



INNOVATIVE PEDAGOGICAL STRATEGIES OF STREAMING, JUST-IN-TIME TEACHING, AND SCAFFOLDING: A CASE STUDY OF USING VIDEOS TO ADD BUSINESS ANALYTICS INSTRUCTION ACROSS A CURRICULUM

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ABSTRACT

Aim/Purpose	Business analytics is a cross-functional field that is important to implement for a college and has emerged as a critically important core component of the business curriculum. It is a difficult task due to scheduling concerns and limits to faculty and student resources. This paper describes the process of creating a central video repository to serve as a platform for just in time teaching and the impact on student learning outcomes.
Background	Industry demand for employees with analytical knowledge, skills, and abilities requires additional analytical content throughout the college of business curriculum. This demand needs other content to be added to ensure that students have the prerequisite skills to complete assignments. Two pedagogical approaches to address this issue are Just-in-Time Teaching (JiT) and scaffolding, grounded in the Vygotskian concept of “Zone of Proximal Development.
Methodology	This paper presents a case study that applies scaffolding and JiTT teaching to create a video repository to add business analytics instruction to a curriculum. The California Critical Thinking Skills Test (CCTST) and Major Field Test (MFT) scores were analyzed to assess learning outcomes. Student and faculty comments were considered to inform the results of the review.

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Contribution	This paper demonstrates a practical application of scaffolding and JiTT theory by outlining the process of using a video library to provide valuable instructional resources that support meaningful learning, promote student academic achievement, and improve program flexibility.
Findings	A centrally created library is a simple and inexpensive way to provide business analytics course content, augmenting standard content delivery. Assessment of learning scores showed an improvement, and a summary of lessons learned is provided to guide implications.
Recommendations for Practitioners	Pedagogical implications of this research include the observation that producing a central library of instructor created videos and assignments can help address knowledge and skills gaps, augment the learning of business analytics content, and provide a valuable educational resource throughout the college of business curriculum.
Recommendations for Researchers	This paper examines the use of scaffolding and JiTT theories. Additional examination of these theories may improve the understanding and limits of these concepts as higher education evolves due to the combination of market forces changing the execution of course delivery.
Impact on Society	Universities are tasked with providing new and increasing skills to students while controlling the costs. A centrally created library of instructional videos provides a means of delivering meaningful content while controlling costs.
Future Research	Future research may examine student success, including the immediate impact of videos and longitudinally using video repositories throughout the curriculum. Studies examining the approach across multiple institutions may help to evaluate the success of video repositories. Faculty acceptance of centrally created video libraries and assignments should be considered for the value of faculty recruiting and use in the classroom. The economic impact on both the university and students should be evaluated.
Keywords	information systems, data analytics, expanding analytical instruction needs, videos, curriculum implementation, scaffolding, reusable learning objects, just-in-time-teaching, business curriculum, zone of proximal development

INTRODUCTION

This case study examines a critical need for institutions of higher learning. Higher education faces challenging times with increased pressure to add value and manage costs as students have experienced rising tuition. The challenge has been exacerbated by the global response to the COVID-19 pandemic, requiring flexibility in content distribution while providing some measure of stability in the assurance of learning across multiple venues. Meanwhile, the increasing demand for analytical and other technical skills has created the need to add these skills throughout business school curricula (Clayton & Clopton, 2018). These skills span multiple business functions as demonstrated by the specific language addressing the need for evidence-based decision-making education in the 2018 AACSB guidelines: “Evidence-based decision making that integrates current and emerging technologies, including the application of statistical tools and techniques, data management, data analytics, and information technology throughout the curriculum as appropriate,” (AACSB International, 2018, p. 35). These skills need to be used in multiple courses, complicating class sequencing, and creating issues for instructors to provide adequate resources without requiring additional student investments. The challenge includes the introduction of a wide range of technical skills while also promoting critical thinking. Reusable learning object repositories are not new and can be beneficial, but the nature of

the content may need to be audience specific as both the students and the curriculum may vary, requiring specific content (Ball et al., 2008). A custom central video repository would allow content to be added while avoiding adding direct costs to the students, but it needs to be pedagogically sound and tested for assurance of learning (AoL). This case examines the incorporation of business analytics throughout a business college by creating a video library that acts as a centralized repository to support assigned topics.

Higher education faces the need to adjust its model to the marketplace's driving forces as federal and state funding has declined and rising administrative costs have driven up tuition and put a financial strain upon students. Additionally, the rising costs of textbooks have steadily increased the need to provide lower-cost or open-sourced materials. While some textbooks have adjusted for the need to include analytics, they may not consider where the student is in their academic career and therefore increases the difficulty of determining prerequisites to courses. Higher education institutions may respond to the need to add concepts to a curriculum by providing additional resources or assignments throughout various courses (Schwieger & Ladwig, 2016). However, not all faculty may be comfortable or knowledgeable of the corresponding analytics techniques or software, thus requiring training for students and instructors and in the use of selected software and techniques.

The institution organized a cross-functional committee to determine how best to include business analytics into the curriculum to address these issues. Alternatives were explored for teaching resources within this committee and course committees, deciding first to examine the use of videos as resources to fulfill the need to reduce costs to the students. As the objective was to include analytics college-wide several core courses that were taught in multiple sections across multiple platforms were selected. The institution selected a business partner in SAS who would jointly certify the students and required an independent research component. The institution determined that centrally generated content was required due to administrative constraints. The pedagogical theories and design concepts of scaffolding (Quintana et al., 2004) and Just-in-Time Teaching (JiTT) (Novak & Beatty, 2016) were examined to determine whether there was sound justification for implementing a video repository strategy considering the need for an independent research project and researched best practices in video production to plan content generation.

The primary research question is, "Do the use of video repositories improve student learning outcomes?" En route to answering the research question, scaffolding and JiTT best practices in using videos in pedagogy, and finally, curriculum assessment literature was reviewed. Since this is a case study involving business analytics instruction, literature defining business analytics was first examined, and case methodology was explored and adopted. Following the literature review, a discussion on the implementation and results is reported. Finally, there is a discussion of the results, the pedagogical implications, and the limitations and suggestions for future research.

LITERATURE REVIEW

The literature review proceeds as follows. First, the term "business analytics" is defined for use in this research. Next, a case study methodology will be described, followed by a review of pedagogical theories relevant to a central repository strategy's appropriateness, specifically reviewing scaffolding and JiTT. Then the researchers review several current studies addressing the use of videos to support learning to explore best practices and gaps in the literature. The literature review concludes with a recap of the use of videos for education and curriculum assessment measures.

BUSINESS ANALYTICS

Business analytics has several synonyms and definitions. It has been referred to as business intelligence and analytics and defined as the techniques, technologies, systems, practices, methodologies, and applications that evaluate business data to enable an organization to understand its business and make business decisions in a timely fashion (Chen et al., 2012). Galetto (2016) stated that business

analytics is the study of data through statistical and operational analysis, the development of predictive models, the application of quantitative techniques, and the communication of these results to various stakeholder groups such as potential customers. For this research, business analytics will be defined as “how businesses use statistical methods and technologies to analyze historical data to gain new insight and improve strategic decision-making.”

The preceding paragraph defines business analytics. The subsequent section explains why this issue needs to be on the “radar screen” of institutions of higher education. It also lays out some available options to academic institutions for incorporating analytics into the undergraduate business curriculum. It also addresses some of the shortcomings inherent in the approach taken by institutions of higher education to integrate analytics into the curriculum.

The process of identifying required skills and incorporating them into curriculums has been varied across schools. For example, traditional business intelligence (BI) coupled with business analytics (BA) has been an increasingly important strategic objective for many organizations (Mitri & Palocsay, 2015). BI/BA are still evolving, requiring universities to develop a new BI/BA curriculum. This new curriculum is a combination of disciplines, requiring “knowledge of information systems, statistics, management science, artificial intelligence, computer science, and business practice/theory” (Bohler et al., 2017, p. 87). Based on the most recent MIS model curriculum constructs, there seem to be two options for the proposed curriculum: a typical IS major with a BI/BA concentration or a comprehensive and integrated BI/BA undergraduate major. These approaches put the focus of universities on creating programs designed for a specific career track towards business analytics. Still, they do not necessarily address trying to embed analytics throughout a business school curriculum.

There have been a few notable examinations of analytics programs. Gorman and Klimberg (2014) surveyed and interviewed university personnel whose schools had created relevant undergraduate majors and minors, Master of Science degrees, certificates, and concentrations within their Master of Business Administration programs to understand how they were introducing analytics into their curriculum. While many programs covered IS concepts such as database and programming, they found a plurality covered introductory statistics and regression analysis. The most common application used in teaching statistics was SAS, with many programs using SPSS or programming languages. Turel and Kapoor (2016) conducted a similar survey that evaluated business analytics programs’ readiness at US business schools. They analyzed current business analytics-related course offerings of the top 104 business schools and 20 unranked business schools in the United States. They analyzed the programs by examining the types of courses offered and assigned maturity levels of the business analytics programs based on course offerings. Their findings indicate that business schools still have much to accomplish to achieve higher business analytics maturity levels to serve the overall industry needs. They noted that top-ranked programs covered more analytics content and were, in their opinion, more “mature” than unranked programs supporting the need for specific analytics training. Both ranked and unranked programs used statistics and database management as the most common foundation, implying that these concepts are essential to add analytical or big data skills to a business program. The research discussed above indicates that the skills students will be expected to have upon graduation include, but are not limited to, SAS, Regression Analysis, Microsoft Excel, and ANOVA.

Universities have been challenged to cover existing material and adding big data and analytical skills to an established curriculum has been a struggle (Schwieger & Ladwig, 2016). Programs often merely incorporate additional analytical assignments into existing courses while maintaining the work’s complexity, such as addressing privacy concerns (Schwieger & Ladwig, 2016). Whether implementing a degree, certification program, or a minor, it is essential to identify the students’ learning objectives. For example, one program has decided that its primary learning objectives are understanding analysis techniques, understanding data storage, retrieval, applying organizational decision-making techniques, and demonstrating interpretation and analysis (Dunaway & McCarthy, 2015). Once the objectives are identified, the programs must identify and obtain appropriate technology and training for their fac-

ulty (Dunaway & McCarthy, 2015). It is also preferable not to reinvent the wheel but instead implement what works using best practices (Dunaway & McCarthy, 2015). Analytics objectives for a business student should not focus on the technology but instead create an analytics curriculum for students who are adept in business (Wilder & Ozgur, 2015). One such curriculum includes base courses and concepts such as data management and general descriptive statistics (Wilder & Ozgur, 2015). In examining the individual courses in this program, it can be seen that the foundation of descriptive statistics is more widely used as a prerequisite than MIS skills such as data management. Later courses cover additional foundational statistical concepts such as correlation, ANOVA, and regression. This emphasis implies an initial priority of learning statistics concepts while also raising concerns that adding analytics objectives to existing courses may cause administrative challenges in coordinating things such as prerequisites.

The preceding paragraphs highlighted how universities have attempted to add analytics and related concepts to their existing curriculum and some of the challenges in trying to do so. Using videos may be one possible solution to address some of those challenges, including affordability and access and teaching prerequisite concepts. Using videos to contain costs provides a consistent message across venues, reduces the need for costly texts, and improves access to diverse student groups.

CASE STUDY METHODOLOGY

Using a case study is appropriate in evaluating a new process (Meyer, 2001). It has also been used increasingly in instruction, which may be an intrinsic case with the researchers involved in the process's outcome (Tellis, 1997). Case studies are challenging, even determining the unit of analysis as the case may evaluate the individual, the organization, or the process (Baxter & Jack, 2008). Case studies need to draw from various sources of evidence, all of which may have various strengths and weaknesses (Tellis, 1997). Participant observation and direct observation may allow context to be taken into account but may become biased due to the researcher's actions (Tellis, 1997). Documentation (e.g., using existing procedures like results from the CCTST and MFT assessments or analyzing course evaluation comments) is exact, repeatable, and unobtrusive but may be subject to reporting bias (Tellis, 1997). Case studies are a holistic approach to evaluating a problem; however, the complexity makes it essential to bind the scope being addressed (Baxter & Jack, 2008). Additionally, while using a single case vs. multiple cases may be appropriate, it impacts the ability to generalize (Tellis, 1997). For this research, a single case study is conducted, and the scope is limited to examining the process of using a video repository to improve learning outcomes. The evidence examined will consist of CCTST and MFT assessment results, course evaluation comments, faculty feedback, and participant observation.

SCAFFOLDING

Scaffolding describes the process in which a knowledgeable individual aids someone less competent to gain knowledge on a subject so that they may learn to apply the concept, thereby enabling a project to be completed that would otherwise be beyond the learner's capability (Quintana et al., 2004; Stone, 1998; Wood et al., 1976). The process of building up students' knowledge and then allowing independent work promotes critical thinking and problem solving (Weinstein & Preiss, 2017; Wilson, 2016). In STEM-related fields, scaffolding has been useful but best utilized in specific problem-based tasks (Beland et al., 2017). Videos have been used as successful scaffolding tools in creative ways, such as preparation for covering a topic, actively learning a topic, and providing assistance for students' post-class (Beland et al., 2017; Rismark & Solvberg, 2019). Scaffolding has been applied in statistics courses even at the graduate level to support understanding the math, the symbols, and running the necessary software, suggesting that various technical skills may be covered (Retnawati et al., 2019).

Scaffolding frameworks, grounded in the Vygotskian concept of "Zone of Proximal Development," have been developed to help build learning technologies that provide a foundation for pedagogical

design (Quintana et al., 2004; Vygotsky et al., 1978). This approach suggests that scaffolding is broken down by evaluating the scaffolding in three steps (Quintana et al., 2004). First, by identifying the elements of the task, interaction, artifact, tools, or practices in which the learner is engaged; second, by identifying the aspects of the first step that the learner will struggle with; and finally, by evaluating how the scaffolding addresses the obstacles identified in step two. This design approach lends itself well to real-world problem solving, which is also a focus of JiTT.

JUST-IN-TIME TEACHING

Just-in-time teaching (JiTT) blends web-based technologies used to prepare the students with active learning to provide necessary skills and then providing immediate feedback on an example task that has a basis in reality (Novak & Beatty, 2016). JiTT is used within STEM-related topics such as statistics, where it has been suggested to create shared resources such as videos and assignments to benefit the community at large (McGee et al., 2016). JiTT is not limited to learning technical skills as it also improves soft skills such as problem-solving versus traditional teaching models (Turnip et al., 2016). JiTT implementation also helps motivation while learning technical tasks such as programming (Martins et al., 2010).

The design principles for JiTT have similar design components to scaffolding and are also grounded in the Vygotskian concept of “Zone of Proximal Development” (Novak & Beatty, 2016). The principles contain sequencing, training wheels, and completion strategy (Novak & Beatty, 2016), implying that tasks should be ordered from simple to complex to break down component skills, including examples to enable independent completion. Additionally, JiTT includes the principles of continual assessment and the assessment of thinking, which means that the instructors should give multiple assignments and provide immediate feedback on how students comprehend and use the skills they are expected to learn in the lesson. One way of delivering a walk-through example for JiTT is through videos. For example, coupling a brief set of questions and videos that show the necessary conceptual and technical components just before a class or an assignment allows for a flipped classroom environment (McGee et al., 2016).

VIDEOS AND TEACHING

Teaching technical courses has traditionally been done through lectures (Tuna et al., 2018). With the rise of the internet and access to content providers and video sharing sites, videos have increasingly been incorporated into lectures. Videos may be used to break apart the monotony of a lecture or to supplement a lesson plan. Online classes have also increasingly been using videos to replace traditional lectures (Hughes, 2009); furthermore, using videos in online courses reduces the drop rate for online instruction (Brecht, 2012). With the advent of the flipped classroom, videos are also being used to replace traditional face-to-face lectures (Herreid & Schiller, 2013; Tuna et al., 2018). A flipped classroom occurs when the students are tasked to undertake direct learning individually, with classroom time reserved to answer questions, discuss topics, or actively work on projects and problems (Flipped Learning Network [FLN], 2014). Videos may also be seen as an additional resource, similar to textbooks or readings, and may be implemented as recorded lectures or short supplemental materials (Deshpande et al., 2014; Petty, 2010). While instructors in STEM fields have voiced concern over content coverage, some have begun to use video cases to flip their classrooms (Herreid & Schiller, 2013). However, educators must ensure that the educational “video content” they are using incorporate sound pedagogical content knowledge and pedagogical content strategies appropriate for the subject matter, learning plan, and the audience (Ball et al., 2008; Melo et al., 2020; Purwaningsih et al., 2020). The knowledge of the audience and the curriculum’s customized nature may dictate that customized material needs to be supplied (Ball et al., 2008), so there is a need to understand the best possible formats for the videos created.

Videos in traditional lectures have been well received by students, but they desire that the video used are short; also, while they appreciate instructor-created content, they want the videos to be something

that the instructor could not have covered themselves (Alpert & Hodkinson, 2019). Videos should not distract from but should relate to the theme of the lesson plan. With longer videos like those done through lecture capture, it becomes vital to index the videos' content, accomplished through automation or via crowdsourcing to supplement or complete the task for a learning experience (Deshpande et al., 2014; Tuna et al., 2018). The ideal video length does not have a standard answer; however, a 2 – 12-minute guideline is suggested, and attention can be sustained in longer videos depending on the content (Fishman, 2016). The attention paid to a particular video also depends on task engagement required, with attention increasing by 20% for long and short videos if viewer interaction, such as using the video to complete an assignment, is needed (Geri et al., 2017).

One of the key pedagogical advantages of videos is the ability to provide closed captioning and transcripts for at-risk students, such as students with special needs and non-native speakers (Deshpande et al., 2014; Jae, 2019). This functionality has become more accessible with various cloud-based platforms where the initial captioning can be automated, but the translation's complete accuracy should be reviewed (Tuna et al., 2016). Reviews of the transcripts and translations may be challenging to accomplish depending on available resources but may be assigned as part of training graduate assistants or new faculty to achieve synergy. Additionally, students may be given points for finding translation or transcript errors. Studies have also indicated increased comprehension, in general, among college students (Gernsbacher, 2015, Kent et al., 2017).

While there were numerous articles on video creation, the effective use of videos, and the use of repositories of reusable learning objects (Neven & Duval, 2002), there was limited research on higher education institutions creating custom video repositories and evaluating their effectiveness in additional analytical content to an established curriculum. This case attempts to address the existing research gap on evaluating the effectiveness of adding analytical content by creating a video repository.

CURRICULUM ASSESSMENT

While formative assessments promote student learning by providing ongoing feedback during the course instruction (Ahmed et al., 2019), of interest in this research are the summative assessments, which attempt to identify student learning up to a given point (Taras, 2005). On its surface, the process seems simple enough. Deploy assessment instruments to students before they begin their upper-level studies to establish a baseline, and then, following the “intervention” of approximately 60 credit hours of upper-level courses, assess the students again to determine any significant differences in results. The institution examined for this article uses two summative assessments in this manner: the California Critical Thinking Skills Test (CCTST) and the Major Field Test (MFT). For this article, the researchers are interested in the effects of introducing data analytics concepts into the college of business curriculum that would impact students across all business disciplines, and the CCTST results will be examined. Additionally, to identify any significant changes in learning outcomes related to quantitative thinking and skills, the “Quantitative Operations and Management Techniques” scores from the MFT will be reviewed.

The CCTST is an objective measure of the core reasoning skills needed for reflective decision making (Insight Assessment, n.d.). The assessment provides metrics on Overall Reasoning Skills, Analysis, Interpretation, Evaluation, Explanation, Inference, Deduction, Induction, and Numeracy. Not all of the measures available on the CCTST are used by the college of business examined in this research; thus, a brief explanation of the six measures that are tracked is presented in Table 1 based on information provided on the assessment instrument (Insight Assessment, n.d.).

Table 1: CCTST Measures and Explanations

Measure	Description
Overall Reasoning	A measure of the test-takers’ ability to form reflective judgments and apply the other core thinking skills measured by the CCTST.
Analysis	A measure of the student’s ability to identify assumptions, reasons, themes, and evidence used in making arguments.
Inference	A measure of the student’s ability to draw conclusions from reasons, evidence, observations, and experiences from their values and beliefs.
Evaluation	The ability to assess the credibility of sources of information and the claims they make.
Deduction	A measure of the student’s ability to determine the precise logical consequences of a given set of rules, conditions, beliefs, values, policies, principles, procedures, or terminology.
Induction	Measures a student’s ability to estimate likely outcomes. The Induction score measures the student’s ability to apply inductive reasoning, providing confidence in one’s conclusions. According to Insight Assessment (n.d.), inductive decisions can be derived from “analogies, case studies, prior experience, statistical analyses, simulations, hypotheticals, trusted testimony, and the patterns we may recognize in a set of events, experiences, symptoms or behaviors.”

The MFT can provide accreditation requirements for external validation of learning outcomes (Educational Testing Service [ETS], 2016). The Quantitative Business Analysis topics comprise approximately 11% of the instrument and measure probability and statistics related topics and quantitative operations. See Table 2 for a list of topics covered by the MFT assessment.

Table 2: MFT Quantitative Operations and Management Techniques Topics

Probability and Statistics	Quantitative Operations Management Techniques
1. Measure of set operations	1. Linear programming
2. Conditional/joint probabilities	2. Project scheduling (including PERT and CPM)
3. Counting rules	3. Inventory modeling
4. Measures of central tendency and dispersion	4. Statistical process control
5. Distributions (including normal and binomial)	5. Special topics (including queuing theory, simulation, and decision analysis)
6. Sampling and estimation	
7. Hypothesis testing	
8. Correlation and regression	
9. Time-series forecasting	
10. Statistical concepts in quality control	

Ideally, results from the CCTST and MFT summative assessments are used as feedback to the college of business’s curriculum design and execution activities. They are part of the continuous improve-

ment process. While the CCTST and MFT are the primary curriculum assessments used by the institution, studied in this research, other assessment instruments are available to institutions, such as internal capstones (Terry et al., 2020) and the Comprehensive Business Exam (Fairchild & Hahn, 2020).

THIS CASE

AACSB accreditation increases the international recognition of business colleges. Current AACSB guidelines call for “evidence-based decision-making education.” Further, Clayton & Compton (2018) found an increasing demand for analytical skills. The evaluation of the curriculum redesign and implementation process is beyond the scope of this research project and is reviewed in Bohler et al. (2017). This case will focus on the implementation of the centralized video repository to improve student learning outcomes. Addressing the administrative challenges of implementing the curriculum changes, including the software and video tool evaluation process, comprises a separate research effort that is yet to be published (Larson et al., in press).

Implementing a centralized video library and analytics curriculum requires substantial agreement and feedback from faculty. To accomplish this, a cross-functional committee called the Data Analytics Working Group (DAWG) was formed, and existing course committees were used to determine how to implement the analytics curriculum and the centralized video library. Results from existing learning outcome assessments (CCTST and MFT scores, and course evaluation comments) would be analyzed to identify curriculum change efficacy. The following is a description of the software used in implementing the centralized video repository.

SELECTED TOOLS (SOFTWARE)

A committee exercised due diligence in identifying promising applications, including benchmarking other analytic efforts (Gorman et al., 2014). The process used to determine the implementation tools for this case study is provided in a separate research effort (Larson et al., in press). This section details the statistical, content creation, and video hosting software selected (Table 3). For statistics, Excel and SAS were selected.

Table 3: Software Used in This Case Study

Software	Strength	Weakness
SAS Studio	SAS is widely used in industry so having some knowledge adds value to the students. The Cloud version of SAS is available through a browser with a GUI interface that is easy to use.	A free cloud version does not allow for version control, so instructions become obsolete if changes are made.
Excel	Many employers require Excel, so advanced skills are nearly a must within a curriculum.	The Cloud version does not contain the analytics add-in, so the hardware requirements for students are increased.
PowerPoint	Allows professional presentation of content.	The ability to show hands-on demonstrations is limited to adding screenshots.

Software	Strength	Weakness
Camtasia	Allows screen presentations and automates closed captioning allowing switching seamlessly from one presentation to another.	It takes time to produce in the proper format to upload into video hosting sites.
Microsoft Stream	Offered within Office 365 and is connected to other programs such as Teams. Automates Closed Captioning and allows for links to be shared and the videos attached to those links to be updated.	To have centrally controlled videos, not under a content creator's account, will take additional management.

Microsoft Excel is a widely used business application whose functionality is taught in several college courses. Students were already being certified in Excel's basic use. Excel was adopted as necessary to be incorporated within the analytics program as it is a widely used program in multiple industries. Excel can be seen as a requirement in some fields. For instance, Excel is a requirement in the Accounting program because Excel skills are required within the CPA exam. However, making Excel the primary application program for statistics was not seen as practical due to its limitations in producing desired outputs. Additionally, the cloud-based version of Excel that some students use limits the available functions and adds challenges to instruction outside of a lab.

SAS is a widely used statistics program (Turel & Kapoor, 2016) that allows data analysis using downloaded software or a cloud-based version. While a cloud-based option is more straightforward and provides an easy graphical user interface for students to use, it also creates other issues such as a lack of version control causing created media (videos, instructional documents, PowerPoint presentations) to become obsolete at unpredictable intervals. SAS also provided an opportunity for learning institutions to offer joint certifications on beginner level SAS skills. As SAS is widely used, this provides value to students who can demonstrate proficiency.

Ultimately, Excel and SAS were kept to provide business students with analytical acumen. Excel would be maintained in the courses that offered certifications. Additional skills would be added in analytics courses, including cleaning and merging data, and running some statistics models such as ANOVA and regression. A certification program using SAS was created, which would be offered jointly through SAS and the college. The cloud-based version of SAS was selected to minimize the need for student software management; however, it also reduced the control that faculty had over the software version, one of the primary drivers for using shared resources such as a centralized video library teaching these courses. By not having the software version control, the instructors may be required to update instructions regularly, as changes to the cloud are made, and this would more efficiently be done centrally.

In evaluating scaffolding, JiTT, and video research, it was eventually determined to create three sets of videos and to make the videos shorter in duration. Following JiTT and scaffolding design concepts, the first set of videos would supplement the student's knowledge of statistics or a concept, while the next collection of videos would address the use of the software, and finally, a set of videos that would "walk" the students through applying the concepts and interpreting the outputs (Novak & Beatty, 2016; Quintana et al., 2004). While the statistics concepts would be conceptual and could use a static document, the lab work would require screen capturing demonstrations that would be longer as the terms would need to be related to how the concepts were applied and displayed using Excel or SAS. PowerPoint was the primary tool used to create mostly static, conceptual videos. PowerPoint was the ideal tool to create content that needed limited updates and would not require extensive interaction with analytic applications. Conversely, Camtasia is a screen recorder and a video editor that allows the real-time recording of user interaction with applications and later editing to highlight the

use of controls and menus, and other editing options. Camtasia and PowerPoint both permitted the creation of MP4 files that could be uploaded and shared using Microsoft Stream.

Microsoft Stream is free with Office 365 and allows simple video hosting, management, and limited automated closed captioning. Members of the organization can access the videos, but they are not tied to a specific course, allowing students and faculty to access the resource as needed. As of this article's writing, Microsoft Stream does not provide extensive viewing statistics beyond view counts, and the instructors and researcher cannot see if a particular student has watched a particular video. Uploading and sharing video content is a useful skill for faculty and students alike. Microsoft Stream also allowed the videos to be updated while maintaining existing links added to instructions.

The institution's BSBA degree program spans four years and involves many courses in various subject areas. SAS's joint certification requirement was to have SAS directly used in at least two courses in the data analytics initiative. Additionally, two other courses would be necessary to discuss communicating analytics and its role in the decision-making process. The two courses that directly required SAS were the "Introduction to Information Systems and Data Analytics" and "Operations Management" courses. Next, the specifics concerning analytics for these two courses are discussed.

INTRODUCTION TO INFORMATION SYSTEMS AND DATA ANALYTICS

This course was previously used solely to introduce information systems where students expanded their knowledge of the terminology and the strategies of using information systems in a business context. Instructors had the freedom to add practical application projects such as working in Access or Excel. As part of the analytics initiative, instructors teaching this course would now be required to include SAS assignments. The "Introduction to IS" course was identified as having some flexibility in the content covered and most closely aligned with the concept of using information for improved decision-making. Thus, the DAWG (Data Analytics Working Group) selected "Introduction to IS" to introduce SAS, the analytical modeling, and completing the required independent project.

The course committee was tasked with how this was to be executed. The committee determined the need for five analytics assignments before the completion of the independent research project. The initial assignments were SAS registration and scatter plots, descriptive statistics, cleaning, uploading data, ANOVA, and linear regression. Information system-related case studies and a Microsoft Access assignment were removed from the course to make room for these additional assignments. ANOVA and linear regression were not covered in prerequisites and therefore needed rudimentary explanations in the class. Students' effort to review and learn descriptive and inferential statistics concepts was perceived as taking away time from information systems material. Therefore, IS topics are elaborated on in lectures and readings. The independent research project involved students having to complete an analysis of datasets using SAS, including submitting a written report and giving a class presentation. The project involved using real-world data, and there was an expectation that both the written and oral components would be at a level that would be considered acceptable at future places of employment. Prior assignments supported by multiple videos provide scaffolding and JiTT opportunities to refresh the student's memory before completing advanced assignments.

Faculty were concerned with the amount of effort needed to create the additional content and the additional time needed to grade and provide quality feedback on the data analytics exercises. Implementation within online sections was also a concern with the complexity of the new topics being added. These concerns were a driving force for the idea to create a video library.

OPERATIONS MANAGEMENT

The operations management course, as previously conducted, covered an introduction to operations management as well as various quantitative assignments. Its text did have some discussion of the use of linear regression but did not have a prerequisite that required exposure to linear regression. This course was designed to be taken after or concurrently with the Introduction to IS and Data Analytics

course. It was determined to add linear regression assignments related to SAS because the faculty felt that this model best fit into the course material and may be useful in forecasting.

Two data analytics exercises involving linear regression were incorporated into this course. Each activity was designed to last approximately three hours, and students were provided two different data sets. The instructor teaching the course walked through one of the data sets in class as a follow-along exercise. The second dataset was assigned as a graded homework assignment where students were expected to interpret and explain the impact of the analysis on an organization and how the analysis is used in decision support. They were also required to submit a written report of the analysis. There was an expectation that this report would be comparable to a professional memorandum that students may be required to deliver in their future place of employment upon graduating from the BSBA program. The faculty concerns were a lack of a prerequisite that covered linear regression and the need for potentially being the initial course for the student's exposure to SAS, which again identified a need for creating a shared resource across courses. The DAWG and the course committees would serve as focus groups for how the videos would be implemented.

CONTENT CREATION AND MODULAR DESIGN

The process of creating the video repository followed design concepts borrowed from scaffolding and JiTT (Quintana et al., 2004). During the initial phase of development, the videos were only broken down into two categories, where one video covered fundamental concepts, and the other covered running the software and interpreting the results. A subset of instructors was assigned to create concept videos and step-by-step instructional videos. The videos created were longer than desired and had not considered the design process's full extent. Thus, the content was divided into three categories covering concepts, running the software, and interpreting the output. Next, the concepts' aspects were further sub-classified or sub-categorized and made into multiple shorter videos (i.e., Descriptive Statistics, ANOVA, and Regression). The videos were then listed in any instructions sequentially (Data Cleaning, Uploading, model assumptions, model interpretation, etc.). The statistics concepts were covered using PowerPoint presentations uploaded with narration and uploaded to Microsoft Stream. The "follow along" lab instructions that demonstrated and partially interpreted statistic models in SAS were captured in Camtasia and uploaded to Microsoft Stream. Through the count of the videos' views, a pattern was seen that view counts were far higher for the follow-along instruction videos while the statistics videos were not widely viewed. However, this is partially due to the narrated PowerPoints' availability and the statistics concepts videos within the learning management system (LMS). Initial reviews of the videos provided in instructor reviews saw them as an essential part of the course with student comments such as "The videos that accompanied these exercises were very helpful" and "I really enjoyed the videos- couldn't (sic) have done it without them!" The video library, alluded to earlier, is described in more detail in Table 4.

Table 4: Video Library

Concepts	Software Use	Output Interpretation
IRB and Research	Registering for SAS	Merging data with Vlookup and Get Pivot Data
Kaggle and Finding a Dataset	Data Cleaning in Excel	Descriptive Statistics in Excel
Data Types	Merging data with Vlookup and Get Pivot Data	Characterize Data in SAS
Central Tendency	Descriptive Statistics in Excel	Scatter Plots in SAS
Correlation	Characterize Data in SAS	Summary Statistics in SAS
Descriptive Statistics	Scatter Plots in SAS	Correlation Table from SAS
Distribution	Summary Statistics in SAS	ANOVA Results in SAS
Control Charts	Grouping Summary Statistics	Regression Assumption Analysis SAS
ANOVA	Correlation in SAS	Regression Results in SAS
Regression	ANOVA in SAS	
Dummy Coding	ANOVA in Excel	
Decision Making		

Concepts	Software Use	Output Interpretation
	Regression in SAS	Regression Model Comparison
	Regression in Excel	SAS
	Filtering Data in SAS	
	Changing Preferences in SAS	

RESULTS

The initial implementation had multiple issues, and indirect benefits that the researchers feel should be addressed before discussing the primary research question's results related to pedagogical effectiveness. These concerns and issues were voiced in committee meetings, in informal interviews, and by course evaluations.

Students often required refreshers on skills and topics covered in earlier videos but found it challenging to locate relevant footage. The instructors created increasingly modular videos that were indexed within the assignments' instructions to address these concerns. These modular videos were shorter and usable with multiple assignments, either as new instructions or as refresher videos. Also, student perception of a substantial increase in the workload and difficulty level in relating the topics covered within the Introduction to IS and Data Analytics course was an issue. Student comments gathered from course evaluations, such as "It felt like I was taking two courses" and "Too many assignments were not related to the textbook," were seen. However, the videos received only positive comments in student evaluations of the courses, suggesting that while the students were concerned with the course workload, the video resources themselves were viewed as effective. Recent graduates have voluntarily reported that the SAS and analytics skills learned were advantageous in their search for employment and mentioned that the critical thinking and soft skills they learned were invaluable.

For the faculty, there were also concerns with adding too much additional content. The videos required updating as the cloud platform or assignments were changed, but the videos' length made re-making the videos a long and tedious process for the content creators. Some faculty expressed concern over the increased time to grade and provide quality feedback on the analytics assignments. These concerns were partially offset by a reduction in course preparation through the central repository of videos and standardized grading rubrics. However, as word of the implementation's success in terms of being an essential resource for assignment completion and that many students found value in the skills learned was spread through the college of business faculty by the DAWG, it inspired other faculty to look for opportunities to integrate the videos and other analytics-related content into their courses. Courses such as Data Mining, Business Programming, Quantitative Methods, and Marketing Research were able to reuse conceptual and technical examples. Instructors began to use Microsoft Stream to create content for other courses such as Database and Systems Analysis Design.

To evaluate the implementation's pedagogical effectiveness, the primary research question, the researchers examined the change in CCTST scores for critical thinking, and the MFT score for Quantitative Operations and Management Techniques. These assessments are an imperfect measurement of success due to the number of interventions and other changes that occur across a curriculum. However, it was deemed appropriate for the institution as the CCTST and MFT are a part of the existing curriculum evaluation process. For this institution, it takes two years from the courses where the videos are initially introduced to the final formal assessments using the CCTST and MFT. The CCTST and MFT show positive results with a 13.75% improvement in Quantitative Operations and Management Techniques scores on the MFT exam when comparing the 2017-2018 cohort to the 2019-2020 cohort. There was also a 6.7% improvement in the CCTST average score on the analysis measure when comparing results from starting the program to completing the program for the cohort that graduated in 2019. The improvement in the CCTST and MFT results, combined with positive course evaluations, indicates that the video repository's initial implementation has positively impacted learning outcomes.

DISCUSSION

This implementation of analytic learning using centralized video libraries resulted in several observations regarding faculty, students, course requirements, and technology. The following paragraphs detail the increased knowledge on this topic gleaned from this case.

First, the video library's implementation was used and appreciated by the faculty as instructors commented that the preparation for the analytics assignments was mostly complete with the inclusion of the videos within assignment instructions. Additionally, instructors in other courses that contained statistics concepts, such as Data Mining and Marketing Research, began to use some of the created material to supplement their courses. Often repositories of reusable learning objects rely on metadata (Neven & Duval, 2002) to allow instructors to find the appropriate object, but this case suggests that the use of committees and word of mouth may also increase the use. However, the faculty who undertook developing and updating assignments had additional work added to their existing responsibilities. The extra work was partially addressed by making the videos more modular so that smaller parts of the videos had to be updated. Eventually, the instructors began to update the videos related to topics over the existing videos so that the links within existing assignments could remain the same.

Second, the students appreciated the videos as valuable resources but had mixed reactions to the number of analytical assignments in each course. Comments from student evaluations in class and online indicated that the videos were useful resources and expressed appreciation. Video counts also support that the videos were widely used, and informal conversations with non-native speakers and deaf and hard of hearing students indicated that the captions were valuable to their understanding. Even when the length was longer than recommended, the view counts remained high for videos that required students to follow along to complete the assignments supporting the concept that interaction improves video utilization (Geri et al., 2017). However, since many assignments were loaded into one course, the students felt confused. They complained that the course felt like two separate courses since statistics concepts were added to an introductory course whose textbook primarily dealt with information systems. Students were confused about the focus of the course. The textbook was adjusted to one that also contained introductory data analytics, which was partially successful as it included more explanation of data analytics. However, it did not directly connect the statistics models taught, so some disconnect remains as perceived through student evaluation comments. A typical introductory textbook primarily covers terms and theory, so the instructors need to continue to adjust the message so that the assignments feel more related to the textbook material. It may also be essential to provide additional and freely available supplemental reading material to connect readings to the application of analytical techniques. Hence, the instructors have worked to include additional information related to each assignment, including illustrated instructions.

Third, Microsoft Stream is a useful application that created easy to share links and provided a quick way to embed videos into an LMS, thereby allowing multiple courses or assignments to use the same video as a resource. Thus, there was a reduction in the number of prerequisites, reduced prep time for faculty, support for student success throughout the curriculum, and student cost reduction. However, the implementation of the assignments was not without technical drawbacks or issues. Cloud-based web services such as SAS Studio undergo periodic changes and, as a free service, may be subject to downtime that is not within the instructors' control. Abrupt changes to the SAS graphical user interface caused several videos to be remade. While automated captioning can be done through either Camtasia or Microsoft Stream, there is still a need to edit the transcripts to match exact wording. Furthermore, creating smaller modular videos that covered certain features helped limit the amount of material that needed to be updated at a given time. The videos also provided more flexibility to review the material when students have not used SAS for an extended period.

Fourth, the concepts of scaffolding and JiTT contained design concepts that helped to support the project-based tasks that the institution was required to include in this implementation of the SAS certification. The content creators examined and first broke down the material by areas students might

find difficult. Later, they began to use feedback from instructors and students to make increasingly modular videos that addressed specific areas so that the students or instructors may refer to an area that needed to be specifically addressed. Informal student comments and comments from course evaluations were extremely supportive of the videos and their value in completing assigned tasks.

Fifth, the researchers found improvements to student scores in both the CCTST and MFT Exams at the end of a curriculum related to critical thinking and business analytics. While it is not entirely possible to place all the credit of score improvement on the video libraries' implementation, score improvements suggest that the implementation had a positive impact. These findings support the literature on JiTT and Scaffolding's effectiveness in improving critical thinking skills (Turnip et al., 2016; Weinstein & Preiss, 2017; Wilson, 2016). The videos were designed explicitly to be a curriculum-wide intervention, designed to improve analytical knowledge and increase critical thinking skills.

Sixth, several technical and procedural issues still need to be addressed, mostly updating the videos to account for software changes and improving the videos' captioning. This process could improve the training of additional instructors or teaching assistants by recruiting them to create the videos or update the closed captioning. While view counts are available, the pedagogy's effectiveness may be easier analyzed by improving the statistics with respect to students who have viewed the videos. The institution also needed to monitor buy-in across departments and to expand analytics to additional courses. The use of cross-functional committees, such as the DAWG to increase buy-in and manage change and process improvement, is essential.

Data Analytics continues to be a "hot" field in high demand that offers high salaries to qualified candidates. The timely analysis of big data and appropriate data interpretation to actionable information enables organizations to make better business decisions providing competitive advantages. Therefore, including general concepts throughout the curriculum is essential, and the development of data analytics degrees, minors, and certifications are valuable.

PEDAGOGICAL IMPLICATIONS

Analytics projects are complex and require knowledge across multiple business functions. The creation of a video library facilitated an addition to the undergraduate business curriculum. The video repository created consistent material that facilitated learning and reduced instructor workload. Learning outcomes in both content knowledge and critical thinking improved, supporting the effectiveness of scaffolding and JiTT in creating a video repository (Turnip et al., 2016; Weinstein & Preiss, 2017; Wilson, 2016). Even the longer videos maintained high view counts and positive comments supporting the observation that requiring interaction improves engagement with longer videos (Geri et al., 2017). The use of committees for content creation discussions may have also increased the use of the videos and presentations, suggesting increased faculty cooperation impacts positively the student learning experience. If there is a need to add custom content across a curriculum, this case study supports creating a centralized video library allowing the use of created content across multiple courses.

LIMITATIONS AND FUTURE RESEARCH

As a single case study, the results have limited generalizability. Additionally, as an intrinsic case, the results are subject to bias, although the researchers have taken measures to reduce this by drawing upon multiple sources, including supporting literature, documentation, and participant observation. Also, the introduction of a video repository was not the only intervention or difference in the assessed cohorts, so it is not possible to assign the entire success or failure to an individual pedagogical process.

This case identifies several avenues for future research. Analytics is a complex topic to teach, with instructors having varying strengths. While the evaluation of the MFT and CCTST indicates that there have been improvements in students' scores for this case study, a more precise examination of learning assurance is needed. Such a study might reveal the benefits and drawbacks in student learning in a single course and longitudinally across the curriculum. The economic impact on both the university

and students should be evaluated to ensure that resources are being efficiently used. Access to detailed viewing statistics could reveal student use patterns that could be used to improve shared resources. An empirical study of the impact of closed captioning on non-native speakers and people with disabilities could be illuminating as many universities have a diverse student body. Studies comparing existing videos and other reusable learning objects and custom created content need to be undertaken both in pedagogical effectiveness and cost-effectiveness. Studies streamlining the development process of technology related videos may aid instructors to create custom content efficiently. While this study suggests that committees aided in faculty cooperation, adoption, and garnering feedback, additional studies on the impact of custom content creation and faculty interaction is needed. While there are studies related to optimal video length, there seems to be a need to continually evaluate length and platforms as students increasingly opt to switch to mobile use and technologies, such as virtual reality, become more prevalent. Finally, due to many factors, higher education is dealing with rapid change and fiscal challenges. Research on how faculty and institutions respond to these challenges, using tools such as a shared video library, could be useful.

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