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Teaching Tip
A Scalable Hybrid Introductory Analytics Course

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ABSTRACT

We report on the design and development of an introductory analytics course delivered to almost 10,000 undergraduate business students to date. One novel aspect of the course is its orientation to add analytics capabilities to a business student's toolbox, resulting in significant design and implementation implications. We anchored the course on three fundamental principles: maximizing learning, operating at scale, and a consistent experience for all learners. To enable a rigorous and valuable learning experience, the underlying course curriculum is based on the modified CRISP-DM (CRoss Industry Standard Process for Data Mining) framework. Bloom's taxonomy is applied to the course assessments to evaluate the depth of learning. The course is delivered in a hybrid mode, arguably the best combination of online and face-to-face delivery modes. In a naturally occurring experimental setting, the COVID-19 pandemic accelerated the evolution of the course and generated additional reinforcing lessons. We explore those lessons and suggest directions for further research.

Keywords: Introductory analytics, Asynchronous learning, COVID-19, Bloom's taxonomy, CRISP-DM

1. INTRODUCTION

The application of analytics in business has seen revolutionary change thanks to a substantial increase in data availability, an increase in breadth and sophistication of analytical methods, a myriad of new tools, and persistent storage and processing cost reductions, to name some major contributors (Dinter et al., 2017; Gupta et al., 2015; Jaggia et al., 2020; Schiller et al., 2015; Wixom et al., 2014). Educating the workforce in analytics and keeping up with its evolution has become both more imperative and challenging (Firth et al., 2011; Paul & MacDonald, 2020; Rodammer et al., 2015; Wilder & Ozgur, 2015; Williams & Elmore, 2021; Zadeh et al., 2018; Zhang et al., 2020). As a highly cited McKinsey report makes clear, obtaining analytical knowledge, skills, and abilities (KSA's) is no longer simply desirable but becoming a fundamental toolset for almost any role, function, organization, and industry (Manyika et al., 2011). There continues to be a widening workforce gap between the supply and demand of those with analytical KSAs (Doshi & Krishan, 2020). In recognition of this unmet need, AACSB has revised its curriculum standards to encompass Analytics KSAs (AACSB, 2020).

The case has been made that Information Systems (IS) is perhaps the most appropriate single discipline to develop and deliver analytics curricula given the already existing interdisciplinary focus of IS (Agarwal et al., 2014; Burns & Sherman, 2019). We build on a tradition of analytics curricula development in IS (Gupta et al., 2015; Schiller et al., 2015; Topi et al., 2010; Wixom et al., 2014; Zhang et al., 2020) by reporting on an introductory analytics course.

How do we implement an analytics curriculum that will satisfy the organizational needs of a pan-disciplinary audience? We achieve this goal by first introducing the concept of problem-solving using analytics in a "business function" agnostic way. Later, we introduce analytical techniques that can be used to solve these problems in real-world settings.

This paper aims to detail the design and implementation of an introductory analytics course for undergraduate students across the entire range of business disciplines. Several aspects of the course combine to generate a unique context worthy of further study and provide several valuable lessons. For example, the choice of a hybrid delivery mode (for reasons discussed in Section 3.2) was made before the COVID-19 pandemic so dramatically changed the landscape for us all; the pandemic ushered in and accelerated several additional aspects of the course implementation. Reflecting on what occurred in the course before, during, and after the pandemic highlighted the course's unique challenges and benefits. Finally, we report the valuable lessons we learned to the larger community of scholars and educators.

The course discussed in this paper has another novel aspect: many of the curricula cited have a stated goal of educating for analytics roles such as data analysts, data specialists, and data scientists (Wilder & Ozgur, 2015). We are educating the entire gamut of business students in using analytics for problem-solving as part of their larger role, whatever that role may be. Providing an introductory analytics course to all business students enables departments to offer discipline-specific analytics courses.

Moreover, changing the motivation of a significant part of the audience from "*I choose to do this course/major/program*" to "*I have to do this because it's a requirement*" has major implications for building course engagement. These distinctions in audience orientations may be subtle, but they substantially impact the course design. Some of the design choices for the course include the potential to spark curiosity towards using data analytics methods without making students fully proficient in specific data roles at the end of the course.

This paper describes a novel design for an introductory analytics course for undergraduate students at a large public business school in the Southwestern United States. To ensure rigorous course foundations, we implemented the curriculum inspired by the CRISP-DM (CRoss Industry Standard Process for Data Mining) framework; learning assessment is evaluated using Bloom's taxonomy. We share the valuable lessons learned about hybrid learning at scale before and during the pandemic through delivery to almost 10,000 students.

The remainder of this paper details the course design, illustrating the reasoning behind essential design decisions, including the choice to implement a hybrid delivery. It also describes the impact the pandemic had on the course implementation. Finally, the paper concludes with lessons learned and future work.

2. COURSE PHILOSOPHY

We believe that our introductory analytics course presents a unique combination of design and implementation choices. For example, we offer the course in a hybrid delivery mode. Further, the course is relevant to students from different majors with a broad range of interests, backgrounds, and capabilities. An active learning orientation in the course design increases student engagement (Burch et al., 2019; Mann et al., 2020).

Many of our reported course design and implementation choices are not new, for example, using a hybrid delivery mode for an analytics course. However, it is the combination of many design decisions that make our contribution unique; analysis of these choices, the culmination of five years of experience and almost 10,000 students, as reported in this paper, is of value to faculty in similar contexts.

In the following two sections, we discuss how the various design and implementation decisions were resolved. Specifically, in this section, we segment the explanation of the course philosophy into subsections on the development of course content and learning assessment.

2.1 Course Curriculum Development

A tremendous amount of work has been done in designing analytics curricula to meet organizational, and educational needs at various levels of higher education, including graduate degree programs, graduate, and undergraduate major and minor programs of study, as well as a variety of standalone elective graduate and undergraduate courses. Though analytics is a highly cross-functional field, many of these curriculum development efforts have taken place in business schools in general and often in IS departments (Gupta et al., 2015; Schiller et al., 2015; Topi et al., 2010; Wixom et al., 2014; Zhang et al., 2020).

The senior leadership of the Business School projected the critical role that analytics would play in the future, concluding that it needed to be part of the core business curriculum. A cross-disciplinary faculty team confirmed the need through their research and developed the initial curriculum for evaluation by the curriculum committees. The primary objective of the course development was to fulfill the need for a wide variety of roles in an increasingly analytics-rich professional and business environment. The course serves as a launch pad for further discipline-specific analytics courses.

Starting in Fall 2017, the Business School added an introductory level undergraduate analytics course as a required upper division 3-unit credit hour course for any student enrolled in any Business School program. Over the past several years, the system substantially evolved to meet all sorts of challenges and opportunities, including going from full face-to-face synchronous delivery to hybrid delivery beginning in Fall 2019. More than 4,000 learners engage in the course in an academic year. The necessary coordination among the faculty at that scale (with up to a dozen faculty across three departments and three campuses) partially contributed to the hybrid delivery choice.

A series of guiding principles drove many decisions in designing and implementing the course. The first principle was to maximize learning; maximizing learning is not about covering an exhaustive list of topics and extensive assignments but rather choosing which topics and assessments spoke most to introductory analytics, given the constraints of a single three-credit course for a vast audience. This principle led us to consider active and engaging course content and assessment. We bring contributions from faculty across the Business School to introduce analytics in their discipline's context, ensuring an engaging motivation was provided for the course. Furthermore, we use actual data and business cases in labs, assignments, and group work.

The second principle driving our design decisions was the consideration of scale. Educating more than 4,000 students yearly leads to confident, practical choices and obviates others. For example, as the course ramped up from a few sections in the early semesters to more than 50 per year, a significant proportion of the extensive set of assessments had to be automated. This was carefully done to ensure the same level of rigor of the assessment while maintaining the timeliness of the feedback provided.

Finally, the third principle we worked with was ensuring consistency in the design and implementation to provide a similar experience to all learners. With more than 50 sections of the course across as many as a dozen faculty, across three campuses, and several departments, a very high level of consistency is maintained around course content, assessment, etc. In tandem with this principle and to leverage the breadth of faculty knowledge and experience, substantial coordination across groups, including faculty, the IS department, the school administration, and the learning design and support teams, takes place to maintain a high quality yet continuously improving and engaging course.

Guided by these principles, we continue to develop a highly intriguing and engaging introductory analytics course. It includes a low barrier to entry to enable a vast range of student learners to get past the initial motivation challenges associated with "*I have to take this course, as it is required.*" As we find more liberal arts skills in data analytics, such as storytelling and effective communication of data insights, in its current design, the course could also be offered to a broader audience, including undergraduate students from the Arts and Engineering.

2.2 Course Content

Our current design is based on these overall learning objectives:

- What problems can be solved using analytics?
- How do we analyze and find insights with data?
- How can organizations affect the data creation and generation process?
- How do organizations generate, store, and organize data?

Inspired by the CRISP-DM framework for data mining (Chapman et al., 2000; Jaggia et al., 2020), we developed a pedagogical framework for teaching the course, as shown in Figure 1. The CRISP-DM framework is the most comprehensive guiding principle for carrying out analytics projects and developing analytics curricula in higher education. Keeping in mind the scope and limitations of this course, the proposed framework is a modified version of the original CRISP-DM. Our framework includes most of the steps in the CRISP-DM, though not all for our introductory course. For example, we do not use the "Deployment" phase of the CRISP-DM framework as it is not feasible to include it given the nature of the course. The modified framework highlights the interplay between different phases of the analytics process and shows how they collectively contribute to an analytics project. A detailed explanation of each step of the framework follows.

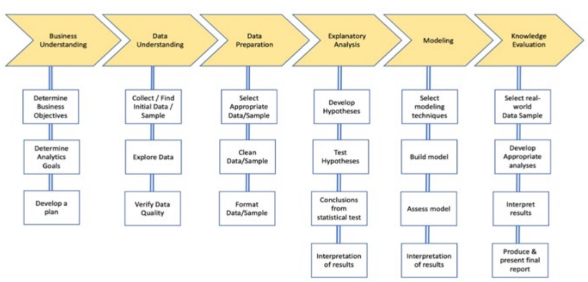

Figure 1. Pedagogical Framework for the Introductory Analytics Course

2.2.1 Step 1: Business Understanding. Students are introduced to various business problems, each with different learning outcomes for which they apply analytical reasoning to solve. This process evaluates the role of multiple business functions and their existing interrelationships. Associated data is typically provided for a specific business problem; in addition, students are taught how they could potentially collect data via surveys and secondary data sources.

2.2.2 Step 2: Data Understanding. Knowledge of data type, data quality, and data insights is crucial at the point where students learn to experiment with exploratory data analysis and data visualizations. We use a more comprehensive range of industry-approved analytics tools than are utilized in Excel-focused courses (Frost et al., 2021), such as Tableau (tableau.com), and JMP Pro (www.jmp.com). The additional tools are just as accessible and have a broader set of data handling and analytical capabilities. When evaluating data for a group project, students are encouraged to have face time with the instructors to receive feedback on their approach to solving their chosen business problems and the corresponding analytics techniques.

2.2.3 Step 3: Data Preparation. In the next phase, students learn how to source clean and pertinent data from the raw data made available to them. In this step, students are taught to use Excel and JMP Pro for various data preparation steps, including data cleaning and transformation for subsequent analyses.

2.2.4 Step 4: Explanatory Analysis. Students are introduced to the foundation of inferential statistics and its applications in real-world problems. A case-based approach to teaching makes applied statistics more engaging to the students in the context of solving business problems. Students learn to develop hypotheses and apply techniques such as t-tests and one-way ANOVA to infer potential explanations for the observed effect in the population. This reinforces their approaches to problem-solving using inferential statistics and developing actionable solutions.

2.2.5 Step 5: Modeling. Next, fundamental problem-solving techniques are introduced, such as model building using the supervised learning approach (linear and logistic regression) and unsupervised learning such as k-Means and hierarchical clustering. Teaching steps followed in this process include (1) identifying the suitable type of model, (2) building regression models using appropriate variables in context, and (3) validating regression model accuracy and predictability. Students articulate and interpret these results to develop innovative solutions for the business problem.

2.2.6 Step 6: Knowledge Evaluation. Hands-on practice of data analytics using these techniques complements the overall approach to problem-solving. With a holistic focus on actionable analytics, how and why organizational data beyond transactional data are collected is also considered, particularly concerning the potential biases in data collection, interpretation, and decision making. Further, we review data ethical issues, including privacy, security, accountability, transparency, and fairness. Towards the end of the course, infusing conceptual knowledge of data storage techniques, big data, and AI builds curiosity and knowledge in the context of value creation for a business.

The proposed framework allows us to integrate the course objectives for students to apply their learned analytics skills to analyze real-world problems using publicly available data (e.g., Kaggle) in a substantive group project.

2.3 Course Learning Assessment

Bloom's Taxonomy has weathered the test of time very well, having been originally published in 1956 (Bloom, 1956), revised in 2002 (Krathwohl, 2002), and widely referenced today. It includes six levels of learning that are aspirational in assessing the depth of learning by participants in a course. Below, we describe how we utilized Bloom's Taxonomy to ensure rigorous and complete coverage of Bloom's six levels of objective educational achievement by the assessments in the course.

2.3.1 Level 1: Remember. Before each session, the online element of the hybrid mix, the conceptual foundations for the module, is delivered via various lecture videos and articles available to the learners; the remembering of the concepts is assessed through an online quiz before each session throughout the semester. It means students do lower cognitive work (knowledge comprehension) before class.

2.3.2 Level 2: Understand. Understanding is more profound than simple memorization and necessitates more reflection and time to absorb the concepts thoroughly. We move beyond the fundamentals to see the application in real-world examples and data. We assess students' comprehension of the subject in a final exam.

2.3.3 Level 3: Apply. Most modules include a hands-on component (labs) using analytics software such as JMP Pro, Excel, and Tableau, where a significant amount of classroom time is devoted to applying the newly learned concepts to reinforce how organizations benefit from analytics. The labs are assessed through weekly applied homework.

2.3.4 Level 4: Analyze. Beyond labs, assignments analyze data from business case situations. These weekly assignments assess critical thinking and students' ability to apply analytical and technical capabilities to solving a real-world problem.

2.3.5 Level 5: Evaluate. Students evaluate business cases and make holistic recommendations. This culminates in a practical exam where business data and problems are addressed by learners using the entire variety of tools and techniques presented in the course to that point.

2.3.6 Level 6: Create. Student teams investigate real-world data and develop actionable recommendations for feedback and evaluation to present to their peers. The learners gain significant experience in the art of storytelling and convince their peers that they have generated solutions of considerable value to a business.

Research suggests a variety of learning outcomes, such as declarative and procedural knowledge acquisition and skill acquisition (Colquitt et al., 2000). Declarative knowledge is often considered the "what" of a topic, the theoretical and conceptual knowledge of that topic. Procedural knowledge can be thought of as the "how" of a topic, as application of declarative knowledge. Skill acquisition involves personal mastery over the "what" and "how" of a topic.

Our current assessment framework includes regular declarative and procedural knowledge acquisition testing, culminating in substantial skill acquisition testing, to design a rigorous and engaging introductory analytics course (Marjanovic, 2012). After about two-thirds of the course, the learning and application up to the practical exam are executed individually. The remainder of the course is where students also work on some of the softer skills as they work in groups to take a more significant and more extensive data set, choose and execute a thorough analysis using the concepts, tools, and techniques learned to that point in the course, and make a presentation of the findings and recommendations in the role of business consultants. Assessment is continuous from the first week to the last; the sequencing of the different assessment categories is shown in Figure 2. The blue-colored parts of each arrow indicate when a particular form of assessment was being applied during the course. For example, the evaluation of procedural knowledge accumulation took place from the beginning of the course through each of the first eight weeks and is represented by the blue arrow stretching to Week 8; skill acquisition developed during that accumulation is assessed in the practical exam administered around week 9 of the course, represented by the short blue arrow.

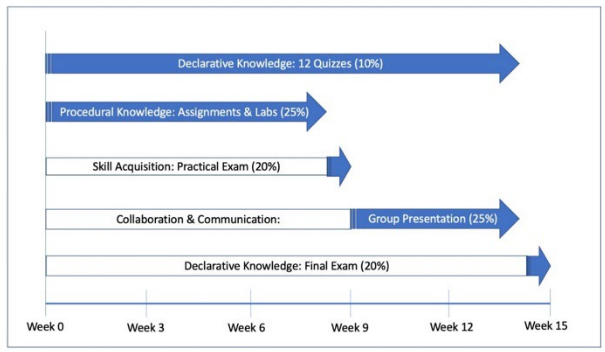

Figure 1: Assessment of Learning for the Introductory Analytics Course

3. COURSE IMPLEMENTATION

We begin by making a tentative plan based on our previous discussion and looking at related issues. We detail two implementation issues with significant course implications: a hybrid course delivery and the unanticipated pandemic's effects.

3.1 Semester Schedule

The appendix presents a 15-week schedule based on the course philosophy described in Section 2. The topics are sequenced in the curriculum based on the modified CRISP-DM framework and assessments discussed in the previous section. The spring 2022 schedule serves as the basis for this tentative outline which is the culmination of several years of content re-alignment, sequence changes, and other improvements, an ongoing process.

The course commences with an introduction to problem-solving using analytics and swiftly covers a broad set of analytical techniques that reinforce the value of analytics in decision-making. Covering these techniques during the early part of the course equips the learners to tackle the challenges they face in preparation for the group presentations (cases) towards the end of the course. A sequence of learning and relearning serves to reinforce the application of analytics that optimizes the educational experience.

Vital support for scale, consistency, and flexibility of implementation across multiple sections, instructors, and campuses is secured via the choice of an appropriate learning management system (LMS). When the course was first offered in Fall 2017, the Business School was using the Blackboard LMS though the wider University was using Canvas. Ultimately, the Business School adopted Canvas, and, starting in Fall 2019, Canvas became the LMS of choice for the Business School and this course. While both LMSs are broadly similar, there were also subtle differences that primarily surfaced in Fall 2019 and were more gracefully implemented subsequently. A feature of Canvas that revealed itself to be essential is the use of a course "blueprint" that enabled us to make course-related changes to the blueprint as needed and push them to the multiple live course sites almost instantaneously.

3.2 Hybrid Delivery

For centuries, the dominant form of learning delivery has been the so-called "chalk and talk" or "sage on the stage" style. Correspondence courses and distance learning have existed for more than a century ("Distance Education," n.d.). The rise of the Internet has furthered delivery mode experimentation and the implementation of viable alternatives to the conventional "chalk and talk" style. The main modes of learning include synchronous delivery ("live"), asynchronous delivery ("recorded"), and various hybrid or blended versions of both.

Hybrid learning captures the benefits of both face-to-face and online instruction and integrates in-person and online content, based on in-person and online education best practices. In hybrid, a substantial portion (between 30-79%) of the course content is delivered online with fewer face-to-face meetings (Allen & Seaman, 2016). Assessments that cover both online and in-person activities are necessary. Despite the face-to-face mode of delivery being generally considered the richest way to learn (Dennis et al., 2008), prior meta-analysis suggests students in hybrid settings had better learning among peers when compared to face-to-face learning (Means et al., 2009). Though that reference is highly cited with thousands of referring papers, it may be considered a little dated (where was Zoom then?); more recent evidence continues to report hybrid delivery adding to learning effectiveness (Noetel et al., 2021; Scaringella et al., 2022; Wang et al., 2022).

Our decision to develop this introductory analytics curriculum in a hybrid format is based on applying the guiding principles of maximizing learning, at scale, and consistently across a range of students and instructors that we established earlier in the course development process. We believe that a hybrid delivery enables us to maximize outcomes on several dimensions outlined below.

3.2.1 Students' Experience. Such an introductory course, like the field of analytics itself, is a recent innovation for Business School curriculums; there was little guidance for incorporating students' interest and passion to inform course design and implementation when we began this five-year odyssey. Therefore, we focused on developing content that would appeal to a wide range of students from a variety of academic backgrounds. We partially achieve this goal by implementing active learning techniques (Prince, 2004) to maintain high and continuous engagement. Many proponents of active learning suggest that the effectiveness of this approach depends on the student's attention span during the lecture, which we see progressively diminishing because of available technological distractions during class. At the same time, instructors with varying experience and abilities to teach with experiential pedagogy could find the task challenging when teaching this course. A shared hybrid platform instantiated through the LMS blueprint is beneficial for maintaining uniformity of students' understanding and overall experiences across sections. It enables us to facilitate most of the first exposure to new conceptual learning outside the class, primarily via lecture videos on the LMS. It then uses the class time for knowledge assimilation and reinforcement through problem-solving, discussions, and hands-on activities.

3.2.2 Flexibility. Adding flexibility to the course delivery method is always a prime design consideration. Several other flexibilities to the hybrid design that we considered are (1) students learning in their time frame, (2) enabling different learning styles, (3) enhancing students understanding of the relationship between concepts and their applications in the real world, and (4) a flipped classroom that encourages students to engage more. In addition, the design choice harbored a flexibility boon in disguise that only materialized when the pandemic resulted in an unprecedented disruption to learning. Transitioning from a hybrid delivery mode to pure synchronous online was relatively easy and seamless, with little additional preparatory effort when the pandemic struck. This enabled a global engagement for the course with students from around the globe, including across the US, Europe, Asia, and the Middle East.

3.2.3 Learning Environment. To succeed, the course must provide an environment where students and teachers can discuss content, exchange ideas, debate, and share their thoughts. A hybrid mode facilitates more engagement in the class and, hence, more overall learning, especially for an analytics course when forming questions about a specific business problem and analyzing to address underlying business challenges. Given the wide range of student preparedness and capabilities, the preference is for the learning environment to be "interactive and engaging," enabling students to learn through discovery and fun. A once-a-week meeting during the course generally proves adequate for students to engage in a conversation and apply the concepts they learned previously from online modules to work by practicing real-world data analytics in each class meeting. In addition, faculty and teaching assistant (TA) office hours close any gap as needed.

3.2.4 Collaborative Knowledge Building. In collaborative knowledge building, group activities are centered around sharing responsibility for learning, distributing expertise, and building on each other's ideas (Hmelo-Silver & Barrows, 2008). With available technologies and applications such as Slack, Google suite, and iClicker, students can collaborate effectively and engage in knowledge building both in and outside the classroom. Combining tools support and in-person interactions multiplies the opportunities for collaborative knowledge building. In addition, faculty can facilitate the experience by monitoring progress and providing appropriate feedback.

3.2.5 Teaching Efficacy. Faculty can be hesitant to teach fully online courses (Guppy et al., 2022). The existence of an apparent gap between students' perceptions and expectations from the subject and providing content on the online platform creates uncertainty that directly affects teaching efficacy. A hybrid design makes it easy for faculty to bridge these gaps while bringing their analytics expertise to the classroom and sharing a unique student experience during the weekly in-person meeting. Students across many sections of this course could then study the same content while experiencing a unique teaching approach from their faculty member.

Our course adds another layer of challenges for faculty when incoming students to this course fall in a broad spectrum of preparation and motivation to be successful in the class. Such diversity could potentially affect teaching efficacy reflected in teaching evaluations. We addressed this problem with a hybrid design choice by providing additional resources (recorded videos, online tutoring by teaching assistants outside the classroom) for students with more significant challenges. With no standard textbook prescribed for the course, the faculty can practice creativity and innovation to individualize teaching and learning. The overall learning outcome can be positive with proper coordination of this introductory course across various sections and a shared course foundation that is evolved and consistently adopted by all faculty.

3.2.6 Sustainability. Though not considered initially as part of the design, given its increasingly pertinent nature, we also considered sustainability. Physically meeting only once each week can imply reducing traveling, parking, and physical space requirements. This course is thus likely to have a lower carbon footprint than comparable face-to-face courses. However, there is little commentary on this topic in the literature. Given the current interest in this topic, more research needs to be done. If we can confirm the hybrid design is better for learning, the sustainability of the design is a further bonus.

3.3 COVID-19 Pandemic

With the onset of the COVID-19 pandemic, the University went from regular in-person instruction to synchronous instruction over Zoom (www.zoom.us). This change was announced at the start of the one-week-long spring break in 2020 and was implemented for the remainder of the spring semester. That style persisted through Fall 2020, Spring 2021, and Summer 2021 semesters with a return to the in-person classroom for the Fall 2021 semester with students and faculty required to wear masks. Almost exactly two years after the initial changes brought about by the pandemic, over the spring break of 2022, in-class learning was changed to mask optional, marking what we hope is the final chapter in returning to "normal." While the pandemic raised significant challenges for educator communities worldwide, we experienced minimal disruption in the course, given the choice of a hybrid format that was already implemented. Moreover, the pandemic provided an environment for further refinement of the design.

To get a sense of how the pandemic changed engagement from in-person class sessions to synchronous but remote Zoom sessions, the map in Figure 3 shows a cross-section sample of 289 students enrolled in Spring 2021 who voluntarily shared their remote location. Whereas an in-person class requires a weekly physical place in the classroom, no such bound existed while the synchronous class meetings occurred over Zoom. Each map dot represents a cluster of students remotely logged in from that location to complete their coursework. There were also a few students based in Europe, none of whom participated in the location sharing.

Weekly synchronous sessions over Zoom replaced in-class meetings where enrolled students in each section joined from their location from anywhere in the world at their respective (local to the University) class section times. Each synchronous session lasted 75 minutes (the same length as an in-class session), was recorded via Zoom, and subsequently shared among students. Doing so benefited many, especially those who could not attend the live class because of a time zone or other conflict, and where they were enabled to review the videos at a convenient time. We performed the weekly hands-on activities (application of data analytics techniques using Excel, JMP Pro, and Tableau) via Zoom sessions. It was engaging as students could ask questions immediately and in parallel for any doubts and technical difficulties. Troubleshooting any technical problems was greatly facilitated via the screen sharing feature of Zoom. Although we observed a decrease in direct student-teacher interaction before, after class, and/or around campus, we also observed an uptick in student content interaction in the learning management system as measured by the average time spent on the learning management system. At mid-semester, we proctored a practical exam during class time via Zoom as a stand-in for doing it in a physical class setting.

Figure 3: Global Engagement by Course Students during the Pandemic

At the beginning of the pandemic-era instruction, there was a heightened concern among students for overall success in the class. Over time, however, their fears subsided when they started to engage in the classroom through attendance and polling features available via Zoom. Students could ask questions via Zoom's private and public chat feature that a fellow student in the class sometimes answered. Discussion and debates in breakout rooms among group members were enriching for many students. It brought an engaging atmosphere during the course. Students could embrace this new teaching method rather quickly because of the user-friendliness and straightforward nature of the Zoom application. The University had an enterprise implementation of Zoom before the pandemic struck, and many of the faculty were already familiar with it. This greatly facilitated the ease with which the faculty pivoted to teaching the course over Zoom, that, in turn, helped lower student anxiety about using Zoom.

4. ROAD FORWARD

In this section, we review the lessons learned from the experience of providing the class to almost 10,000 students over five years and from before, during, and after the pandemic. We also highlight on some of the challenges one could face in the process of developing and implementing such a curriculum in a business school.

4.1 Lessons Learned

Instruction via Zoom is not the same as classroom instruction. We cannot assume that students' behavior remains the same and that they stay focused to the same degree in a virtual room. Recent studies found that it is difficult for students to balance their studies with the pressure of home and work commitments during a crisis such as the pandemic (Jankowski, 2020) and that, despite the increasing ubiquity of online technologies, we may not be ready for online learning (Power et al., 2022). Understanding students' needs is critical; showing empathy throughout the course was essential to boost self-fulfillment among students. A pedagogy that gives importance to students' needs is always a winner, and our experience with this introductory analytics course is no surprise. Online education has found a new face for teachers to get excited about, and the pandemic has provided a unique environment to innovate.

Having a single textbook flex to cater to the entire course's needs is challenging. Ultimately, we chose to develop and use our materials which is a very intensive process though it provided the most flexible environment during course evolution. Another choice with a significant challenge was to use multiple analytics tools (currently including Excel, Tableau, and JMP Pro). While using various tools mirrors real professional and business environments, the technical issues inherent in doing so for a college course are significant. We ultimately chose these three tools for their lower barriers to getting started, shorter learning curves, and existing availability of a site license.

To date, we have observed no significant change in students' performance in terms of final course grades as we went from an in-person hybrid (Fall 2019-first half of Spring 2020) to a Zoom-based hybrid (second half of Spring 2020) and back again to an in-person hybrid (Fall 2021). Moving from an in-person class meeting to a Zoom meeting does not change the synchronicity of the delivery perhaps explaining the lack of any measurable student performance difference in terms of their final course grades. What we do not yet understand is the effect, if any, on longer term learning retention. Nevertheless, as with many aspects of pandemic life, this synchronous Zoom-based mode of instruction has shown significant potential for learning introductory analytics, if not beyond.

4.2 Challenges and Caveats

As with any form of asynchronous learning, such as the hybrid choice we made, a great deal of preparation is necessary to create and deliver high quality asynchronous content and assessments; this is a significant up-front time burden. While the scale helps to spread those efforts, it is nonetheless significant because preparing material for asynchronous consumption requires greater foresight and experience than preparing in person material as the feedback loops usually present in person are absent for asynchronous content.

Perhaps the greatest factor in student success we have observed is in the students' willingness and ability to take on the greater responsibility of working with asynchronous content. Hybrid is still relatively new and can be daunting as a new or unfamiliar mode of learning (Power et al., 2022). Further, while hybrid generally comes with less face-to-face time, some additional support is necessary to catch those unfamiliar to the hybrid challenges or who are struggling with the hybrid mode.

A potential challenge to this course concerns inclusiveness. It is not common at universities to require bringing a personal laptop into the classroom. Classes with significant technical components, such as those discussed here, often occur in computer labs. However, the hybrid delivery mode adopted for this course raised a concern, mainly because many of our institution's students come from lower-income households. Not having the in-person lab sessions in a computer lab, having assessment activities (such as the practical exam) in a classroom not equipped with computers, and requiring the students to use their laptops meant that some proportion of the student body could struggle to effectively participate (Deng & Sun, 2022). With almost 10,000 students having completed the course and laptops being so fundamental to so much college activity, we have had only a handful of situations where this digital divide has arisen. We comfortably handled them by having laptops available to borrow on a short-term basis from the main campus library. We continue to monitor this issue.

We acknowledge that the proposed course design and delivery may not be universally applicable for several reasons. First, a massive factor for a successful offering of our course depends on students' discipline and how they manage time to get the best out of this course. At times, this could be a challenge and distraction for faculty to manage if they are not well equipped with technical knowhow and lack adequate class management skills. Requiring up-to-date technology (computer and Internet) during class and outside the classroom could pose hurdles for some students who struggle to attend school already challenged by poverty and inequality. Finally, while we describe our specific tool choices, this course could be offered with other tools; doing so may warrant modification of the proposed pedagogical and assessment framework.

4.3 Future Work

While a substantial quantity of the previously cited analytics curricula was designed with industrial participation, we intend to complement that work by vetting this design from the student's learning process perspective. We will empirically research the learning process, course engagement, enthusiasm about the course, and analytics in general from the students' perspective. Understanding students' sentiments for this course is also interesting in driving design improvements. We will further leverage the relevant results from these explorations to enhance the design, content, and assessment. Another direction for future development is to further practice inclusiveness by examining relevant case studies and data. As the scale of this course continues to grow, we are investigating the use of AI-enabled tools to assist in the grading and feedback process. Finally, we will develop an advanced version of this course for Honors College students.

5. CONCLUSION

We have successfully designed and delivered an introductory analytics course for all incoming School of Business undergraduates (more than 4,000 per academic year at this point). The course foundation, in terms of content and course assessments, met all design goals and curriculum guidelines for our undergraduate programs. Integrating industry-standard analytics tools into the curriculum complements the learning experience and adds to students' curiosity.

The novelty of this work is that we developed a hybrid course on introductory analytics that we offer at scale, targeted to all business undergraduates. Our course model has proven easy to embrace for onboarding faculty to teach the course with relatively minimal preparation. Also, the integration of accessible analytics tools such as Excel, JMP Pro, and Tableau makes this course unique for students from diverse backgrounds. In addition, faculty coordination enables seasoned faculty to share their valuable experience in successive course evolution. Based on informal student feedback, our design provides self-fulfillment in learning analytics and serves the purpose well. Our explanation can help other faculty in a similar situation.

Our course design and implementation have been battle tested through the pandemic and by thousands of students; it serves well in fulfilling our objectives of maximizing learning across a diverse student body, comfortably handles scale, and can be coordinated with little friction. Those looking to move in similar directions would also be well served in considering the caveats and challenges that arose for us in going this way.

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APPENDIX

Introductory Analytics Course Schedule

Learning Objective	Module	Quiz	Deliverables
	[Intro] Problem Solving & Actionable Analytics		Excel refresher
Performing Analysis & Finding Insights	[Science] Science of Analytics	Science of Analytics	Advanced Excel
	[Visualization] Data Visualization & Interpretation	Data Visualization & Interpretation	Visualization
	[Descriptive] Descriptive Statistics	Descriptive Statistics	Descriptive statistics
	[Inferential] Inferential Statistics	Inferential Statistics	T-tests & ANOVA
	[Regression] Supervised Data Mining	Supervised Data Mining	Linear regression
	[Logistic] Logistic Regression	Logistic Regression	Logistic regression Case 1 Preview
	[Clustering] Unsupervised Data Mining	Unsupervised Data Mining	Clustering; Case 2 Preview
Generating, Organizing & Storing Data	[Transformation] Data Transformation	Data	Practical Exam Review; Case 3 Preview
	[Practical] Practical Exam		In class exam
	[Architecture] Data & Information Architecture	Data & Information Architecture	Case Review
	[Organizations] Experimental Design	Experimental Design	Case 1
Data Collection Strategy	[Biases] Biases & Ethics	Biases & Ethics	Case 2
Analytics in Business	[AI&ML] AI & Machine Learning	Machine learning	Case 3
	[Review] Course Review		Final exam review
	[Final] Final Exam		

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