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Developing a Data Analytics Practicum Course

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Abstract

Data analytics is a rapidly growing field that plays a crucial role in extracting valuable insights from large volumes of data. A data analytics practicum course provides students with hands-on experience in applying data analytics techniques and tools to real-world scenarios. This practicum is intended to serve as a bridge between the student's academic environment and the professional application of their skills in an employment and internship setting. This study examined the design of a data analytics practicum course. The main objectives included (1) the identification of topics and skills employers look for in new hires in data analytics-related internships and entry-level positions, (2) the development and implementation of a Data Analytics practicum course and (3) reflection on the first-time offering of the course and suggested improvements for the next iteration. As part of this study, industry and organization survey responses drove the design of the course and development of key student learning gains for five learning modules throughout the semester. Faculty within the departments of information technology (IT), mathematics, and statistics collaborated in the construction, development, and implementation of team-teaching instructional practices of the Data Analytics Practicum in Spring 2023. This study applies an interdisciplinary approach to data analytics practicum development and instruction.

Keywords: Data analytics, practicum, experiential learning, pedagogy, curriculum development, interdisciplinary

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Developing a Data Analytics Practicum Course

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1. INTRODUCTION

There has been an explosion of data analytics and data science programs at colleges and universities both at the undergraduate and graduate levels in recent years. While the two are different degree programs, they share some similarities but also have some distinctions. "… [B]oth work with data, the main difference lies in what they do with it (Burnham, 2021)." The two disciplines both require data mining, programming languages, statistical analyses, problem solving, and data storytelling (Martin, 2020). Data analysts usually perform typical statistical analyses on larger data sets from numerous fields and make use of business intelligence and data visualization tools (Aasheim et al., 2015; Davenport, 2013; Martin, 2020; Viswanathan, 2014). Data scientists are more likely to devise analytical algorithms, model processes and program code, use machine learning, and evaluate the results and implications to make data-driven decisions. (Aasheim et al., 2015; Burnham, 2021; Dumbill et al., 2013; Martin, 2020; Provost & Fawcett, 2013).

Glassdoor Inc.'s (2022) 50 best jobs in America ranked Data Scientist at #3 and Data Analyst at #35. The Occupational Outlook Handbook shows a projected employment growth for the Data Scientist-related professions of 36% between 2021-2031 (Bureau of Labor Statistics, 2023). The Data Analytics degree program was established at our campus due to the increasing demand for graduates with the requisite skill sets for these positions. The degree consists of eight foundation courses, two elective courses, and three experiential courses. One of the experiential courses is a Practicum in Data Analytics. The intended purpose of the practicum course is to prepare upper-level students, majoring in data analytics, for internship and capstone courses. The practicum offers a unique inter-disciplinary opportunity with faculty from mathematics, statistics, and IT.

The research was conducted at a regional campus of an R1 university in Western Pennsylvania. A review of 26 colleges and universities in Western PA revealed that half have programs in data science and/or data analytics either at the undergraduate and/or graduate levels – with one institution requiring a similar practicum experience, and other schools requiring a capstone and/or an internship experience. The main objectives of this study included (1) the identification of topics and skills employers look for in new hires in data analytics-related internships and entry-level positions, (2) the development and implementation of a Data Analytics practicum course and (3) reflection on the first-time offering of the course and suggested improvements for the next iteration. This study contributes to the literature by identifying need, examining pedagogy, and designing of a practicum in the growing field of data analytics (Hartzel & Ozturk, 2022).

2. LITERATURE REVIEW

Data analytics is a rapidly growing field that plays a crucial role in extracting valuable insights from large volumes of data. A data analytics practicum course provides students with hands-on experience in applying data analytics techniques and tools to real-world scenarios. The practicum experience is intended to serve as a bridge between the student's academic environment and the professional application of their skills in an employment and internship setting. These courses aim to bridge the gap between theory and practice by providing hands-on experience with real-world datasets, enhancing students' proficiency in data analytics tools and technologies, deepening their understanding of various data analysis techniques, fostering critical thinking and problem-solving abilities, and promoting effective communication and presentation skills to convey their findings and insights to stakeholders (Alzen et al., 2022). This literature review aims to explore the existing literature on team-teaching practices and data analytics practicum courses, including their objectives, methodologies, and outcomes to understand the key elements that contribute to an effective and successful learning experience.

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Team Teaching as an Interdisciplinary Approach

Team teaching is a collaborative method of instruction that has been seen in the literature for decades, with many educational researchers expressing its benefits; yet this instructional methodology is not widely prevalent within undergraduate classrooms (Wadkins et al., 2004; Perignat et al., 2023). It has been used successfully in introductory data science, business, and operations management courses (Asamoah et al., 2015; Ducoffe et al., 2006; Hoefle et al., 2020). Teaching a class with a team of teachers and a staff member benefits educators and students alike. Collaboration allows for diverse expertise and perspectives to be incorporated into the teaching process. The collaborative environment fosters creativity and innovation, through brainstorming teaching strategies and development of course materials. Teachers can bring their unique strengths and specialties, enriching the learning experience by offering different teaching styles, approaches, and knowledge (Hurd & Weilbacher, 2017; Wadkins et al., 2004). Team teaching can improve students' critical thinking, problem-solving, and analytical skills (Austin & Baldwin, 1991; Levy et al., 2006; Little & Hoel, 2011; Yellowley & Farmer, 2005). Moreover, having multiple teachers ensures that students receive individualized attention and support, with greater capacity to provide personalized guidance, and to address specific student needs (Hurd & Weilbacher, 2017). This ultimately helps to facilitate student engagement and critical thinking (Perignat et al., 2023; Roland & Jones, 2020).

Additionally, the workload can be distributed amongst teachers, reducing individual stress, and allowing more time and energy to be invested in lesson planning, promoting student engagement, and overall classroom management. Teacher teamwork can enhance professional growth and development through shared experiences, peer observations, and continuous learning (Hurd & Weilbacher, 2017). By leveraging the collective expertise of a team, the teaching quality and effectiveness can be significantly enhanced, resulting in a more comprehensive and rewarding educational experience for everyone involved.

Practicum Experiences

The use of the practicum experience has been described in fields such as education, nursing, psychology, public health, and other areas (Zeichner, 1990; Clarke, 1995; Ryan et al., 1996; Kolaczyk et al., 2021). Although there is not much literature describing the development of data analytics practicum courses (Hartzel & Ozturk, 2022), it is growing. Literature concerning data science curricula/programs (De Vaux et al., 2017) and for business analytics curriculum development (Ceccucci et al., 2020) exists. There have also been recent developments in offering a practicum in statistics in which students serve as external consultants (Kolaczyk et al., 2021; Paloian et al., 2022). The literature about capstone courses and statistical consulting experiences suggests that students benefit from doing real-world project applications under faculty supervision (Martonosi & Williams, 2016; Paloian et al., 2022). Students learn software packages and "soft" skills like communication. Students also learn the workflow or data analysis cycle of a project (Horton, 2015; Paloian et al., 2022). Unlike a capstone course which typically comes at the end of the program, the practicum can come earlier in the program curriculum (Kolaczyk et al., 2021).

Employer Needs

The design of a data analytics curriculum involves the interplay between academics who develop the curricula, the expert practitioners from industry who provide input to academics and write job descriptions (and hire), and the online occupation services platforms whose advertisements provide data about the job skills requirements (Hartzel & Ozturk, 2022). Faculty can use the skills data and practitioners' expertise to develop their program's courses. Due to the multi-disciplinary nature of data science projects (Hartzel & Ozturk, 2022), some schools have their analytics program in the Information Science Department (Chiang et al., 2012); some in the business department (Wymbs, 2016); and other schools have inter-disciplinary programs (Leman, et al., 2015; Havill, 2019), similar to the one in this study.

Pan et al. (2018) surveyed the advisory boards of the Samford University Business School to determine the characteristics and data analytics skills they desire in graduates. The 50 respondents prioritized five broad areas of study as communication with data, spreadsheet, statistics, data management, and software packages. The chief data aptitudes chosen were obtaining relevant data, documenting data, presenting data, and using basic and intermediate spreadsheet skills.

Using web scraping, Almgerbi et al. (2022) identified seven key job market skill sets in the field of data analytics: business intelligence, data engineering, data science, market analysis, machine learning, software development, and project management. These were found to be among the top key words within job postings. Additionally, the authors identified coding, tools for data analytics, application development, statistical modeling, and machine learning were the most common topics introduced in MOOCs (Massive Online Open Courses) in this field. Understanding these high-demand topics can help students focus their skills accordingly. Also, effective communication and presentation skills were found to be crucial in this domain with students being able to facilitate meetings with communication levels comparable to expert statistical collaborators (Çetinkaya-Rundel et al., 2022; Alzen et al., 2023). Therefore, developing communication and presentation skills becomes an important objective of data analytics practicum courses (Almgerbi et al., 2022).

Employers seek individuals for Data Analytics positions with experience in data visualization, data cleaning, linear algebra, calculus and tool usage skillsets with SQL, Python, R, MS Excel, Tableau, SAS, and Spark (Hu & Cleland, 2019; Johnson et al., 2020). Johnson et al. (2020) also found soft skills of communication, presentation, project management, critical thinking, leadership, management, and negotiation to be highly sought by employers. Practicum courses can introduce students to these analytical methods, business intelligence applications, data collection techniques, analysis processes, and analytic tools (Hu & Cleland, 2019).

Practicum Course Design

Data analytics practicum courses serve various objectives, primarily aimed at equipping students with practical skills and knowledge in data analysis. The Columbia University School of Engineering and Applied Science blog (2019) discussed focused skills sought by employees in Data Analytics including data visualization, data cleaning, MATLAB, R, Python, SQL and NoSQL, machine learning, and linear algebra and calculus. Practicum course design, a comprehensive approach to teaching data analytics, involves introducing students to analytical methods, business intelligence applications, MS SQL, data visualization, and individual projects that encompass data collection and analysis processes and tools used within the field of data analytics. Learning processes should be scaffolded, focusing on key topics, and gradually building up to a final project with evaluation based on projects and an examination (Hu & Cleland, 2019).

Cribbs et al. (2020) identified the skills expected for an optimal, student-centered practicum experience include needs assessments, quantitative and qualitative data collection and analysis, quality improvement projects, and de-identified data analyses. Çetinkaya-Rundel et al. (2022) emphasized the importance of incorporating data analysis and presentation skills in practicum courses, highlighting their crucial role in reinforcing concepts and skills. Consequently, including a project component in the data analytics practicum course is suggested.

Tiahrt et al. (2022) changed their traditional introductory information systems course to a data analytics focused course so "students learn the data acquisition–preparation–mining–presentation process in an information-systems setting" by including additional statistical techniques and data analytics tools. Hu and Cleland (2019) designed a first course in Data Analytics and Business Intelligence. This course introduced students to analytical methods, Big Data, Business Intelligence in practice, data analytics, decision-making, exploration of data with emphasis on the usage of Business Intelligence tools such as MS Excel PivotTables, Power View Reports, and MS Power BI applications. The course also made use of MS SQL Server Integrated Services and Reporting.

In summary, the objectives of a data analytics practicum course are to bridge the gap between theory and practice, develop proficiency in data analytics tools, enhance understanding of data analysis techniques, foster critical thinking and problem-solving skills, and promote effective communication and presentation abilities.

Practicum Evaluation

The outcomes and effectiveness of data analytics practicum courses can be assessed through various evaluation methods. The development of evaluation rubrics is crucial in assessing students' writing, oral presentation, and overall communication skills, catering to both statistical experts and laypersons. Students should

demonstrate the ability to critically analyze and interpret data using statistical models and programming skills (Smucker & Bailer, 2015). Additionally, Hu and Cleland (2019) recommend evaluating students based on project development, individual project reports, and exams.

The evaluation of data analytics practicum students can be approached through various methods. First, performance assessment measures students' application of data analytics techniques, their interpretation of results, and their ability to effectively present their findings. This assessment can involve project deliverables, reports, presentations, and demonstrations of technical skills. Second, gathering feedback from stakeholders, such as industry partners or clients who have engaged with student projects, provides valuable insights into the practical relevance and impact of the students' work. Finally, incorporating self-reflection and peer evaluation allows students to reflect on their learning experience and evaluate their peers' performance, facilitating individual growth and assessing the overall effectiveness of the practicum course (Smucker & Bailer, 2015).

The studies referenced in this literature review provide evidence that data analytics practicum courses play a vital role in equipping students with practical skills, knowledge, and experiences in data analysis. By employing project-based learning, collaborative approaches, and industry partnerships, these courses enable students to bridge the gap between theory and practice. Evaluation methods focusing on performance assessment, stakeholder feedback, and self-reflection contribute to measuring the effectiveness and outcomes of the practicum experience.

Continued research in the areas of team teaching, employer needs, and practicum experiences can further enhance the design and implementation of data analytics practicum courses. The current study contributes to the literature in these areas.

3. METHODOLOGY

This study's purpose was to design a data analytics practicum course which meets the needs of local employers and internship sites. A mixed methods approach was used to (1) identify topics and skills employers look for in new hires, (2) develop and implement a Data Analytics practicum course, and (3) reflect on the first-time offering of the course and provide suggestions for improvements for the next iteration. Institutional Review Board approval was received prior to the start of the research study. Surveys administered, module development, and student learning assessments are discussed below.

Community Survey

The development of the Data Analytics Practicum course began with the surveying of local employers to determine the needs for data analysts in Southwestern Pennsylvania. The list of prospective employers was obtained from the Career Services department. The survey included questions concerning industry types, likeliness to hire, data analysis tools used, and desirable skills for incoming interns and/or entry-level hires (see Appendix C). The survey was administered through Qualtrics via email to 156 unique contacts. The contact list was compiled of industries and organizations that had hosted interns from the University within the last five years. Twenty-eight (n=28) responses were received. Survey results were analyzed quantitatively using *SPSS v. 28* software. Responses were used to identify specific skill sets in which employers felt are beneficial for interns and new hires. These results were used to develop a series of modules for a three credit Data Analytics Practicum course.

Module Development

Based on tools and skills identified within the initial community survey, five modules were constructed. These modules introduced career and internship exploration, data ethics, data collection techniques, data cleaning, and data analysis with visualizations. Learning development and skills were evaluated at each module with an assignment that encompassed the main learning goals of each module.

Course Implementation

A three-credit Data Analytics Practicum was team-taught and developed by four faculty members in the Spring Semester 2023 to a small section of upper-level students majoring in Data Analytics (n=4). The faculty consisted of two individuals within the IT Department and two in the Mathematics and Statistics Department, to account for the interdisciplinary nature of the data analytics major. Each faculty member received one-credit remuneration. Once modules were developed, each was co-taught by individuals with expertise in the module's subject area. The course met two times per week for one hour and 15 minutes throughout the semester. Upon completion of each module, students were given an assignment that encompassed the module's content, learning goals, and intended to promote communication and critical thinking

skills. The objectives of the course were incorporated into the syllabus and included: (1) to identify data analysis requirements and solutions (2) to apply data science practices and techniques to analyze extensive data sets, (3) to discuss principles for effective data visualization and apply those principles to real-world problems, (4) to apply ethical standards to data extraction (analysis and visualization), and (5) to effectively communicate project methods and explain results in written and oral form (see Appendix B).

Course Requirements

Assignments were created for each module aimed to prepare students for internship experiences and to help students gain skills required to complete an independent research project. Each assignment encompassed the learning goals relating to each module (1) cleaning data, (2) research question proposal, (3) data analysis proposal, and (4) communication skills development through presentations. Instead of exams, each student gave a presentation about his or her project with formal submissions of executive summaries and research papers. The faculty team evaluated final paper submissions based on developed rubrics focusing on student's introductions, methods for data cleaning, methods for data analysis, result presentations, and conclusions (See Appendix E).

Student Learning Gains Survey

Students from the course completed a final survey at the end of the semester. This survey was administered through Qualtrics and evaluated the learning gains listed above and identified students' perceptions of their own growth in technical and soft skills related to data analytics. Open ended questions allowed students to evaluate the course and provide feedback on areas of improvement for subsequent semesters (see Appendix D).

4. RESULTS

This section presents the findings from the community survey, the development of course modules, and the evaluation of student technical and soft skills.

Community Survey Results

Twenty-eight (n=28) responses were received for the Community Survey. Survey results indicate that many respondents were small businesses/organizations (71.4%) representing non-profit (25%), healthcare (14.2%), information technology (7.2%), entertainment (3.6%), manufacturing (3.6%), government (3.6%), education (3.6%), social services (3.6%), and media (3.6%) industry types. Respondents ranged from mid-level employees to presidents of companies. Of those who responded 10.7% reported their place of employment is extremely likely and 10.7% indicated they are somewhat likely to hire a data analyst within the next two years.

The remaining questions in the survey helped to identify both technical and soft skills employers seek for new hires and interns. Overwhelmingly Microsoft products were identified to be the most used within local industries with 50% of industries identifying Microsoft Excel as their primary database or data mining tools and 10.7 % reporting Microsoft Power BI as their primary data visualization software used by interns and personnel. The full list of responses for mining tools, data visualization software, and coding environments is presented in Table 1.

		Frequency (%)
Database or Data Mining Tools	Access	2 (7.1%)
	Adobe	1 (3.6%)
	Amazon RedShift SQL	1 (3.6%)
	Ceridian/Dayforce	1 (3.6%)
	Excel	14 (50%)
	Microsoft SQL Server	3 (10.7%)
	MySQL	2 (7.1%)
	OPTIMA	1 (3.6%)
	Oracle	1 (3.6%)
	Program Specific Software	1 (3.6%)
Data Visualization Software	Ceridian	1 (3.6%)
	Congos	1 (3.6%)
	Microsoft Power BI	3 (10.7%)
	Tableau	2 (7.1%)
	Unsure	1 (3.6%)
	None	5 (18%)
Coding languages and Environments	Excel	11 (39.3%)
	Java	3 (10.7%)
	Python	2 (7.1%)
	R/R Studio	1 (3.6%)
	SPSS	1 (3.6%)
	SQL	1 (3.6%)
	Visual Studio	2 (7.1%)
	None	2 (7.1%)

Table 1: Community Survey on Tools, Software, and Coding Usage

Survey respondents were also asked which technical and soft skill(s) would be most beneficial for interns or potential applicants to have when beginning a position. Based on this question, data visualization (17.9%) and data cleaning and preparation (17.9%) were found to be the top-ranking technical skills. Many respondents identified soft skills such as critical thinking and problem solving (42.9%), communication (50%), both oral and written, and active listening (35.7%) to be most beneficial. A full list of survey results for technical and soft skills is presented in Table 2.

		Frequency (%)
Technical Skills	Creating Dashboards and Reports	2 (7.1%)
	Data cleaning and Preparation	5 (17.9%)
	Data visualization	5 (17.9%)
	Domain knowledge	2 (7.1%)
	Linear Algebra and Calculus	1 (3.6%)
	Machine Learning	3 (10.7%)
	SSQL and NoSQL	1 (3.6%)
	Statistical knowledge and Programing	2 (7.1%)
Soft Skills	Active Listening	10 (35.7%)
	Communication (Written and Oral)	14 (50%)
	Critical Thinking and Problem solving	12 (42.9%)

Table 2: **Beneficial Technical and Soft Skill(s) for Interns or Potential Applicants**

Practicum Course Development

Based on tools and skills identified within the initial employer survey and literature review, five modules were constructed. These modules introduced themes relating to career and internship exploration, data ethics, data collection techniques, data cleaning, and data analysis with visualizations. Throughout each module, students were allotted time to actively work on projects in which they could have a hands-on experience practicing each concept introduced with faculty present to individually consult as questions arose. Learning development and skills were evaluated with an assignment that encompassed the main learning goals of each module.

The following outlines the 16-week semester and module summaries (see Appendix B):

Week 1: Syllabus and Course Introduction
Week 2-3: Module 1
Week 4-5: Module 2
Week 6-7: Module 3
Week 8-11: Module 4 (including spring break)
Week 11-14: Module 5
Week 15: Independent Project Work
Week 16: Project Presentations (Finals week)

Module 1: Career and Internship Exploration was developed in collaboration with the campus career services to allow students to examine career options, gain experience in resume writing, creation of cover letters, and interviewing. Students gained information about skills, experience, and qualities that employers are seeking in entry-level candidates within the field. After focusing on applicant preparation for one week, each student was also given the opportunity to meet individually with a staff member from the Office of Career Services to discuss any questions or areas of interest they chose for guidance and/or practical application.

Module 2: Data Ethics was developed to give students insight into ethical decision making, reproducibility of data collection/analysis, and responsible reporting. Students were given the opportunity to critically evaluate published works in class, introduced to documentation tools, the importance of documentation and transparency to support ethical conduct, and additional online learning resources and modules.

Module 3: Data Collection was developed to introduce several types of data as well as data resources. This included the evaluation of data resources used by data analysts, common data classifications in statistics, data structures in coding, study design and data collection techniques.

Module 4: Data Cleaning was developed to introduce students to commonly used data cleaning techniques using Microsoft Excel and SPSS. This allowed students to gain hands-on experience with different data formats and with the use of Excel functions and SPSS syntax coding. This module included information on cosmetic cleaning, checking for errors, importing, and exporting various file formats, and recoding variables.

Module 5: Data Analysis was developed to give students an introduction to several types of data analysis and visualization software/tools using SPSS, Excel, Power BI, and Tableau. Students were also introduced to concepts of diagnostic, cognitive, predictive, and prescriptive data analysis techniques.

Final Project: The culmination of the course resulted in a final project to tie together information and skills developed from module 2 through module 5 with faculty mentoring throughout the semester. This project allowed students to gain hands-on experience in completing, writing, and presenting a research project within the field of data analytics.

Student Demographics and Incoming Skills

The Data Analytics practicum was offered in Spring 2023 to the first cohort of data analytic majors (n=4). These students were sophomore level or above. All students had completed or were currently enrolled in introductory courses in information systems, database management, linear algebra, statistics, and regression. Seventy-five percent of the students completed coursework in finite mathematics and principles of data science. Half of the students had completed courses in Python. None of the students had taken elective courses in data visualization or geospatial information systems. The courses listed above are requirements for the major. Incoming students identified prior exposures to Microsoft Excel (75%), Microsoft

Power BI (25%), SPSS (100%), Tableau (50%), and R (100%).

Changes in Student Skills

The final survey measured student perceptions of changes in technical and soft skills from studying the modules in the course (see Appendix D). The course modules supported students learning additional skills with Excel, SPSS, Power BI, and Tableau. Students overall felt the same familiarity, somewhat more familiar, or much more familiar with the mentioned programs based on Likert scaled responses, as seen in Appendix A (Figure 1).

Students' comfort level for each of the measures ranged from feeling neutral on program usage, somewhat comfortable, or extremely comfortable based on Likert scaled responses, as seen in Appendix A (Figure 2).

Students in the course were asked within the final survey to evaluate their own confidence in their abilities to perform tasks such as cleaning data, analyzing data, and presenting research and results. Students overall answered that as a result of the course they viewed their ability had increased (somewhat more or much more) as a result of the learning modules within the course. Complete responses can be seen in Appendix A (Figure 3).

To gain more in-depth understanding and feedback from students about the course, open-ended questions were incorporated into the final survey to allow students to evaluate what aspects of the course were most beneficial and indicate areas of improvement. Student comments indicated that students enjoyed the module aspects of the course and the building of a final project as an iterative process. Students also indicated that the reviews of Excel and SPSS and overviews of Tableau and Power BI were beneficial to further their familiarity and ability to use these programs. Students also identified that they enjoyed the interactive "labs" within each module which furthered their understandings. Students provided feedback that they would like more hands-on examples during class time outside of project work, more time to collectively discuss, and more independent workdays for each module.

5. CONCLUSION

The field of data analytics is experiencing rapid growth and is increasingly important in extracting valuable insights from large amounts of data. A data analytics practicum course offers students a valuable opportunity to gain hands-on experience by applying data analytics techniques and tools to real-world situations. This study focused on designing such a practicum course, aiming to identify the topics and skills sought by employers in data analytics internships and entry-level positions, develop and implement the course, and reflect on its initial offering for future improvements. Results enabled a better understanding of local industry and organization needs in terms of job/internship opportunity growth in Southwestern Pennsylvania. With over 21% of the surveyed companies and organizations indicating their likeliness to hire data analytics-related positions within the next two years, the development of practicum experiences helps to better train students for these opportunities.

Scholarly research in developing a data analytics practicum is in its infancy (Hartzel & Ozturk, 2022), and it is necessary to draw on the studies from related disciplines such as statistics to understand the best practices in this form of pedagogy. A gap exists in the literature as to how to best prepare a student for a data analytics practicum experience, and our study helps to address that gap by providing a tested outline for course design aligned with employer and student expectations and based on similar industry best practices. This study contributes to the literature in terms of the design and implementation of data analytics practicum courses. Practicum experiences help to prepare students for the challenges and opportunities seen within data analytics-related internships and careers. Community Survey results were consistent with literature in terms of sought-after soft and technical skills (Johnson et al., 2020; Tiahrt et al., 2022). Employers need interns who have developed both the analytical capability to analyze data and the knowledge of the commonly used tools to perform that analysis and present the findings. These tools include Microsoft Excel, Tableau, and Power-Bi for small to medium-sized employers.

Since faculty aligned the course with the expectations and needs of employers, students who participate in this practicum will be better prepared for the professional application of their skills in employment and internship settings. The hands-on nature of the practicum allows students to bridge the gap between their academic environment and the practical demands of the work force. This study developed an interdisciplinary, team-taught, module-based data analytics practicum which could be implemented at other undergraduate institutions.

Students benefited from team-teaching as the primary method of instruction. Team-teaching enabled the practicum to cover a diverse, interdisciplinary set of topics. Based on the team-teaching structure, students received individualized support throughout the semester, with hands-on in-class activities, discussions, and project development. The faculty benefited by building a greater rapport with each other and gaining exposure to different teaching techniques and diverse thoughts.

A well-designed data analytics practicum focuses on careers and job types, identifying data sources, analyzing data which includes obtaining and cleaning data, and presenting findings. Using videos, assigned readings, class discussions, and face-to-face lectures, provides the foundation of learning. Individual student projects, using active learning, synthesizes their understanding and prepares them for an internship experience. While this study laid the foundation for the Data Analytics Practicum, there is room for continuous improvement in future iterations. The insights gained from this initial study as well as future data collected can aid future course development, ensuring that the course remains up to date in the growing field of data analytics.

Study Limitations

The primary study limitation involves the use of surveys for data collection so results may not be generalizable. Sample size was a limitation. Of the 156 invited participants for the Community Survey, only 28 unique responses were obtained. These respondents tended to work for small businesses or organizations; therefore, may not be working with large datasets, and may not be representative of all organizations with data analytics needs. The community survey was voluntary and required individuals to self-report based on their own understandings and knowledge which may not have been representative of the company as a whole. Additionally, the first cohort of data analytics majors eligible to take the practicum course consisted of four students. Students were asked to self-report skill development and may have been reluctant to express opinions while currently enrolled in the course and the small class size limited generalizability. Another limitation was that half of the students enrolled in the practicum had not completed all prerequisite courses which required additional instruction to fill gaps in their knowledge. Some additional class periods were needed for the Data Cleaning and Analysis modules and project work.

Future Research

One possibility for future studies is to compare the first offering of the practicum to future offerings, in which students have all prerequisite courses completed. Future research is also needed focusing on the pedagogy and implementation of data analytics practicum experiences in larger classrooms. Longitudinal studies could aid in gaining a better understanding of the benefits of a practicum course on student's internship experiences and provide additional suggestions for course revisions for future offerings. Additionally, a pre- and post-test assessment of confidence and knowledge in subject areas introduced in the practicum could be used to better assess knowledge gained throughout the course.

6. ACKNOWLEDGEMENTS

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Appendix A
Figures from Practicum Final Survey Data

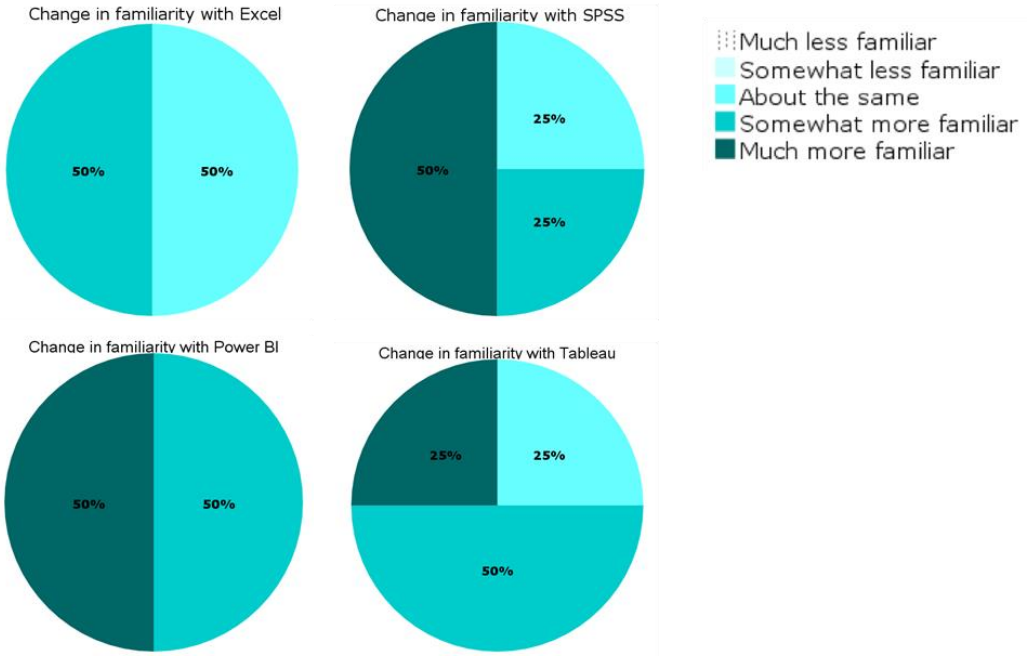

Figure 1: Changes in Familiarity with Tools

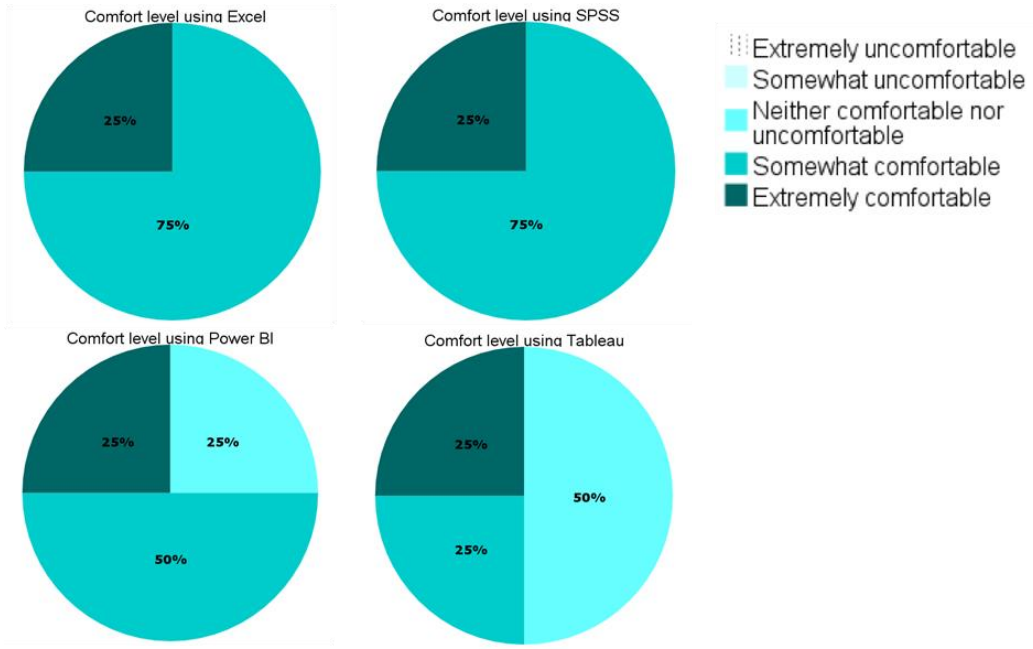

Figure 2: Changes in Comfort with Tool Usage

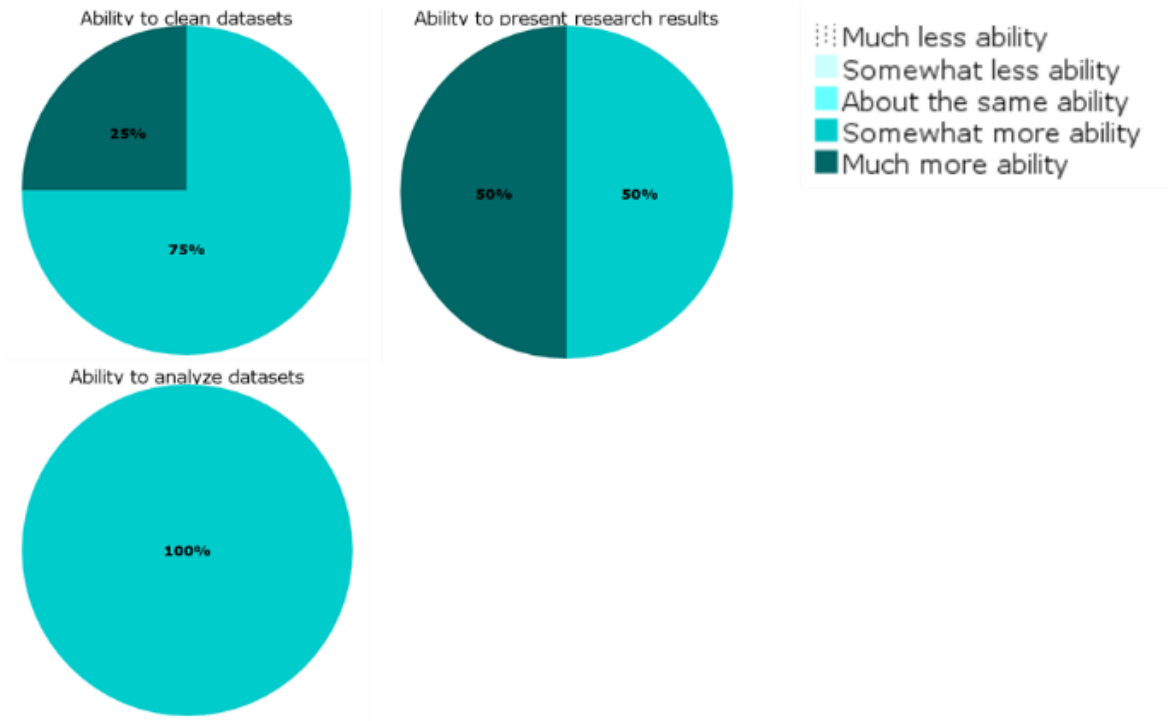

Figure 3: Student Self-reported Changes in Ability (Skills)

Appendix B
Example Course Syllabus

Data Analytics Practicum

Spring 2023

Class Meeting: MW 3:00PM – 4:15PM Classroom: Powers Hall 120

Instructors:

Dr. Neelima Bhatnagar:
E-mail: bhatnagr@pitt.edu
Office Hours: *by appointment**
Office: Powers Hall 124

Dr. Victoria Causer:
Email: vdc5@pitt.edu
Office Hours: *by appointment**
Office: Powers Hall 127

Dr. Michael Lucci:
Email: mlucci@pitt.edu
Office Hours: *by appointment**
Office: Cassell Hall 237

Prof. Michael Pry:
Email: mip84@pitt.edu
Office Hours: *by appointment**
Office: FOB 105

*You can also schedule other office hours with any instructor through email.

Course Description

Students will be introduced to learning modules, based on various topics in data analytics, in preparation for projects, internships, or job experiences. Students will develop the skills necessary to understand, interpret, and analyze data based on multi-disciplinary approaches in data analytics.

Data Science Practicum (PREQ: Regression, Python, Database management systems) is to be completed prior to completion of junior year.

Required Materials

All materials will be provided by instructors and posted on canvas.

Software used in class is available through The University's Virtual Lab and available for download using the Software Download Service.

Course Objectives

Upon successful completion of this course, the student will be able to:

- Identify data analysis requirements and solutions. i.e., what decisions need to be made, what data is available to help, how should data be presented?
- Apply data science practices and techniques to analyze extensive data sets.
- Discuss principles for effective data visualization and apply those principles to real-world problems.
- Apply ethical standards to data extraction (analysis and visualization) and communicate results.
- Effectively communicate project methods and explain results in written and oral form

Course Requirements & Grading

- Attend class and be on time.
- Participate in class discussions and activities.
- Complete learning modules and corresponding assignments.
- Complete final project.

Final course grades will be assigned based on the percentages listed below.

Course Assignment	Weight
Attendance and Participation	10%
Module 1	15%
Module 2	15%
Module 3	15%
Module 4	15%
Module 5	15%
Final Project	15%
Total	**100**%

The scale used to calculate the final course grade is as follows (based on overall percent):

A+: 100 A: 93-99 A-: 90-92	B+: 87-89 B: 83-86 B-: 80-82	C+: 77-79 C: 73-76 C-: 70-72	D+: 67-69 D: 63-66 D-: 60-62	F: 0-59

Modules and Assignments

INFSC 1851 and STAT 1851 are cross listed as a requirement for the Data Analytics Major. This practicum will be organized into modules which introduce students to interdisciplinary topics and programing in statistics and information science that will be beneficial for internships and capstone.

The following modules will be covered throughout the semester (more details are provided in the tentative schedule). Each module will have corresponding assignment(s) that reinforce concepts introduced in class. Rubrics and descriptions for assignments will be provided throughout the semester.

- **Module 1: Career and Internship Exploration**
- **Module 2: Data Ethics**
- **Module 3: Data Collection**
- **Module 4: Data Cleaning**
- **Module 5: Data Analysis Miscellaneous concepts**
- **Final Project: Paper and presentation**

Weekly Schedule & Due Dates

Week	Date	Class	Assignment Due	Faculty
1	M Jan 9	Syllabus and Introductions		All
	W Jan 11	Data Analytics v. Data Science		All
2	M Jan 16	MLK Day - No classes		
	W Jan 18	Module 1: Career and Internship Exploration Resumes & Cover letters		IT/Career Services
3	M Jan 23	Interviewing, Networking, & Professionalism		IT/Career Services
	W Jan 25	Class time for individual appointments	Career Service Appointments	
4	M Jan 30	Module 2: Data Ethics LinkedIn Learning	Resume, Career Assignment	IT/STAT
	W Feb 1	LinkedIn Learning		IT/STAT

5	M Feb 6	Reproducibility & Responsible reporting		STAT
	W Feb 8	Documentation of Study		STAT
6	M Feb 13	Module 3: Data Collection Types of Data	Executive Summary	IT/STAT
	W Feb 15	Data Resources, Project Ideas, & Examples		IT/STAT
7	M Feb 20	Project development work		IT/STAT
	W Feb 22	Project Proposal Presentations	Proposal Presentations	All
8	M Feb 27	Module 4: Data Cleaning Lab 1 Excel		STAT
	W Mar 1	Lab 2 SPSS		STAT
9	Mar 5- Mar 12 Spring Break – No classes			
10	M Mar 13	Project Data work		STAT
	W Mar 15	Module 5: Types of Data Analysis	Clean Data and Summary	IT
11	M Mar 20	DA tools		All
	W Mar 22	Data Analysis Techniques		STAT
12	M Mar 27	Data Analysis Techniques		STAT
	W Mar 29	Lab 1 (SPSS)		STAT
13	M Apr 3	Lab 2 (Excel)		STAT
	W Apr 5	Lab 3 (Power BI)		IT
14	M Apr 10	Lab 4 (Tableau)	Analysis Plan	IT
	W Apr 12	Module 5: Project work		All
15	M Apr 17	Module 5: Project work		All
	W Apr 19	Module 5: Project work		All

Appendix C
Community Survey Questions

Data Analytics Skills Practicum Study

Q2 Which of the following categories best represent(s) your organization? (Select all that apply)
Business
Healthcare
Entertainment
Manufacturing
Government
Information technology
Software Development
Education
Social Services
Non-Profit
Other (Please list)

Q3 Which of the following categories best describes the organization you work for?
Small business (Less than 1500 employees)
Mid-market enterprise (1500 to 2000 employees)
Large enterprise (More than 2000 employees)
Other (Please list)

Q4 What is your current relationship to your organization?
Entry-Level
Mid-level Employee
Manager
Director
Vice-President
Chief Executive Officer
Chairperson and/or Board of Directors
Other (Please list)

Q5 Which of the following categories best describes your organization's likeliness to hire a data analyst type position within the next 2 years?
Extremely unlikely
Somewhat unlikely
Neither likely nor unlikely
Somewhat likely
Extremely likely

Q6 Which of the following Database or Data Mining Tools do your Data Analytics interns/personnel use? (Select all that apply)
Access
Excel
Microsoft SQL Server
Oracle
MySQL
Other (Please list)

Q7 Which of the following Data Visualization Software do your Data Analytic interns/personnel use? Please select all that apply.
Apache Spark
Cognos
ElasticSearch
Graphana
Kibana
Logstash

Microsoft Power BI
QuikTech QuickView
Tableau Software
TIBCO Spotfire
Other (please enter)

Q8 Which of these coding languages/environments do your Data Analytics interns/personnel use? Please select all that apply.
Java
Python
R / RStudio
SAS
SPSS
Visual Studio
Excel
Other (please enter)

Q9 Which of the following do you believe are the most beneficial technical and soft skill(s) for interns or potential applicants to have when beginning a position? (Select all that apply)
Data Visualization
Data Cleaning and preparation
Statistical knowledge and Programing
SQL and NoSQL
Machine Learning
Linear Algebra and Calculus
Creating dashboards and Reports
Critical Thinking and Problem Solving
Communication (Written and Oral)
Active listening
Domain knowledge
Other (Please list)

Appendix D
Student Learning Gains Survey Questions

Data Analytics Practicum Final Survey

Q1 Prior to starting practicum, which of the following computer software packages were you familiar with? (Check all that apply.)
Microsoft Excel
Power BI
SPSS
SAS
Tableau
R
Other (please list)

Q2 Based on experience in this class, which of the following describes your overall change in familiarity with Excel?
Much less familiar
Somewhat less familiar
About the same
Somewhat more familiar
Much more familiar

Q3 Based on experience in this class, which of the following describes your overall comfort level using Excel?
Extremely uncomfortable
Somewhat uncomfortable
Neither comfortable nor uncomfortable
Somewhat comfortable
Extremely comfortable

Q4 Based on experience in this class, which of the following describes your overall change in familiarity with SPSS?
Much less familiar
Somewhat less familiar
About the same
Somewhat more familiar
Much more familiar

Q5 Based on experience in this class, which of the following describes your overall comfort level using SPSS?
Extremely uncomfortable
Somewhat uncomfortable
Neither comfortable nor uncomfortable
Somewhat comfortable
Extremely comfortable

Q6 Based on experience in this class, which of the following describes your overall change in familiarity with Power BI?

Much less familiar
Somewhat less familiar
About the same
Somewhat more familiar
Much more familiar

Q7 Based on experience in this class, which of the following describes your overall comfort level using Power BI?

Extremely uncomfortable
Somewhat uncomfortable
Neither comfortable nor uncomfortable
Somewhat comfortable
Extremely comfortable

Q8 Based on experience in this class, which of the following describes your overall change in familiarity with Tableau?
Much less familiar
Somewhat less familiar
About the same
Somewhat more familiar
Much more familiar

Q9 Based on experience in this class, which of the following describes your overall comfort level using Tableau?
Extremely uncomfortable
Somewhat uncomfortable
Neither comfortable nor uncomfortable
Somewhat comfortable
Extremely comfortable

Q10 Based on experience in this class, which of the following describes your overall change in comfort of your ability to clean datasets?
Much less comfortable/able
Somewhat less comfortable/able
About the same comfort/ability
Somewhat more comfortable/able
Much more comfortable/able

Q11 Based on experience in this class, which of the following describes your overall change in comfort of your ability to analyze datasets?

Much less comfortable/able
Somewhat less comfortable/able
About the same comfort/ability
Somewhat more comfortable/able
Much more comfortable/able

Q12 Based on experience in this class, which of the following describes your overall change in comfort of your ability to present research results?

Much less comfortable/able
Somewhat less comfortable/able
About the same comfort/ability
Somewhat more comfortable/able
Much more comfortable/able

Q13 Which aspects of practicum do you feel were most beneficial in your preparation for the work force and why?

Q14 Do you have any suggestions to improve the course?

Appendix E
Final Project Description and Rubric

Project Description:

The final paper should **tie all the previous assignments together** as a formalized paper. The final paper should be in APA format (formatting and citations), written in third person, and make use of proper grammar and full sentences.

The report should include the following sections:

- **Introduction:**
  - Describe the topic you are examining (include 2-3 references)
  - Purpose of project/Research question
- **Data description (Module 3)**
  - Where data was found
  - Variables included
  - Variable description
- **Data cleaning (Module 4)**
  - Program(s) used to clean
  - Process of cleaning
  - Description of dataset used for analysis
- **Data Analysis (Module 5)**
  - Program(s) used to analyze
  - Description of analysis (e.g., Descriptive statistics, formal tests, visualizations)
- **Results:**
  - Tables and visualizations resulting from analysis
  - Include titles for tables and figures using APA formatting
- **Discussion/Conclusion:**
  - Description of results tables and figures
  - What do the results mean with respect to research question(s)?
- **References**

Grading Rubric:

Criteria	Ratings				Pts
Introduction	**5 pts Full Marks** Proper use of sources and description of research topic. Clear research question. Use of 2-3 sources. Use of full sentences with no/minor grammatical errors.	**3 pts Partial** More detail needed to explain research area. Did not include 2-3 sources. Clear research question.	**1 pts Partial** Only contains research question	**0 pts No Marks** Missing	/5 pts

Criteria	Ratings				Pts
Data **Description**	**5 pts Full Marks** Detailed data description. Contains information on sources of data, variables included, and variable description.	**3 pts Partial** More detail needed. Only describes two of three pieces of information	**1 pts Partial** More details needed. Focus only on one aspect of the information that was to be listed.	**0 pts No Marks** Missing	/5 pts
Data **Cleaning**	**10 pts Full Marks** Fully describes the data cleaning process including program(s) used, process, and clean dataset description used for analysis. Written using full sentences and proper grammar.	**8 pts Partial** More details needed to describe data cleaning process including program(s) used, process, and clean dataset description used for analysis (e.g. only discussing two of three items).	**6 pts Partial** Bulleted points. Section not written using full sentences and proper grammar.	**3 pts Partial** Bulleted points. Missing some aspects of section.	**0 pts No Marks** Missing	/10 pts
Data **Analysis**	**10 pts Full Marks**	**5 pts Partial**	**3 pts Partial**	**0 pts No Marks**	/10 pts

Criteria	Ratings				Pts
Results	**10 pts** **Full Marks** Tables and visualizations resulting from analysis Included titles for tables and figures using APA formatting.	**7 pts** **Partial** Tables and visualizations resulting from analysis Does not include titles for tables and figures using APA formatting	**5 pts** **Partial** All results not presented	**0 pts** **No Marks** Missing	/10 pts
Discussion**/Conclusion**	**10 pts** **Full Marks** Full explanations of results tables and figures. Clearly described what results mean in respect to research question. Use of full sentences and proper grammar.	**8 pts** **Partial** Some confusion on interpretation of results tables and figures. Clearly described what results mean in respect to research question.	**6 pts** **Partial** Some misinterpretations of results tables and figures. Some confusion on what results mean in respect to research question.	**3 pts** **Partial** More explanation needed. Does not relate results back to research question.	**0 pts** **No Marks** Missing	/10 pts
Total Points: _____/50					