is considered deliverable to an extent and so on until the final cycle and final product. Using agile methods results in each step of the project contributing to the final outcome by providing a result that can be functionally used at every stage of completion. Agile project management helps in finding the source of the problem quickly through frequent testing and feedback [6]. A graphical flowchart of agile project management is shown in *Figure 2.5* [12].

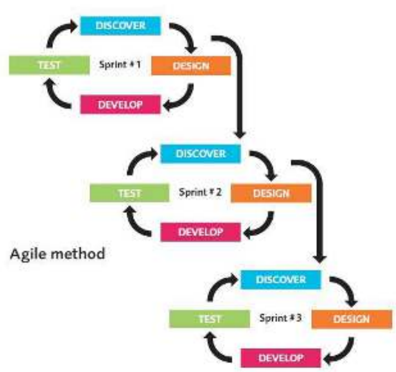

Figure 2.5: Agile Project Management Flowchart

Figure 2.5 shows a generalized agile method that consists of three sprints being performed for one project lifecycle. Each sprint conducts all steps included in the Waterfall method. By utilizing the Discover, Design, Develop, and Test steps at the beginning of every sprint, feedback and changes can be accounted for throughout the project lifecycle. Below in *Figure 2.6*, a graphical comparison between Agile and Waterfall methods is shown [12].

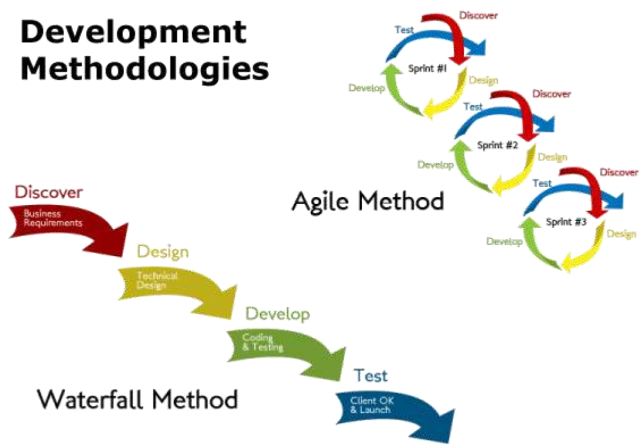

Figure 2.6: Agile v. Waterfall Graphical Comparison

Agile methods, pictured as a combination of multiple waterfall processes, allow for more flexibility in making adjustments than waterfall methods because of the quick turnaround from testing feedback into the next iteration. This flexibility can be presented in many forms within the classroom, including but not limited to: the student(s) understanding of material, impromptu class cancellations, etc.

2.6 Agile In the Classroom

Agile should be implemented when the product is intended for an industry with rapidly changing standards [9]. With the engineering industry and practices rapidly changing, the students entering the engineering industry have to be able to assimilate to their environment. Instructors using Agile in the classroom have the opportunity to present new environments that introduce students to different conditions either in the classroom or outside the classroom. In relating the classroom to the workplace, instructors serve as the project managers in the classroom to help student development. The completion of course outcomes should be viewed as a project. Students serve as the project team members. Customers will include:

1. Industry partners – they want job ready engineers
2. The school – this helps build their reputation in producing job ready engineers
3. Students – they are looking for effective training/education in return for their financial contribution.

The product that is being produced consists of: An environment where consistent feedback and adjustments are welcomed, students who are prepared for post-graduate endeavors, classes where outcomes are being reached in a timely, effective approach, and professors that are actively engaging students in current engineering practices.

Within this setting, there will be regular opportunities for reporting progress through stand up meetings or open discussion dialogue. During the standup meeting, team members (students) can present and express mastery or understanding of objectives and concepts to professors or industry partners (stakeholders). Also in this meeting, the group (instructor and students) decides together what and how they should adjust for the next sprint to aid instruction method and course objective improvement. With this providing a method of active feedback within the classroom, the question of class size may be brought into play, especially with larger groups. The flexibility of Agile is important in that effective approaches, such as designated study groups, can be implemented and serve as class teams to present updates and questions similar to functional team leaders. Another sign of agile flexibility is the types of methods that stem from agile methodologies.

2.7 Agile Technique: Scrum + Kanban = Scrum ban

Two commonly used agile techniques are Scrum and Kanban. Scrum is push-based process that consists of a Product Backlog, Sprint Backlog, the Sprint, Standup Meetings, Sprint Retrospective, and Sprint Deliverable. *Figure 2.7* below shows a graphical representation of Scrum [12].

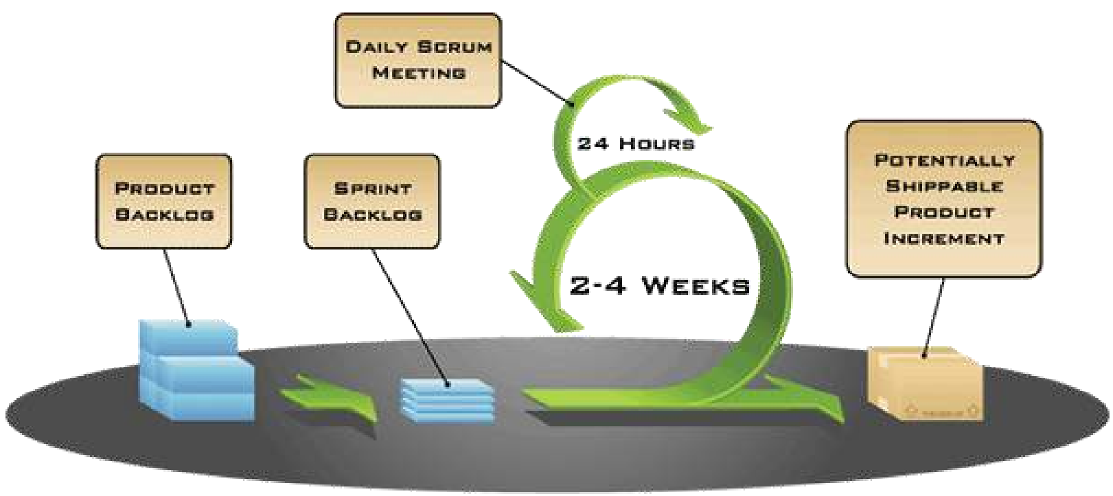

Figure 2.7: Scrum Graphical Process

The Product Backlog consists of all objectives and tasks that must be completed throughout the entire lifecycle of the project or course in this situation. The sprint backlog is a designated list of objectives that are to be completed within the sprint, which ranges from 2-4 weeks. For the classroom, a Sprint could possibly even last one week. During the sprint, there are scrum meetings, some being daily, that are used to receive progress regarding the completion of tasks and to receive feedback that could help improve process completions or sprint management. The three main questions that are asked during a regular scrum meeting are:

1. What did you do yesterday?
2. What is planned to be done today?
3. Are there any impediments/concerns that may hinder progress?

The scrum meetings also allow team members to gain a level of understanding of what each part of the project is responsible for. With engineering courses being scheduled on a Monday-Wednesday-Friday basis, the scrum meetings would occur during the class periods to focus on problem-solving and discussions that students may have about the material. Students would also be able to peer review, learn study habits, and understand how their peers are receiving and processing the information. At the end of the sprint, the objectives and tasks assigned at the beginning of the sprint should be completed. A way for students to exhibit the completion of the tasks and objectives is through exams or projects based on the professor's discretion.

Kanban is a pull-based system that allows the users to "pull" tasks to the next state/status using a Kanban Wall/board. The basic statuses used in Kanban are Planned/To-Do, In Progress/Doing, Completed/Done, as shown in *Figure 2.8* [12].

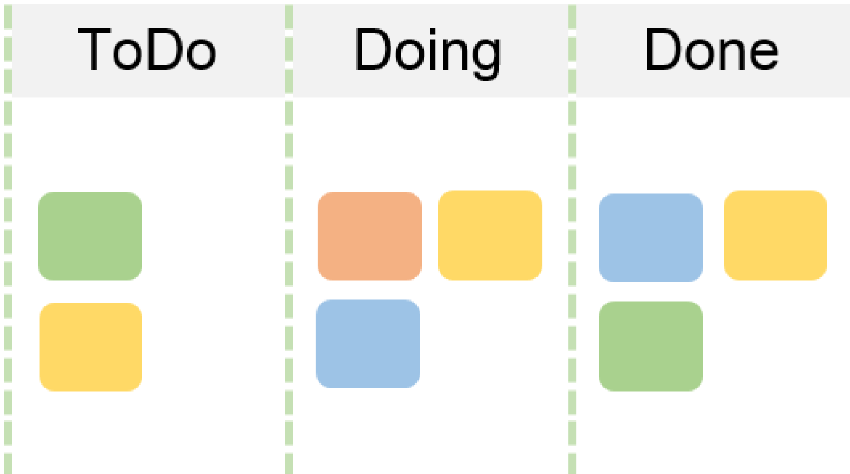

Figure 2.8: Kanban Wall

Kanban users begin by placing their tasks into the To Do column. When the user is ready to begin the next task, the user "pulls" the task from the To Do stage to the Doing stage and begins working until the task is pulled to the Done stage. So what if the Scrum process and the pull-based system of Kanban were combined? Here enters Scrum ban, *Figure 2.9* below [12].

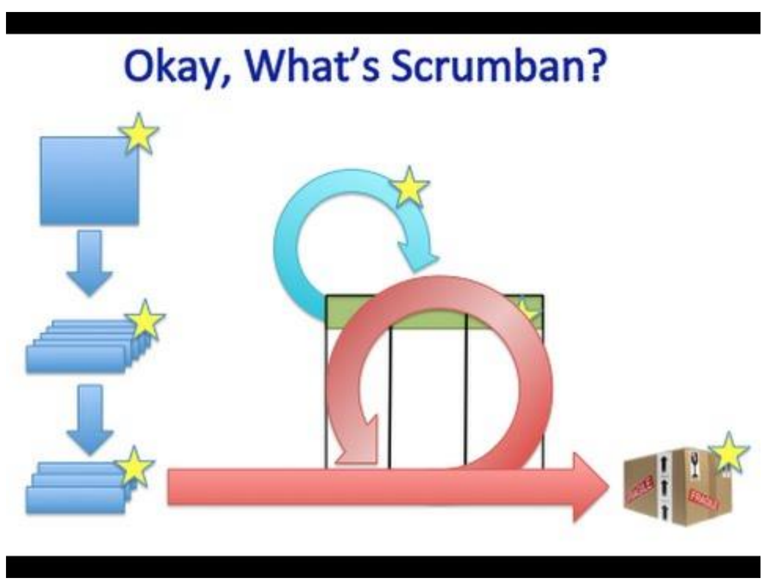

Figure 2.9: Scrum ban Diagram

In Scrumban, the Product Backlog, or for this method, Task Backlog is defined. A sprint backlog is produced and placed within the Kanban board. As the tasks are being pulled toward completion during the sprint, scrum meetings are conducted to assess the progress of the sprint and task completion. Once the sprint is completed, the designated tasks can be labeled as deliverables. At the end of each sprint, the instructor and students (team) have the ability to review and conduct a sprint retrospective of the work that was completed and the assessment metrics of the sprint. Observations that can be made can include:

- Were enough main tasks or learning objectives accomplished during the sprint?
- Could we, as a group, have gone into deeper application of the material and concepts?
- Could the group have included another main task or objective in this sprint?
- Did we achieve the sprint objectives in more efficient time than last sprint?

These questions help students grow comfortable with tasks and workloads while the instructors are able to gauge the potential of their students to increase the challenge of getting more initiative and effort from the students.

Furthermore, the scrumban process resembles a flipped classroom in that the classroom meeting times can be used as the scrum meetings or check-ins. The task completion will be conducted outside of the classroom and a list of objectives will be completed and accounted for at the end of the specified sprint or lesson. This correlation led to experimenting with the flipped classroom in engineering education to validate if agile methods could be used as well in reference to this paper's hypothesis.

CHAPTER 3: METHODOLOGY

3.1 Proposed Methodology:

The proposed scrumban classroom experiment combined the flipped classroom and agile method approaches while taking place in the ELCT 221 (Circuit Theory) General and Honors section within the Electrical Engineering Department at the University of South Carolina over a three exam period. The first week of the experiment would serve as the observation period to gather baseline data from exams. The experiment asked the instructor to develop a Kanban wall outlining the assignments and objectives for the students. The assignments for the students, for experiment week two, included reading and preparing study notes for Chapter 9: Network Theorems of Robert Boylestad's Introductory Circuit Analysis in accordance with the learning outcomes of the chapter, shown in *Figure 3.1*.

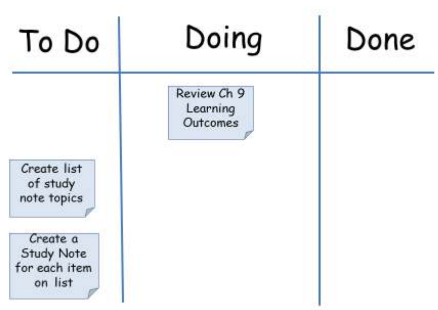

Figure 3.1: Kanban Board Used for Experiment Week 2

The third week of assignments, *Table 1*, would be a repeat of week two with the expectation of improvement and comfort in the instructional approach.

Table 3.1: Week 3 Kanban Board

To Do	Doing	Done
1. Develop Study Notes from Chapter 13 Reading that addresses chapter objectives		
2. Develop Study Notes from Chapter 14 Reading that addresses chapter objectives		
3. Develop Study Notes from Chapter 13 Reading that addresses chapter objectives		
4. Compile a list of study topics for Wednesday Exam		
5. Take Exam		
6. Complete any optional homework		
7. Develop Questions for Class to help with understanding reading material and sample problem solving.		

The study notes compiled by the students were to allow them to complete assigned homework with explanations connecting the example problems to the theory and prepare them for the exam. The Kanban boards were produced to document the tasks for the week and task completion progress.

Students were encouraged to peer review each other's notes and bring questions to class to engage in open discussions with the professor. During the week, the meeting days for the class were encouraged to be used for problem solving, Q&A sessions, or open discussions to expand on deeper aspects of the material and exam preparation. At the end of the week, the students were to be tested on the chapter. The class grades (average, maximum, and minimum), exam duration, question retries, incorrect answers, and unanswered questions would be documented for observation. Lastly, the students and professors were asked to complete a survey on their experience within the flipped agile classroom for further implications and future research. The survey questions can be found in *Appendix B*. The Honors section class population is seven (7).

3.2 Implemented Methodology

Aspects of the proposed methodology were not implemented. Only the Honors section students were presented with the Kanban Board shown in *Figure 3.1* for the first week of implementation and developed their Kanban Board for exam preparation in the second week of implementation. The instructor developed the Kanban wall shown in Fig 10 with the assignment to the students being to develop their own list of study topics and pull them across the wall as they completed their studies.

Also, the survey questions that were formulated were condensed into an interview style conversation that was held with the students and instructor present. The results of the study may present a margin of error given that the exam taken during the normal instructional approach consisted of seven (7) questions. The exam consisted of four (4) questions and then eight (8) questions for exam 2. Additional pitfalls of the experiment included:

- The instructor and student loss a day of class due to hurricane conditions and class cancellations
- Also, the absence of the main instructor for five of the eight remaining classes during the 3-week experiment period. Guest instructors were employed during these absences, giving the Honors students the opportunity to attend the General section class if desired.

Human error and interaction could also aid to the margin of error for the experiment therefore, the margin of error was not calculated for this experiment.

CHAPTER 4: RESULTS/DISCUSSION

In observing the results from the experiment, the general section statistics from the class were documented to show trends in the class exam performance throughout the experiment. The trends that appeared in the general section were compared to the trends that appeared in the Honors section study group. *Figure 4.1* shows the grades analysis of the general section.

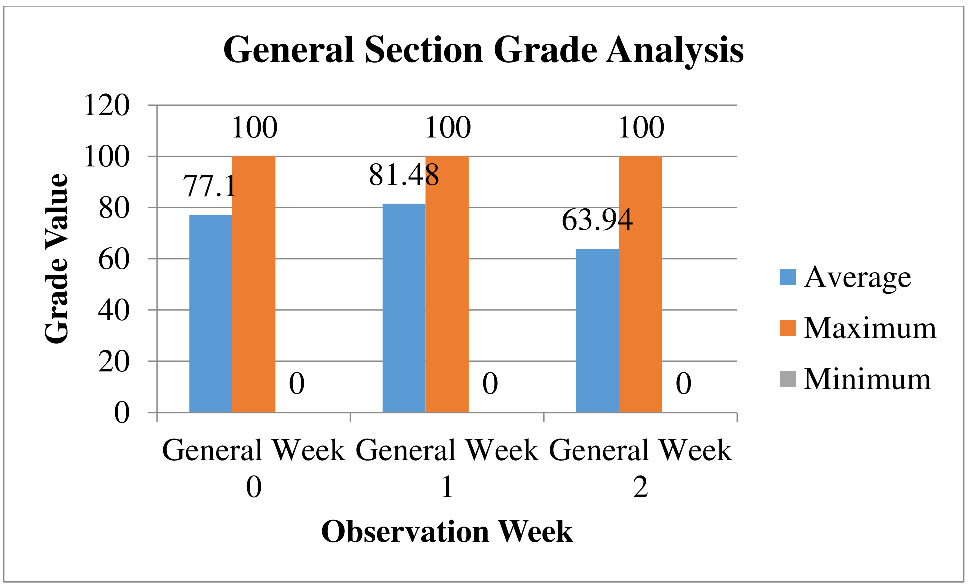

Figure 4.1: General Section Grade Analysis

The average exam score for the general section showed an increasing trend of 4.38 points between weeks 1 and 2. Between week 2 and 3, there was a downward trend of 17.54 on the average exam score. For the time analysis, *Figure 4.2* was produced.

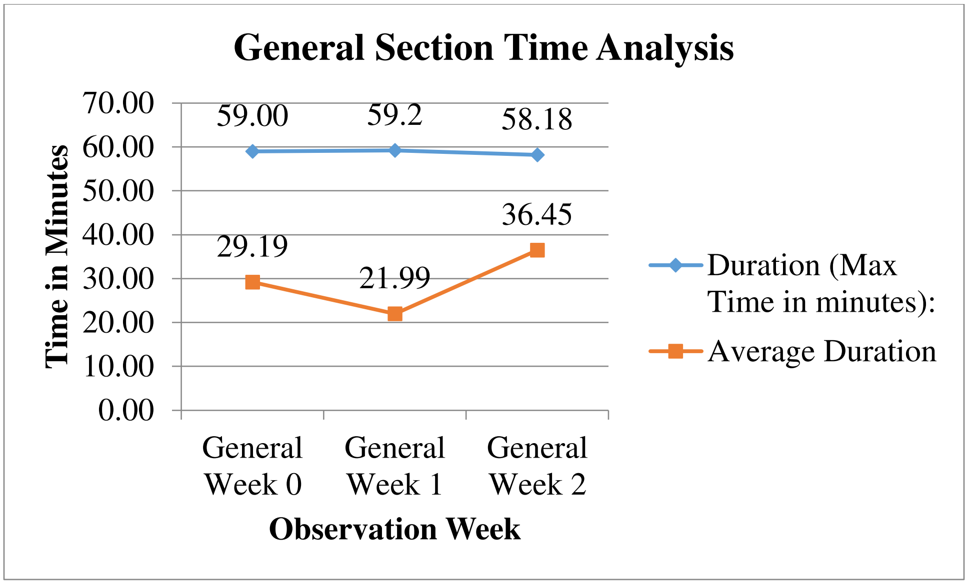

Figure 4.2: General Section Time Analysis

The maximum duration (time of completion) for the general section exams were 59 minutes for week 1 and remained within 1 minute for the subsequent exams. For the average time of completion, Week 2 experienced a 7.2 minute drop, meaning the class average time of completion was faster than before. For Week 3, the average saw a 14.46 minute increase. With these defined trend analyses, the results of the Honors section focus group can provide some insight to the effects of the Kanban Board's implementation. *Figure 4.3* represents the exam grades for the class section before introducing the Kanban Board to the class.

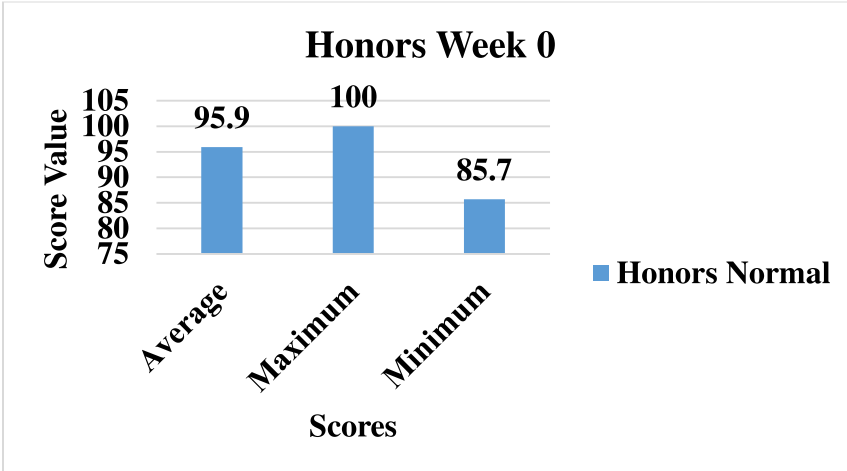

Figure 4.3: Honors Week 0 Scores

The average grade for the Honors section was 95.9%. The maximum grade was 100% and the minimum score was 85.7%. *Figure 4.4* shows the exam results after the first week of Kanban implementation. The exam that the students took had four questions with 50 minutes allowed to complete the exam.

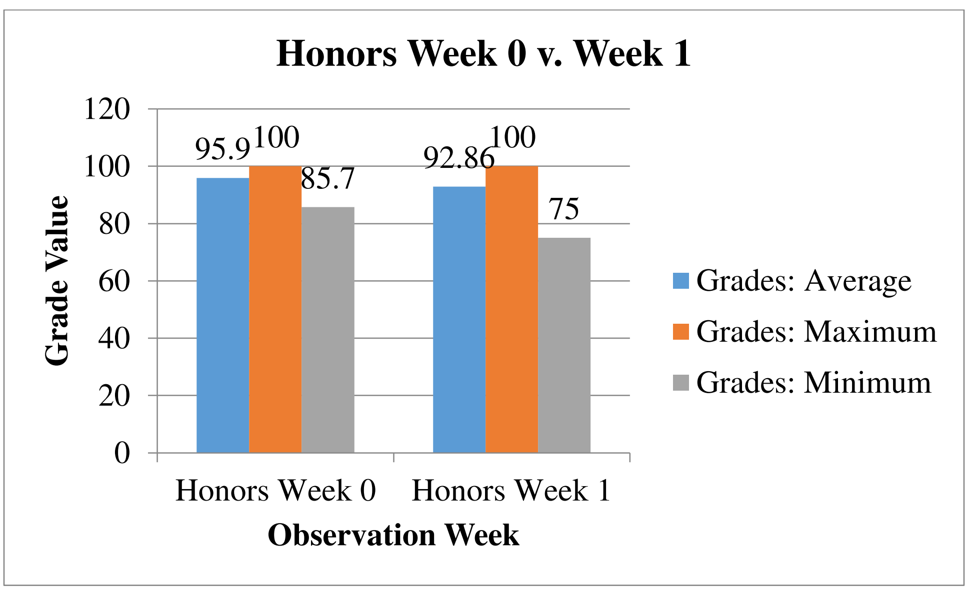

Figure 4.4: Honors Week 0 v. Week 1

In comparing the two exam grades, the maximum score of 100% remained the same. The differences are noticeable in the average and minimum grades decreasing.

The average grade decreased 3.04 points to 92.86 and the minimum grade decreased 10.7 points to 75%. Exam grades from Week 2 of implementation, *Figure 4.5*, show another decrease in the average and minimum scores.

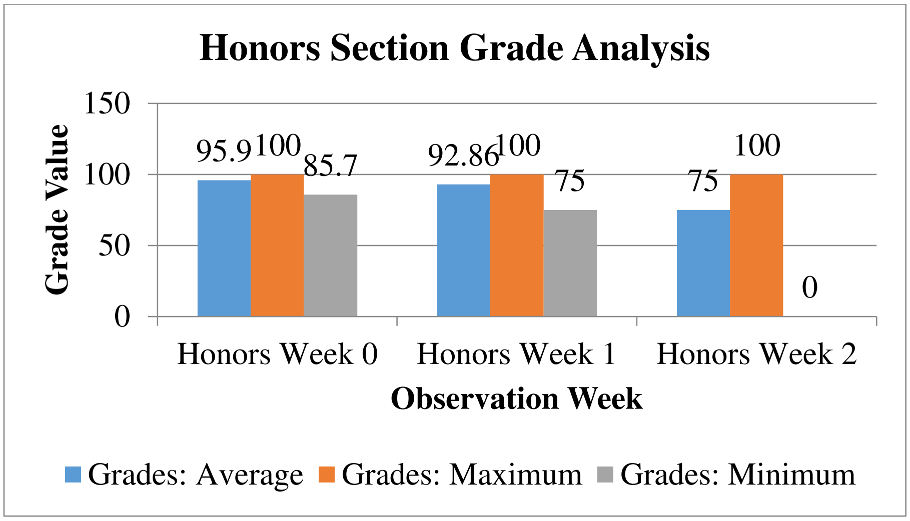

Figure 4.5: Week 3 Observations

The average score for the second week of Kanban implementation decreased to 75 and the minimum score was zero. This drastic change in the average and minimum grades could be attributed to the style of exam for that week. The students were to write a computer code to answer the eight question exam and each question of exam was built upon the prior question. If one part of the student's code was incorrect, then the following questions were less likely to be answered correctly.

For the trend analysis comparison for the General and Honors sections, *Figure 4.6* shows the trend over the experiment duration.

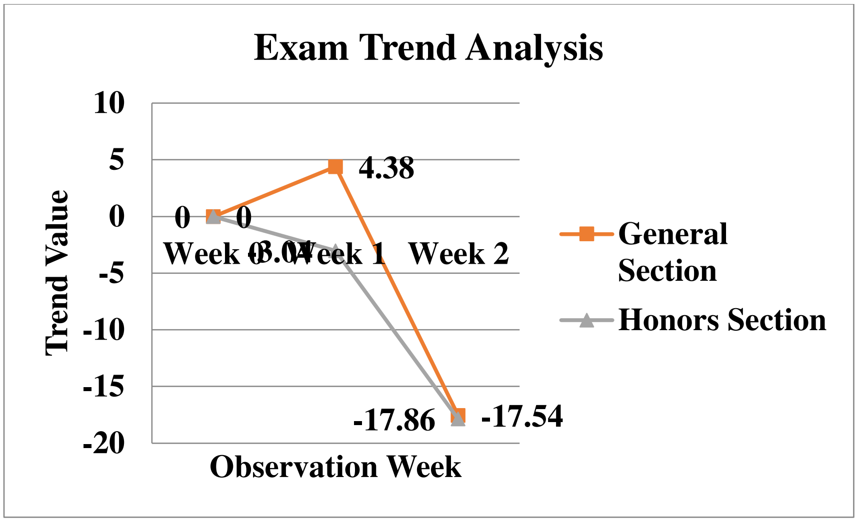

Figure 4.6: Exam Trend Analysis

The observation of just the exam grades do not provide a concrete determination of the viability of the implemented Kanban board so more analysis was conducted that involved the exam duration and an exam question breakdown. *Figure 4.7* shows the baseline (before experiment) duration metrics for the experiment. The maximum time needed to complete the exam and the average exam duration was observed. For the Honors section, only the maximum amount of time spent on each question (7) was provided for study.

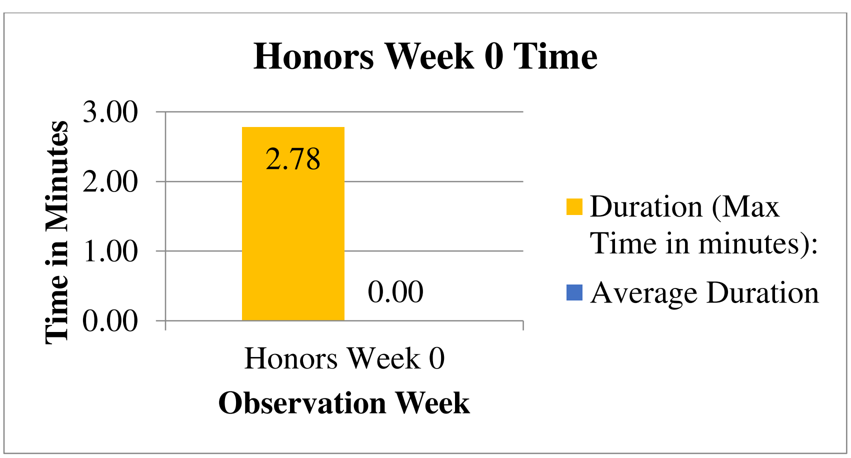

Figure 4.7: Exam Duration Week 0

The maximum amount of time that was needed to complete the first exam by the Honors section was approximately 2 minutes and 47 seconds. As mentioned, the individual time stamps for the students were not presented so the average and max time of completion may not be properly represented. After the experiment, the Honors section exam durations were compared in *Figure 4.8.* All individual data was attainable to calculate the maximum time of completion along with the average time of completion.

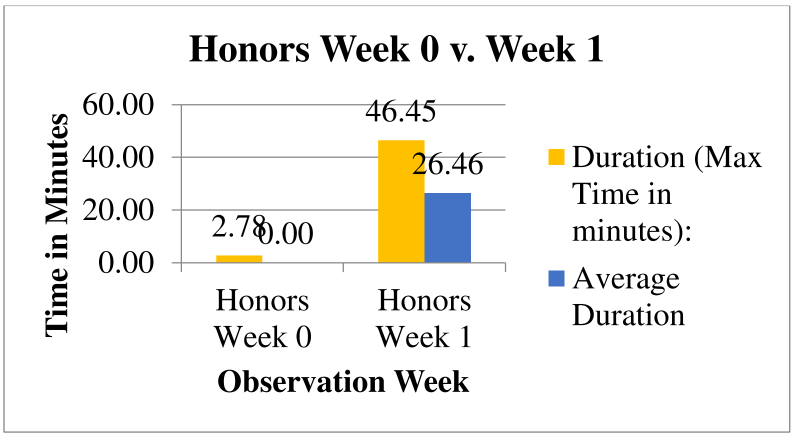

Figure 4.8: Exam Duration Honors Comparison

For the second exam, the maximum time of completion in the Honors section was 46 minutes and 27 seconds. The average time of completion was 26 minutes and 28 seconds. *Figure 4.9* shows the change of the time analysis over the experiment period of time.

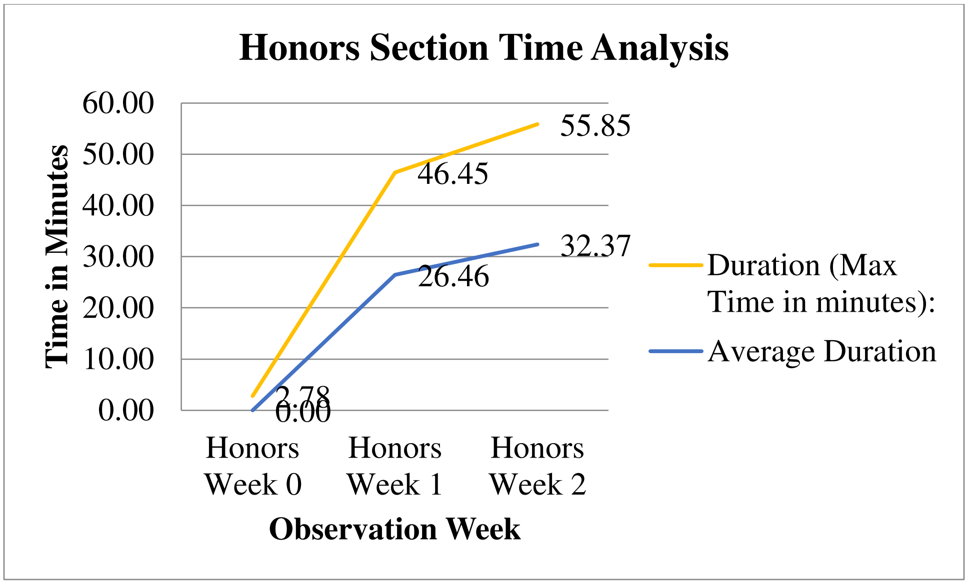

Figure 4.9: Honors Section Time Analysis

The maximum time of completion for the exams increased greatly between the first observed exam before the experiment to the first exam under observation. The second exam under observation showed an increase in the maximum amount of time needed to complete the exam but not as drastic as the first jump. The average duration of the exams followed the trend of the maximum duration trend. The increase in duration could be caused by the difficulty in material for that given exam. The increase could also be attributed to the use of simulation tools, such as MATLAB, that were used during one exam that was not used for another exam.

Another comparison of the time trend analysis between the Honors and General sections are shown in *Figure 4.10* below.

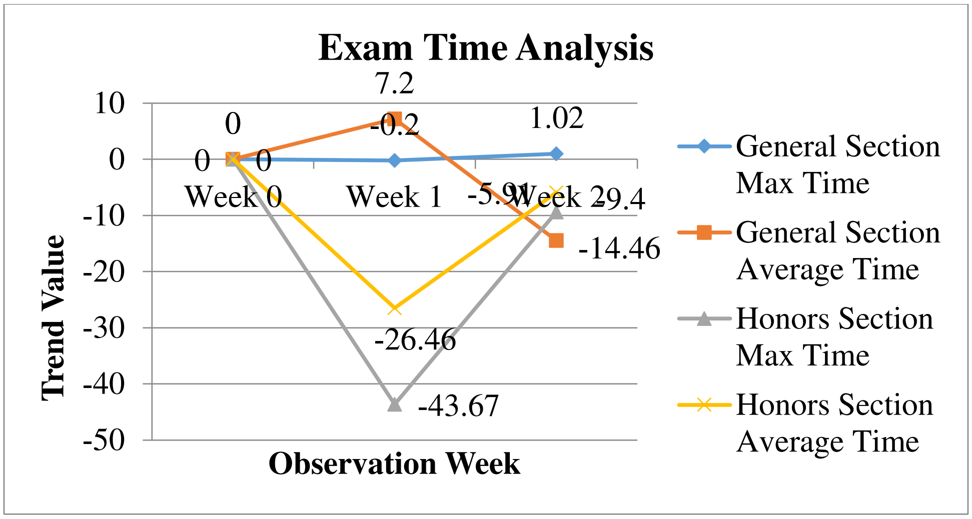

Figure 4.10: Exam Time Trend Analysis

The General section showed an improvement in average exam time of completion between the first two weeks but regressed in the last exam. The maximum time of completion for the General section relatively remained the same with a small improvement in the last exam. As for the Honors section, between weeks 0 and 1, there was a jump in average and maximum time of completion. This jump could be attributed to the lack of time information reported for the Week 0 observation, especially within the maximum time of completion. Between Week 1 and 2 of observation, the time of completion still increased, but at a smaller margin than the first two weeks.

With the grades and exam duration data from the experiment, the Honors section has shown an increase in exam time of completion and a slightly lower class grade average. The next step was to analysis any negative question results that occurred during the exam. The negatives included the number of total (cumulative) number of question retries, cumulative incorrect answers, and cumulative unanswered questions. *Figure 4.11* shows the negative results of the questions.

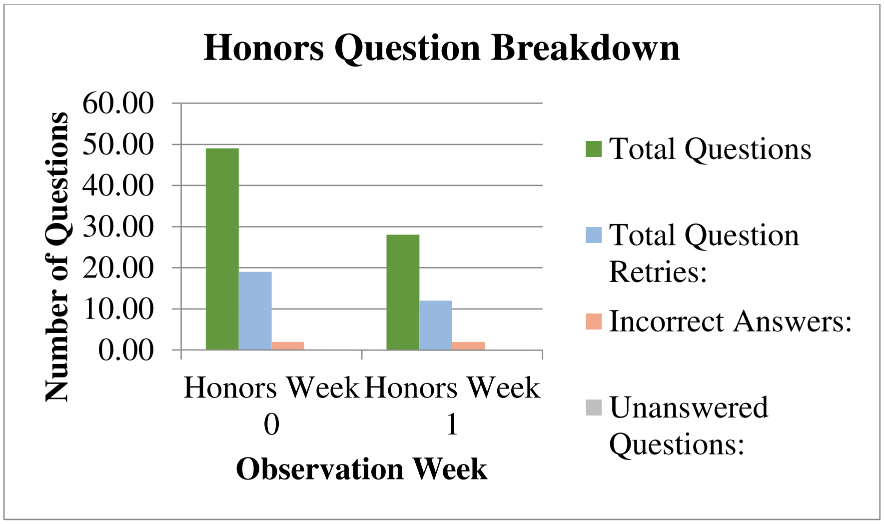

Figure 4.11: Honors Question Breakdown

For the first exam, the Honors section completed a total of 49 questions; seven questions for each of the seven students to complete. Of those 49 questions, students had the opportunity to retry a question that had an incorrect answer initially. The students were given three tries before the question was marked completely incorrect. Two of the 49 questions were marked incorrect and all questions were answered. During the second exam, a total of 28 questions were completed. 12 of the 28 questions were retried and two were marked incorrect. All questions were answered as well. *Figure 4.12* shows the analysis for all observations.

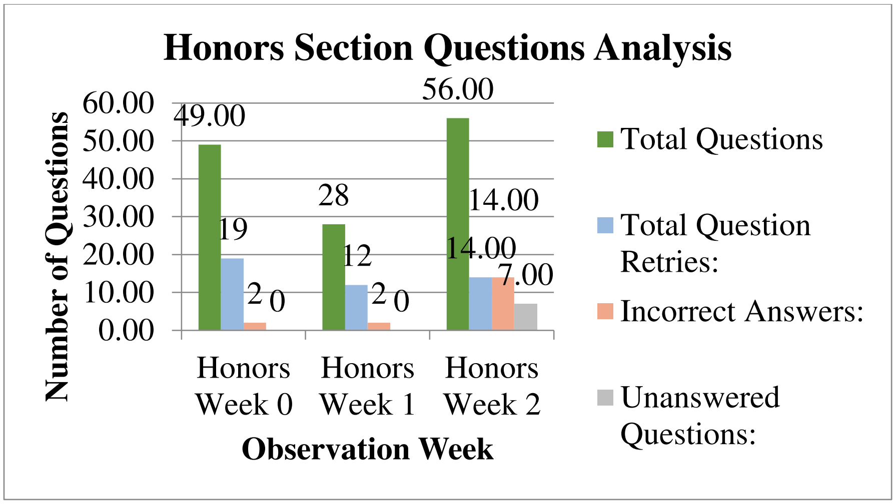

Figure 4.12: Honors Section Questions Analysis

For the Week 2 exam, 14 question retries were needed for the 56 total questions. Fourteen of the questions were ultimately answered incorrectly and seven of the questions went unanswered. In analyzing these question results (or negative results), *Figure 4.13* displays the percentage values of the results along with the likelihood of these negative question results occurring.

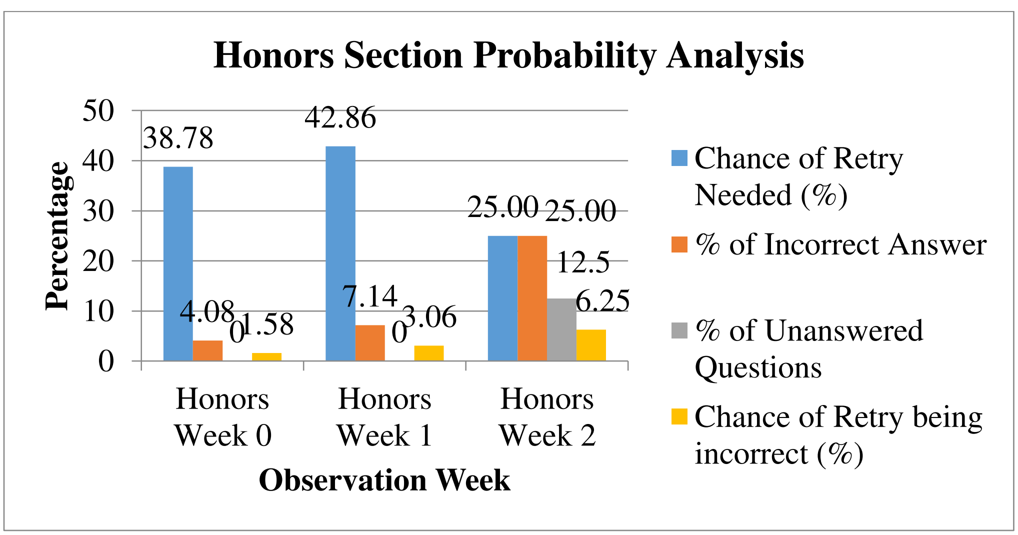

Figure 4.13: Honors Section Probability Analysis

Analyzing the Honors section question breakdown for the normal instructional approach, a retry was needed for 38.78% of the questions. Of the 38.78% of the retries, 1.58% of the retries ended in an incorrect answer with 4.08% of all answers being incorrect. In comparison to the Week 1 data, the percentage of retries needed, incorrect answers, and retries being incorrect all increased to 42.86%, 7.14%, and 3.06%, respectively. In Week 2, there was a decrease in the percentage of retries needed. The percent of incorrect answers, unanswered questions, and the intersection of a retry occurring and being incorrect increased.

The results from the metric analysis show that the Honors section, which has a small class population, had a decrease in average exam grades, increase in duration, an increase and a decrease in negative question results. After the completion of the experiment, the students and professor were interviewed to gain their feedback on the experiment.

The following student responses were gathered from the survey questions:

1. The Kanban Board outlined the objectives in an organized manner.
2. The board served as a great reminder tool and forced me to be organized.
3. Maybe better suited for a senior design class/group more than an individual class setting.
4. Helps outline bigger tasks to complete and analyze smaller tasks needed.
5. It felt like extra work/chore just to maintain the board versus using it for organization.
6. It gave me great personal satisfaction in completing the board; being able to pull the to-do items into the done section.

7. As a learning style, I learn best when given the full background proof and practical application; think this can help in providing that model
8. I prefer a balance of lectures and hands-on instruction. Not sure if this approach was framed to separate those two.

From these student responses, there were some positives in using the Kanban Board. Students believed that the objectives were outlined and organized while serving as a great reminder tool. One student felt that maintaining the board felt like and extra chore because they were asked to submit any revisions that they made to the board to the instructor. One student felt great personal satisfaction from completing the board. And lastly, some of the students believed that the use of the board worked better in a team setting versus an individualized class setting.

The instructor added, “This method was different; it was a very different approach than I normally use. It was good for insight on to-do items and study topics that as a class we were able to develop.”

CHAPTER 5: CONCLUSION/FUTURE IMPLICATION

In conclusion, the experiment did not yield a conclusive trend therefore rendering the thesis as inconclusive due to design implementation and limitations. The proposed experiment was not fully implemented so the performance metrics only reflect the implementation of the Kanban Board method, not the flipped classroom or scrum components. Even though some students mentioned the organization that the board offered, the industry soft skills that were predicted to be emphasized were not readily evident. In regards to limitations that were encountered, the time limit to conduct this experiment did not support long term discernment as the instructor and students would need an adjustment period to learning and implementing the experiment. The absence of the instructor and cancelled class meetings, due to weather, also strained the limits of the experiment. The agile and flipped classroom experiment, when fully implemented, can help overcome these limitations. With students conducting the bulk of their learning outside of the classroom, the absence of the main instructor or cancelled class meetings would not affect the students performing tasks before meeting for the class.

Therefore, a blueprint for agile project management tools can still be formulated to implement within the engineering classroom framework. In future studies, clearly explaining the full experiment to the group would be useful in the students understanding the process in which they are undertaking along with providing a detailed and graphical representation of what is expected. With a fuller understanding, the expectations and results can be shared by the instructor and students as the entire team then has the same goal and process understanding to achieve that goal. To ensure that agile project management skills can be useful in the classroom, referencing Harold Kerzner's 16 Points of Project Management Maturity could be used to enforce focal points of implementing agile project management methods. Referencing Kerzner's 16 Points of Project Management Maturity, the four points listed below serve as key cornerstones:

1. Adopt a project management methodology and use it consistently.
2. Focus on deliverables rather than resources.
3. Cultivate effective communication, cooperation, and trust to achieve rapid project management maturity.
4. Measure Progress periodically [4].

In Agile method implementation, professors must adopt a project management methodology and remain consistent in using it. Focus should be on the development of the students in their field along with completing course objectives in a timely manner; not only on tools and resources used to get the correct answer. The environment, students, and professor should actively promote effective communication, cooperation, and trust to achieve designated tasks and course objectives efficiently and effectively. Professors should regularly measure the progress of course objective completion, the effectiveness of their instructional approach, and the aptitude of the students in retaining the course material through standup meetings and open discussions. The use of Scrum ban can provide a manageable pathway into implementing agile into the classroom in conjunction with a flipped classroom. Sprints can make instructor time management more effective by reinforcing the core concepts and tasks directly related to course objectives and consistently relate theoretical knowledge to practical application. Stand-up meetings would emphasize personal accountability and team communication. The Kanban wall can promote lifelong learning in the students by encouraging them to pull the information from sources and tasks during cycles instead of professors automatically having to push the information onto the students.

Engineering practices and environments are constantly changing, supporting the implementation of agile methods in engineering education. Agile Project Management offers more freedom and flexibility to team members to accomplish goals, allowing for innovative approaches to arise. Even though the final completion of course objectives can be different from the original designed path of completion, the opportunity for professors and students to adapt is present and can be related to the adaptability of engineers in the workplace. This is an opportunity for instructors to create an environment that subtly introduces and utilizes industry practices in the classroom and that can improve class performance metrics while encouraging students to be more engaged and accountable for the class material.

Works Cited

[1] ASEE. *Transforming Undergraduate Education in Engineering Phase I: Synthesizing and Integrating Industry Perspectives*. American Society for Engineering Education, 10 May 2013. Web. 18 June 2016. <https://www.asee.org/member-resources/resources/transforming-undergraduate-engineering-education>.

[2] NSPE. *Engineering Education*. Issue brief no. 1739. National Society of Professional Engineers, July 2001. Web. 1 Aug. 2016. <https://www.nspe.org/resources/issues-and-advocacy/take-action/position-statements/engineering-education>.

[3] Whitaker, Sean. "The Benefits of Tailoring: Making a Project Management Methodology Fit." Project Management Institute, Inc., Sept. 2014. Web. 22 July 2016

[4] Kerzner, Harold. *Project Management A Systems Approach to Planning, Scheduling, and Controlling*. Hoboken, NJ: John Wiley & Sons, 2013. Print

[5] "Organizational Influences and Project Life Cycle." *A Guide to the Project Management Body of Knowledge*. 5th ed. Pennsylvania: PMI, 2013. 44-46. Print.

[6] "Agile & Waterfall Methodologies - A Side-By-Side Comparison." *Base 36*. Base 36

Smart Solutions, n.d. Web. 22 July 2016. <http://www.base36.com/2012/12/agile-waterfall-methodologies-a-side-by-side-comparison/>.

[7] APM, North West Branch. "The Practical Adoption of Agile Methodologies." Association of Project Management (APM), May 2015. Web. 22 July 2016.

[8] "The Agile Movement." *The Agile Movement*. N.p., n.d. Web. 22 July 2016. <http://agilemethodology.org/>.

[9] Editorial Team, MindTools. "Agile Project Management." MindTools, n.d. Web. 22 July 2016. <https://www.mindtools.com/pages/article/agile-project-management.htm>.

[10] Felder, Richard M., Donald R. Woods, James E. Stice, and Armando Rugarcia. "The Future of Engineering Education II. Teaching Methods That Work." North Carolina State University, 2000. Web. 22 July 2016. <www4.ncsu.edu/unity/.../f/.../Quartet2.pdf>.

[11] Lamm, Monica H., Michael Dorneich, and Diane T. Rover. "Team-Based Learning in Engineering Classrooms: Feedback Form and Content Adds Value to the Learning Experience." American Society for Engineering Education, 17 Oct. 2014. Web. 22 July 2016.

[12] Google, n.d. Web. 2 Aug. 2016

[13] Brame, Cynthia J. “Center for Teaching.” *Center for Teaching*.N.p., n.d. Web. 16 Sept. 2016.

[14] “Center for Teaching.” *Center for Teaching*.N.p., n.d. Web. 16 Sept. 2016.

APPENDIX A

Differentiated Instruction: Checklist and 5 Step Lesson Plan

Content Area/Names:______________________Grade:_____Date of Lesson: ___________________________________ Standard:

Objective:

Standard's Bloom's Level (circle one): Remember-Understand-Apply-Analyze- Evaluate-Create

Objective's Bloom's Level (circle one): Remember-Understand-Apply-Analyze- Evaluate-Create

Anticipatory Set

- Attention-grabber that relates to learning objective:
- Rationale for objective:
- Connection to prior knowledge:
- Review/introduction of vocabulary (may occur in instruction):
- CFU (Checking for understanding of LO):

Instruction

- Explanation of concept (How T. will deliver knowledge):
- Introduction of vocabulary (Content and Academic):
- Modeling/Demonstration of skill:
- Critical attributes identified (T. selected strategy):
- Active student participation
  - □ S. explain concepts, definitions, attributes in their own words
  - □ S. discriminate between example and non-examples
  - □ S. generate examples
- CFU (Key Questions):

Guided Practice

- Highly-structured step-by-step practice (We do together):
- Multiple opportunities for students to practice:
- Immediate corrective feedback
- S. gradually released to work from highly structured practice to guided practice:
- CFU:

Closure-Last CFU before Releasing Students to IP

- Key points of lesson reviewed/clarified (T. selected strategy):
- CFU-S. apply key points correctly in a variety of contexts (an individual mini- assessment without T. assistance) :
- Determine if 80-100% of students have achieved the objective; either move on to IP or give more GP

Independent Practice

- S. practice on their own to develop fluency and automaticity (T. selected activity/strategy):
- S. are able to work without help, at an 80-100% accuracy level
- T. provides effective, timely feedback

APPENDIX B

Student Survey Questions:

1. What did you like best about the flipped classroom experiment?
2. What part of the experiment could be improved upon in further research?
3. Is this an educational approach that could be helpful in student/career development?
4. Was the Kanban wall of tasks helpful in preparing for the exam?
5. Were your study/learning habits helpful in learning the information? Did you have to adjust? How did you adjust, if so?
6. Would you be interested in having a class structured in this model in the future?
7. How did this affect the interaction with your professor?
    a. Were classroom times more focused on asking the professor questions on the understanding of the theory?
    b. Was the classroom time more focused on working/completing the homework problems?
    c. Did you read the required text to complete the guided notes?
8. What future implications can this lead for the field of engineering education from a student perspective? Do you believe this helps in applying the classroom environment to the industrial/post-graduate environment of engineering?