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Editors

Using Constructive Alignment, eduScrum and Tableau to Teach Managerial Analytics

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Abstract

The research sought to study potential efficiency in course design and execution using Constructive Alignment, and then classroom workflow grounded in eduScrum based on the Agile Project Framework of Scrum for graduate classes in managerial analytics. The research measured performance based on the Scrum concept of Velocity, defined as the rate of improvement in learning as measured by the number of Constructive Alignments' Learning Objectives achieved. The process of class design creates a list of activities for each class that lends itself to a standardized learning workflow. Scrum, as a project framework originated within software development in the early 2000s, but has now become a managerial method of choice for projects in a wide variety of industries and sectors. The final product to be delivered is broken into increments of value that can be created by the team in short work periods, also called Sprints. EduScrum mimics the same approach, using each class session to act as a sprint in which the students are assigned to self-managed teams of students and assigned a list of learning activities to achieve. The teacher/professor's role shifts to coach, moving from team to team and improving workflow, overcoming barriers, providing resources, and ensuring each class maximizes value creation. Scrum and eduScrum rely on a short reflective learning session at the end of the Sprint, called a Retrospective, in which students and professors assess how they can improve the velocity of learning. Assessments are embedded for individuals as part of Constructive Alignment, and are connected to the Teaching/Learning Activities.

Keywords: eduScrum, Scrum, Agile, Constructive Alignment, Managerial Analytics

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Using Constructive Alignment, eduScrum and Tableau to Teach Managerial Analytics

Matthew Boyne

1. INTRODUCTION

The research for this paper began with the desire to craft a graduate class for organizational leaders on business analytics and data-driven decision making, that integrated the fundamentals of Agile Project Management in order to fully prepare students to lead a digital transformation in organizations. The paper describes a course design method, Constructive Alignment, to connect Intended Learning Objectives (ILOs) with specific Teaching/Learning Activities (TLAs). A teaching method known as eduScrum, which mimics an Agile Framework called Scrum (after the rugby term) was used to execute the TLAs and prepare the students for Assessment Tasks (ATs). For both data visualizations, data management and management of the class as an agile project the software Tableau was used. "Flipped", meaning outside class lectures, were recorded and added with guided readings for classroom preparation, freeing in class time to simulate project management with the ILOs acting as the work from an Agile Product Backlog (Tudevdagva, Heller, A., & Hardt. W., 2020).

The Mckinsey Global Institute (2011) highlighted the transformational potential of data. However, the report also highlights that turning data into information that can be acted on in a knowledge creating cycle requires actual transformation of the organization that precedes and anticipates technologies' opportunities. In order to execute data-driven strategies, agile management methods are needed given the uncertainty and rate of change (Brocchi, Brown, Machado & Neiman, 2016). Drawing from Mckinsey's studies, the course design needed to provide the necessary guidance to lead a data analysis effort using descriptive, predictive and prescriptive analytics while also acknowledging that the management of data requires a team of data scientists, data analysts, programmers and those with the necessary business/organizational expertise. Without understanding the context of the firm's problems in relationship to the data available, the process of data driven decision making will lack relevance to the organization.

Strategic organizational problems are too complex to solve without integrating decision-support systems, and the process of business analytics (Dewi, & Muniandy, 2014). The course was designed to prepare students to execute data projects with agile management in order to address organizational problems in areas such as supply chain, marketing, education, retail and healthcare as well as governmental problems such as homelessness using data analytics.

Previous work on the class design for data analytics courses tended to be focused on information systems management undergraduate majors, and have included visualization (Zhang, Chen, & Wei, 2020) with heavy emphasis on application of technology such as R, Microsoft BI and Tableau. Bacic, Jukic, Malliaris, Nesterov and Varma (2023) conducted a thorough literature review in their development of a graduate certificate supporting the dominance of analytical skills in academic programs that are highly valued by industry. Hartzel and Ozturk (2022) integrate non-resident expertise with industry experts as an integral part of their design studies, supplementing practical observations with the academic findings.

As part of the development for course content, 17 executives from the San Diego technology and life science fields were interviewed for their view of the necessary managerial skills for data analytics and digital transformation. The three top themes mentioned by each executive had to do with data visualization, data communication and team leadership skills. When asked what software skills they desired in their hires and managers 15 of the 17 stated they wanted people with knowledge of Tableau. Integration of agile management was only mentioned by 3 of the 17. Every interview specifically emphasized the need for data visualizations as descriptive analytics. The reason stated was the need to visualize the data as descriptive analytics. Only one executive expressed interest in enhanced forecasting methods found in regression analysis as predictive analytics.

From the study of literature on previous uses of eduScrum, and field interviews with executives,

the course design was established to cover the following learning modules over a 14-week course:

1. Introduction to Statistics Fundamentals for Analytics Managers
2. Descriptive Statistics
3. Data Visualizations
4. Regression Analysis and Predictive Analytics
5. Prescriptive Analytics
6. Dashboard Design and Presentations

In order to ensure the required participation and accreditation limits of hours per week (7-8) were not exceeded, separate modules for agile management were not feasible. Rather than teach agile management methods separately, integration of the eduScrum as part of each class's Teaching/Learning Activities allowed students to learn agile project management by doing, and to apply team learning to the field of data analytics. Tableau can act as both a data visualization, and analytics tool, as well as a project management software for agile visualizations such as schedules, resources, burndown charts, budgets and risk.

2. EDUSCRUM AND SCRUM FRAMEWORKS

The motivation for organizations to use agile methods in complex situations is supported because of the flexibility in execution with the self-managed, and in many cases, autonomous high performing teams that are able to respond directly to customer demands (Sutherland, 2001; Sutherland & Sutherland, 2014; Schwaber & Sutherland 2012;2020). The agile methods are characterized by iterative and incremental value creation with collaborative engagements between stakeholders, customers, organizational leaders and teams (Neuman & Barham, 2021). As more users have adapted agile methods, and particularly the Scrum Framework, application has spread from software development to business, analytic, supply chain, healthcare, financial services and aerospace (Sutherland & Sutherland, 2014). Scrum as a framework has been used in teaching college classes in software engineering and product development (Lundquait, Ahmed, Friedman, Bernard, 2019). Mahic (2010) found most direct agile applications in class were in computer science, with one found in advanced mathematics.

The Scrum Framework, which eduScrum mimics, originated as a lightweight framework grounded in the Agile Manifesto as a way to generate adaptive solutions to complex problems (Schwaber & Sutherland, 2020; Sutherland & Sutherland, 2014). Grounded in empiricism, and applying the Lean Systems and Thinking from the Toyota Production System, the fundamentals of the framework drive ongoing process improvement, enhanced rates of learning and waste reduction (Wijnands, 2019; Wijnands & Stolze, 2020). The framework focuses on the essentials of people over processes, and collaboration over control. Using four formal events that are transparently open to all, and integrating inspection into the work along with adaptation to learning opportunities because of the self-managed teams yields a cycle of learning and continuous improvement.

The four formal events begin with the Sprint, a specific time frame consistently executed over the same duration, during which ideas on products are turned into accessible value for customers. The Sprint begins with planning, in which the team takes elements from a list of components or deliverables, the Product Backlog, and selects a manageable amount of work, the Sprint Backlog, that can be accomplished over the Sprint. The next event begins each workday as a Daily Scrum. This event acts as a daily brief, resource discussion and lessons learned from the previous day to keep focus on the definitions of value. The third event occurs after the Sprint and integrates stakeholders in a product increment review, along with Backlog adjustment. This is the Review and is product focus. The Review compares the product's value state with the expectation of the stakeholders. The last Scrum event looks at the workflow and processes from the perspective of effectiveness, and the team dynamics that offer learning opportunities. The Scrum Retrospective studies the rate of change of the learning, called the velocity so as to quantify the team's performance and improve (Brown, et.al., 2019).

Within the Scrum Framework there are three roles. The Product Owner creates and manages the Product Backlog determining value creation of product quality performance specification. The Product Backlog is an ordered definition of work that needs to be accomplished and represents what the customers have described as a usable product. The Scrum Master is the leading advocate and facilitator for establishing Scrum throughout the organization and facilitating the team dynamics within the Scrum Framework. The Scrum Master is a team coach and leader that serves removing impediments from team learning. The Developers are the team and hold themselves accountable for the value creation. The Developers determine what

work can be accomplished in each Sprint, in consultation with the Scrum Master and Product Owner (Williams, 2010).

The key artifact for the Scrum Framework is the Product Backlog which lists specific components, processes, tasks, products, communications, and relationships that come together to meet the customers' needs. When filtered by the team down to what can be accomplished in the next Sprint, the Sprint Backlog becomes the incremental addition of value using the lessons from previous Sprints to refine products and processes. (Otero, et al., 2020).

EduScrum adapts the roles, events and artifacts into a classroom environment (Wijnands, 2019; Wijnands & Stolze, 2020). The teacher takes a combined role of Product Owner and Scrum Master, possibly sharing the Scrum Master duties with a student as a Team Captain, depending on professor preference, and class maturity. The Product Backlog is a listing of learning objectives represented as teaching and learning activities, broken down into Sprint Backlogs. EduScrum is often established with seven-week Sprints, though other researchers have used durations from two to four weeks.

Rush and Connolly (2020) emphasize the soft-skill development opportunity for students when integrating Scrum into the learning process. The students are required with the Restrospective opportunities to critically reflect and de-brief overall team performance bringing aspects of conflict resolution, negotiation and team-mate development into the analytics classroom. Linden (2018) adds to the human factor with research that details positive student responses to the opportunity for self-regulated learning using Scrum in a classroom. The students highly preferred working in a Scrum environment in which they had control over how they learned as compared to lecture-based classes. Magana, Seak and Thomas (2018) reported the constant feedback from the periodic Retrospectives and Reviews was found to be beneficial by students; and preferred to traditional quizzes as a way to assess learning.

EduScrum measures the rate of learning with a Run Up Chart tracking learning objectives given a quantitative value over Sprint duration allowing assessment of the velocity of the students' learning. The Run Up Chart is the same as a Burndown Chart in Agile Project Management, a tool to measure velocity of learning. The measurement of velocity, or student learning was the key measure for performance in this type of research (L´opez-Alcarria, Olivares-Vicente, & Poza-Vilches, (2017). Appendix A contains Figure 1, a commonly used class work board to visualize the eduScrum flow from ILOs in the form of Sprint Backlog (Blickharz, 2021).

3. COURSE DESIGN WITH CONSTRUCTIVE ALIGNMENT-LEARNING OBJECTIVES AND TEACHING/LEARNING ACTIVITIES

Shuell (1986) describes the teacher's fundamental task as motivating students to engage in learning activities that build into desired learning objectives for the course, because of effective design. What the student does to achieve the objectives through the activities is more important than what the teacher says or does. Constructive alignment engineers the classroom as a method of outcomes-based teaching (Biggs & Tang, 2011). The design of the course moves from the end state of all learning objectives (Intended Learning Objectives) being executed through class Teaching/Learning Activities (TLAs) followed by the demonstration of competency in Assessment Tasks (ATs). Biggs (2014; 1993) emphasizes that careful construction of content specific ILOs that are achieved because of the TLAs, and then how they are assessed with the ATs accomplishes Schuell's guidance to focus on what the students are doing, rather than the teacher's actions. There are four stages for Constructive Alignment course design:

1. Describe the ILOs using activity verbs
2. Create a learning environment with TLAs using the activity verbs
3. Use ATs to assess student performance using the activity verbs
4. Translate the performance into standardized grading criteria

Biggs (2014) and Biggs and Tang (2011) emphasize the importance of verbs in Constructive alignment. The same verbs, that are found in the ILOs and represent the requisite level of Bloom's Taxonomy for the class level should also describe the same action in the TLAs and well as what will be assessed in the ATs.

Class Organization

Beginning with Constructive Alignment, and in order to create ILOs, seven business analytics text books were reviewed seeking ILOs that were common in the support material, and emphasized by the authors in the provided lectures and teaching notes. This review provided a list of seventeen potential learning objectives. Peer universities as described as

liberal arts universities in the Southern California region, that offered graduate level analytics classes were contacted. In the area, those that have an evening MBA or MS program for working adults, but also have traditional undergraduate programs dedicated to liberal arts revealed seven candidate universities. The seven all had analytics classes designed primarily with a data management foundation and focused on communication, leadership, team development, fundamental statistics, visualization and data-driven decision making, rather than a data science/information systems primary focus. Each of the seven colleges was contacted and the faculty were kind enough to share their learning objectives. The seventeen potential learning objectives from the textbook were reduced to seven. This list was reduced to the following six in order to manage each ILO being achieved in two-week Sprints.

Intended Learning Objectives

1. Create data visualizations describing organizational performance using financial, human resource, operations/supply chain and customer feedback key performance indicator data.
2. Derive insights from data that translates to creating organizational improvement projects using gaps in performance with Key Performance Indicators.
3. Design effective data reports describing organizational problems and opportunities.
4. Predict effective outcomes using regression analysis based on organizational data.
5. Apply data driven decision making to organizational performance gaps and communicate outcomes in a data report integrating ethical decision making as well.
6. Create a dashboard as an Executive Support Systems using the Balance Scorecard Framework

The ILOs became the Product Backlog for the semester with Week 1 dedicated to an introduction and practice session. Weeks 2-7 were broken into separate Sprints for each ILO, followed by a Midterm in Week 8, and then more Sprints for Weeks 9-14. An Individual Assessment Task was assigned as a Final. In order to focus the classes on the Sprints the classes were "flipped," with videoed lectures on guided readings and explanation of the deliverables for the Learning Objectives. The classroom itself was managed as a Scrum, with a Sprint Backlog creation, Daily Scrum, and at the end of the class a Sprint Review with a Retrospective. The teacher/Product Owner explained the Teaching/Learning Activities necessary to succeed with the ILOs during the "flipped" lectures, as well as during the Daily Scrum. The TLAs were connected to specific parts and problems within the text that built towards the ILO and Product Backlog.

At the start of class students were divided into teams of five or six students. This allowed each class to have four or five teams working, while also fitting into the physical constraints of the classroom layout. The rubrics used for each of the deliverables that derived from the Individual Learning Objective (ILO) was the connection from the ILOs, to the Teaching/Learning Activities (TLAs) and then the grading of the deliverable as the Assessment Tasks (ATs) in order to maintain the flow for Constructive Alignment.

As an example of the eduScrum work from class along with the Constructive Alignment process, and using the "Design effective data reports describing organizational problems and opportunities" ILO, the TLAs for a two-week Sprint was presented in an eduScrum Sprint Backlog with the following items using a real estate data set of home sales. The report from the Spring became the Assessment Task for the team:

1. Find the mean and median home price for the five areas and state them in a table. What are the outliers? What is the effect of the outliers?
2. Create a visual analytic describing the average home prices.
3. Find the average square footage by city and state them in a table. What are the outliers? What are the effects of the outliers?
4. Create a visual analytic describing the square footage by city.
5. Create a visual analytic showing a comparison of the square footage and the home price for each city.
6. Find the average lot size for each of the five cities and state them in a table.
7. Create a create a visual analytic showing the average lot size for each city.
8. Create a visual analytic showing the three variables for each city of average price, average square footage and average lot size.
9. Using these analytic results create a 3-page report summarizing the results and embed the visualizations. What area should be considered for future real estate investments? Why?

4. USE OF TABLEAU

Given accessibility, intuitive use, a graduate demographic that tended more towards non-technical and quantifiable undergraduate majors; along with superior user support, Tableau was chosen as the primary analytics and visualization software. R was experimented with in each class but without exception students preferred using Tableau for analysis and visualization. Excel was partnered with Tableau, so as students would create a visualization or solve a problem in Tableau, the same result had to be achieved with Excel. In some applications, such as complex linear regression for predictive analytics or the Monte Carlo Simulation for prescriptive analytics only Excel was used given limitations in Tableau.

Tableau was also used as project management software to create Gantt Chart schedules, assign and level resources, manage the burndown of the ILOs, along with simulated budgets and earned value management problems. The Tableau visuals that were applied to each ILO and the project management worksheets were managed together in a single Tableau workbook. Tableau was embedded into each class as part of the Sprint, use of Tableau videos from the student resources were assigned as part of the flipped class.

5. RESULTS

Each Sprint for the Product Backlog was given a "story point" or user value of 7.5% of the grade, or 45% overall. The midterm and final made up 35% and two short individual case studies contributed the final 20%. A burndown chart was created beginning with 450 (out of a total of 1000 for the class) points and a linear line descending over each Sprint. Five semester-long classes, the first two in Summer 22, one in Spring 23 and one over Summer 23 have been run. The total number of students in these classes was 107 students. Lessons from each Retrospective and Review have been applied, along with feedback from end of course evaluations.

Classes Summer 21

The first Sprint resulted in 45 and 50 points achieved out of the possible 75 in the first Sprint. During the Retrospective students gave feedback that the into lectures in the classes were too long and did not add value since I was repeating what the "flipped" lecture provided. The process was changed to a 15-minute Scrum Plan, primarily focused on the rubric so students would have clarity as to the deliverable. The velocity increase to 80 points in the second sprint, then 120 and 125. The Individual Learning Objectives were complete in Week 12, allowing a Week for integration of a guest lecturer from industry. The two classes of 57 students also returned high assessment grades on the class for team dynamics, leadership, quantitative knowledge and decision making. The professor assessments resulted in an overall grade of 4.7 out of 5. Particular attention was placed in the Sprint Retrospectives on the clarity, quality and thoroughness of the rubrics to ensure students understood and applied the elements towards the quality standards for the deliverable. A specific question was inserted into the Professor Review asking about the quality of the rubrics. All 57 students responded that the rubrics showed the alignment between the ILOs, the TLAs and the ATs.

Classes Spring and Summer 23

More emphasis was placed on the "flipped lectures over the first two weeks concerning the underlying set up for visualization. End of course feedback from the previous classes had indicated clarity was needed on the specific way the quantitative and qualitative data had to be placed in order to create the proper visualization. The root cause of the delays in the first two Sprints' productivity was understanding how certain charts were needed for certain types of statistics. As an example, a Line Chart tends to work best with time phased data, such as budgets. Bar Charts work well with Categories and Numerical data. By closely relating the types of charts to the types of data the velocity of the Sprints improved by 30% over the first three weeks completing the ILOs by Week 12 and freeing up additional time an additional public policy case study. The student reviews of the professor for these classes resulted in a slightly higher score of 4.8 out of 5.0 for the 50 students. The same 100% response rate on the importance of clear and through rubrics was received highlighting that aspect for effective Constructive Alignment.

In order to additionally quantify the opportunities in using eduScrum as a way to improve the teaching of analytics, data was collected from a standardized Statistics exam that each MBA student had to take as part of their Analytics class. The test is from Peregrine, a company that specializes in levelling modules for students in graduate programs that may not have had an undergraduate class in basic statistics. Prior to the summer of 2021 and eduScrum, 294 students had taken the test with an average grade of 82 and a median of 87, showing some significant low scores. The failure rate was 12%. The Module had been given after computer-

based work in the second week of class. In the first class run, the Module was moved to Week 13 and each week a short eduScrum Sprint of about 20 minutes was dedicated to working through the basics of Statistics. The average moved to 88 with a median of 89 for the 107 students. The failure rate dropped to 3%.

6. LIMITATIONS AND FUTURE DIRECTION

The method of merging the Scrum roles of Scrum Master and Product Owner into the eduScrum class assumes the professor/teacher is comfortable managing Agile Projects, or receives significant training to function in those roles. Project Management development classes often take 40 hours of in class work with 80 hours expected outside of class. In cases such as this research the method was intuitive because the researcher had spent 15-years leading agile teams and had performed roles of Product Owner and Scrum Master in dozens of actual projects. For a professor not having that background initial study time may prove prohibitive.

Future opportunities for this class process will focus on the integration of Artificial Intelligence that Tableau is being equipped with. Future research will seek to employ these Agile classroom methods while at the same time seeing how AI can enhance analytics with human-system integration.

7. CONCLUSION

Constructive Alignment in course design can be used to create a Product Backlog and subsequent Sprint Backlogs for eduScrum classrooms. The key for execution in each Sprint is a clear and thorough rubric. The ongoing classroom improvements motivated by the students' own rigorous Sprint Retrospectives increased the velocity of learning and completed the ILOS ahead of schedule allowing additional topics to be brought in. eduScrum teaches both the subject of the class, and the leadership methods, communication, and team dynamics for projects.

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Appendix A
Figure 1

Source: eduScrum library

Figure 1: Sample class work board to visualize the eduScrum flow from ILOs in the form of Sprint Backlog