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In this issue:

We're happy to have another great group of papers, along with a teaching case and a teaching exercise. The general theme of the issue is the broad topic of student skills – skills that our employers want, skills that our students are seeking, and skills that will serve as foundations for helping our students to become great IS practitioners, as well as great future educators. This focusing on skills for both Computer Science and Business courses, leveraging concepts from IS, assessing mobile learning and skill development, and learning design and development, robotic process automation, and Internet of Things. Never a dull moment in the IS community, and there's more to come!

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INFORMATION SYSTEMS EDUCATION JOURNAL

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Enhancing Learning in Business Education Utilizing Project Management Practice and Skills

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Abstract

While industries compete to hire capable employees, it is essential that business education curriculum delivers graduates who can solve complex problems and implement multifaceted solutions. This approach to curriculum design focuses on developing project management skills to deliver an integrated, student-centered methodology across multiple disciplines. The development of undergraduate curriculum with a project management approach provides a framework centered on developing essential career skills in critical thinking, decision-making, and problem-solving.

Keywords: business education, project management, curriculum development, student-centered learning, project-based instruction

1. INTRODUCTION

As industry demands trained knowledge workers who can synthesize data, think critically, and develop solutions, undergraduate curriculum must evolve (Rocca, 2010). A well-designed undergraduate curriculum within a dynamic and rapidly evolving industry supports student recruitment, program reputation, and prepares students for careers (Thai, De Wever, & Valcke,

2017). Coupled with employer expectations, current students demand higher levels of engagement and practical classroom experiences. Undergraduate curriculum founded on active student-centered learning can meet this need and deliver increased problem solving, stronger critical thinking, and more developed organizational skills (Rocca, 2010; Vandenhouten, Groessl & Levintova, 2017). Project management skills development can help support embedding industry tested methodology into curriculum. This can help to provide a set of principles to explain process and structure into course design assignments (Morrison, Ross, & Kemp, 2005). Implementing skills development and project management processes can help faculty develop interactive, and well-designed courses.

Curriculum development throughout undergraduate education has not done enough to leverage the innovation of project management practice and skills development across undergraduate curriculum. Our goal is to share an approach utilized effectively in our own curriculum redesign process. We believe that this advancement in the curriculum will better serve business students' needs and provide structure to project work across the curriculum. In our classroom, students can often struggle with basic introductory project management processes. While certain departments such as CIS and Management offer foundational project management-specific courses, we have surveyed students in introductory courses and capstone courses to determine the overall increase in their project management skill and application. We propose that integrating project management practice should be included across the core business curriculum. As evidenced by recent survey collections, it is imperative that we provide foundational project management skills development, earlier in our curriculum starting with first-year business core curriculum. Foundational applications of project management methodologies can be applied consistently throughout student course work and team projects. Information Systems and Management programs can be instrumental in helping to provide context and training by offering fundamentals of project management class options via general education requirements to benefit students across disciplines. The time has come to breakdown silos and expand curriculum access so students across majors can gain these critical skills that apply to all professions and industries.

Project management allocates setting goals and meeting due dates. Emerging time management practices can increase student efficiency and desired outcomes. In this ever-evolving workplace, enhancing communication skills would benefit students and employers. Communication within a project team is essential to project success. Iterative project management practices such as Agile are helping project managers provide benefits throughout the project's lifecycle. This trend is becoming relevant for students to understand and value as project management practice evolves. If faculty do not stay current with industry practices, we feel there is a disservice to our students' future applications.

Project management practice often encompasses recognizing and addressing real-world problems. Project management includes working with a team of various subject matter experts to complete a common goal. Students can advance skills to understand several aspects of project work such as managing deadlines, allocation of specific resources, the value of time, and the impact on budgets and cost.

Overall, improvement of project management skills in undergraduate curriculum, across multiple disciplines (not just computer information systems or business) can support students in both academic and professional growth. They can also develop valuable and marketable skills that will be useful in their future careers (Karanja & Grant, 2020).

Additionally, recent project management trends indicate we should continue to focus on education related to developing interpersonal skills essential to project management practice. Creating curriculum that includes team-based leadership exercises can help develop these skills. Experiential learning project-based assignments should be integrated consistently across the entire undergraduate degree program to improve curriculum and to more effectively train students to adapt and thrive amidst common business disruptions. Karanja and Grant (2020) also stressed the importance of real-world project management assessments.

2. LITERATURE REVIEW

As research has identified, pedagogy must align with employer expectations of graduate skills (Daniel, 2012). There is a growing demand for project management courses that prepare graduates with skills in professional communication, critical thinking, collaborative problem-solving, and critical reflection (Gharaie &

Wingrove, 2020). Business classrooms allow students to engage in an applied approach to active learning both online and in-person (Martin & Bolliger, 2018) which can further increase knowledge through application, engagement, and problem-based learning. Students must explore challenges using data to find the root cause analysis, generate ideas, allocate resources, and provide innovative solutions while understanding project management practices (Eckhardt, 2018). Utilizing project management fundamentals can help them do this.

These skills are particularly important in a business school, where assessment and accreditation factors measure course learning outcomes and course design (Currie, 2017). Using project management methodology in curriculum can increase strategic and critical analysis skills. Students learn and apply knowledge to gain an appreciation for the proposed gap between theory and overall application and include critical thinking and strategy into their mindset (Dirksen, 2015). Reducing cognitive load can assist in knowledge and skill retention and application (Doyle & Zakrajsek, 2018).

The use of evidence-based pedagogies to inform practical business application in the classroom enhances engagement and relevance (Mitchell, 2016), while leveraging the expertise of faculty and providing structure and support to students (Dirksen, 2015). Project management skill development and the use of appropriate tools provides an opportunity to enhance structure and application of methodologies that are empirically supported practices in industry. The integration of industry skills and problem-based pedagogy prepares graduates to successfully transition from the rigor of the academic environment to the modern expectations of the business world (Ewing & Ewing, 2017). Linking course learning outcomes to industry requirements is essential and should be ongoing in course design (Dirksen, 2015). However, curriculum must continuously evolve, and this link should be revisited regularly to address ongoing organizational changes and industry disruptions while providing an efficient, cohesive, and holistic structure (Nisula & Pekkola, 2018).

While hands-on, business focused problem solving that transfers into real world scenarios is commonplace and expected in the classroom (Echkardt & Wetherbe, 2016; Ewing & Ewing, 2017), a project-based pedagogy supports academic rigor in the business curriculum and provides students with a platform to apply their program learning as they prepare for the workplace (McNamara, 2009; Vieregger & Bryant, 2019). Rosenbaum, Otalora, and Ramírez (2015) suggest that addressing challenges to learning can be complex and, "although practitioners want to hire new employees with the ability to solve real-world problems, a pertinent question to address is the best method for heeding their request" (p. 183). Through thoughtfully designed real-world projects, students can demonstrate critical thinking and adaptability in evaluating business problems and determining the most feasible solutions (Seow et al., 2019).

To develop a curriculum that increases higher-order thinking, students must be exposed to the application of how to investigate organizations, apply knowledge to problem-solving, establish ideas, and produce creative solutions to problems identified (Pellegrino & Hilton, 2012). In addition, encouraging students to organize team projects using project management methodologies provides them with the experience to increase critical thinking and problem-solving skills while fully investing in learning the course material beyond just memorization (Kuh, 2008). They must also have opportunities to reflect on actions with their team members, which affirms the skills developed during the learning process and provides opportunities for critical personal reflection and enhanced self-awareness (Perusso et al., 2020). These reflective practices lay the groundwork for the self-efficacy and change-making skills necessary for business professionals (Perusso et al., 2020).

Students that improve project management skills can identify and address problems as they arise instead of finding errors at the end. Learning these skills in an undergraduate business curriculum will help individuals to become more proactive and better at decision-making. Understanding scope management, along with project management process will help students with future workplace application (Salapatas, 2000). In addition, communication skills and enhancement of team dynamics will increase workplace efficiencies.

Our curriculum integrates consistent project management tools integrated into each course project, supporting literature that underscores the importance of real-world alignment between course projects and industry standards. For example, successful project managers seek support from the Project Management Institute (PMI) for fundamental, foundational tools and resources to aid in the execution of projects. PMI is an international project management

organization that delivers guidelines, resources, networking opportunities and best practices for the project management field. Our faculty are actively engaged in working with PMI to support the development of experiential learning activities, exposure to industry speakers, and providing guidance on careers in the project management field. In addition, the Project Management Book of Knowledge (PMBOK) is a valuable resource that explains the value of project management structure, guidelines, and practices. This guide is valuable for faculty to utilize when enhancing the curriculum and introducing students to industry standards.

To complement the tools that they are exposed to while engaging in course projects, we encourage students to seek professional certifications in project management, such as the Certified Associate Project Management (CAPM), and Project Management Professional (PMP) certifications offered by PMI. These certifications tie industry standards to the overall learning experience. While PMP certifications require extensive project experience, understanding the competency requirements can help students to build project experience and track hours for future certification testing requirements.

3. PROJECT MANAGEMENT PROCESS

Our aim is to enhance project management-based learning and curriculum development across our school. For the project deliverables, students demonstrate proficiency and the ability to use credible research to solve ongoing challenges. We propose that the integration of project management skill integration, fueled by innovation and critical strategic analysis, can lead to an increase in problem-solving capabilities for students. We monitor learning outcomes within projects related to problem definition, the innovation of ideas and challenges, and problem-solving in business and consulting using an applied approach.

This paper outlines a structure to integrate project management processes into course design. Project management applications in pedagogical design can further increase effective collaborations and relationships with industry leaders and support cross-functional, interdisciplinary curriculum. Our approach addresses the needs of employers and the relevance for graduate application and future employability.

4. METHODOLOGY

Student Feedback Survey

To determine the level of project management awareness and skill development present in undergraduate business students, we collected online survey data regarding project management experience and skills from 185 undergraduate students at a medium-sized private university. No identifying data was collected, and participation was voluntary. Students were invited to participate in the survey via email and recruited from two business core classes and one senior-level course and included various majors (e.g., international business, finance, supply chain, human resources, accounting, marketing, business analytics, management, entrepreneurship, CIS, and business minors with majors from across the university). Survey items can be found in the Appendix. 30.3% were first years, 27.6% were sophomores, 21.1% were juniors, and 21.1% were seniors. Sixty percent of respondents had never taken courses or workshops regarding time management, resource allocation, budgeting, or project management. Of those who did, 21.8% had taken only a general introduction. 50.3% reported wanting to see more project management content in their courses. When asked if they were implementing project management skills such as time management, scope organization, milestone schedules, risk management, etc., 55.7% reported they were in their class projects; 20% said they were in their student organizations; 10.3% reported they were in their internships; and 15.7% reported they were in their jobs. On a Likert scale from 1 (none) - 6 (expert), 73% of respondents rated a 3 or 4. When it came to utilizing a project management charter or contract in their classes, 48.9% had never used one whereas 75.1% reported using a project schedule or plan; 76.2% had never used a project schedule software or tool; and 79.9% had never used a project scope statement.

Course Design

Our course design methodology is based on the convincing argument that academia must look at education from a different mindset, one that can implement practical applications across multiple disciplines. Not only do we need to implement project management consistently throughout our curriculum, but we must help other disciplines to see the value. Our unique contribution is to utilize a consistent experiential approach based on project work to deliver curriculum consistently across an entire program. In our approach, we first identified ways to enhance our courses by applying project management principles within

course design. Second, our project approach provides an opportunity to implement the project management process into undergraduate education. Third, by recognizing the importance of skill applicability, there could be an increase in employability factors relevant for our graduates. Fourth, we find that project management skill development provides a realistic, structured approach to in-class problem-solving that helps to make solutions real-world feasible.

When building course projects, students should understand expectations, have clear project learning goals, and be able to retain foundational project management skills for future application. Project planning requirements include developing an understanding of the scope of work to be completed. This consists of students understanding the role that project management plays in using structure to increase efficiency and outcomes. To this end, we utilize project-based assignments that mimic industry workloads and ask student teams to work with clients preparing written deliverables and client presentations. Teams learn the value of documentation of lessons learned and reflect upon the importance of understanding team dynamics and execution of work.

Project Assignment Details

In this section, we provide sample project descriptions used in our courses to train project management skills, allowing students to apply that knowledge in practice.

Project Management Methods

The goals and outcomes of the student's project work include:

Creating the project team and establishing a team charter. The team charter identifies rules, norms, and expectations. The team charter aligns the project goals with a clear understanding of roles and points of contact. Best practices could include insight into the value of the change control process, use of status reports, or analyzing risk mitigation plans to keep projects on track.

There is an opportunity to use project management techniques to create a project plan and to schedule project activities with deliverables and due dates. Often scheduling software can assist with tracking deliverables and may be covered throughout multiple courses.

Defining the project scope and boundaries becomes a critical component of the project plan. While this is not a new practice, understanding the parameters necessary to keep the scope from changing will help students value scope management practice. While our students have been exposed to the topic of scope management, many did not appear to retain the introductory content that was introduced in some of the core classes.

Students could benefit from analyzing the work involved in the project plan and integration of a work breakdown structure (WBS). The WBS can help students by breaking down tasks associated with the work and breaking it down into smaller, more manageable parts of work activities. When leading projects, using a WBS could help facilitate a more organized approach to fulfilling the tasks.

Once the project is completed, it is recommended to review the results and close the project. Documentation of lessons learned throughout the project will help with overall project execution in the future. This data can be stored in a repository for future project use. We have encouraged our students to learn from each project experience to enhance their project leadership potential.

Project Examples:

Introductory Management Project Based Work

Students participate in management consulting teams. The teams review assigned businesses experiencing challenges. Students are evaluated on their ability to demonstrate knowledge and evaluation of management philosophies as they relate to quality indicators such as identifying a problem or challenge, research of balanced scorecard, understanding competitors including benchmarking, and financial statistics outlined in an executive summary. Framing the problem is the foundation of the course project and is part of the project management scope statement. In the introductory management course, students review specific company research and metrics by benchmarking against industry competition. Students identify the top challenges and outline research-supported plans to overcome those challenges.

Operations and Supply Chain Project Based Work

The project analysis piece in coursework focuses on identifying and analyzing the supply chain operations of a particular company. Students then use data and research to provide managerial insights. They then apply concepts developed in class to evaluate and make recommendations. Students are held accountable using the project management planning and scheduling tools outlined above to improve team tasks and

processes. The transferrable skills that are developed provide a solid foundation for success in the future.

Senior Seminar Project-Based Work

While students are asked to think critically about several businesses, they apply their management program learning outcomes. As students engage in project-based work, support and direction are provided by instructors through the course structure and design, alignment to program learning outcomes, and the creation of a student-centered environment for problem-based learning. The project work uses several smaller assignments where students recall their learning to show subject understanding in preparation for a final real-world project.

Students are given the chance to present their learning in a presentation requiring student teams to organize and communicate on a specific management curriculum subject area. These areas include forecasting, data analysis for production demand or inventory control, quality standard and defect analysis, bottlenecks and process improvements, product and team performance issues, ethics compliance, employee retention, staffing, sourcing, recruitment, selection, and human resources documentation.

Outcomes

Students are encouraged to think strategically and critically. Students present their research and findings to the class including a panel assigned to be the acting Board of Directors. The research and application across business disciplines allow for valuable experiences for students. Alumni have returned to our classrooms and have shared evidence that the hands-on curriculum and project management skills development in our curriculum helped them to further their career advancement quickly. Alumni have entered the workforce prepared to identify challenges, opportunities for change, and were prepared for execution.

As supported in the literature, consistency in project deliverables can assist students in the retention of the knowledge, skills, and motivation we are trying to develop. Holding team members accountable using project management planning tools and schedules helped to structure team success and improve team task and interpersonal processes. Students who engaged with a program with this practice often demonstrated these valuable skills. This consistent approach served as a model for interactions and expectations in team interactions.

5. DISCUSSION

As evidenced in our survey, not all project management skills were present in the undergraduate student population. In fact, the students that took multiple courses with a specific project management focus could articulate the application of the skills and competencies. We believe that threading project management throughout multiple courses and majors will further strengthen this critical skill development and application.

Survey results suggest that while students are exposed to project management processes and techniques, they are not proficient in implementing standard business practices. The data demonstrates the value of the integration of project management practice throughout undergraduate courses across disciplines. We cannot fully implement project management practice and reinforcement without it being threaded throughout several courses.

Integrating project management tools and techniques allows students to grow both academically and professionally in their skill application. Programs can address the demand for project management skills, the consistent use of project management tools and processes in their pedagogical design of team projects across courses. When students see that project management methodologies are used consistently across courses, they can continuously hone these skills and improve team process effectiveness and deliverable outcomes. When asked to analyze challenges, students must understand the practical application of problem-solving, project management techniques and the consequences of team decisions.

The driver behind our effort has been ongoing feedback from stakeholders that guide the process improvement of learning outcomes such as the demand for graduates with project management skills. Our applied projects allow students to link education to increased business knowledge, improved team dynamics and communication, critical thinking, and time management. While we have made progress in updating the project management curriculum, we concur that we have not yet fully integrated project management skill development across the business curriculum. Our intent is to share the ideas and thought processes behind the course design to help others in the development of an updated project-centric curriculum. While project

management is not a new skill, we feel that it is highly underutilized and undervalued in the business education curriculum. We understand that project management practice continues to evolve, and educators must continue to enhance curriculum along this continuum.

Practical Application

We have designed our course assignments and experiences to be more applicable and meaningful for our students and their future employers. A strong body of evidence proposes integrating feedback from stakeholders and research theory into each curriculum discussion. While it is common to offer a project management curriculum in business schools, integration should continue to be a thread throughout various majors. The important development of project management skills cannot be fully executed in one or two programs to be successful across the curriculum. Faculty and practitioners should continue to stay current with industry trends to support the development of curriculum and student outcomes.

Incorporating experiential project-based learning opportunities, such as student internships and ongoing project work, should continue to be included in the curriculum. These experiences will allow students to apply their project management skills in an academic and professional setting. In addition, one of the most effective ways to learn project management skills is ongoing exposure and experience participating and leading projects. By offering more project-based learning experiences in the undergraduate business curriculum, you are enhancing the experiences and applications for your students. In addition, it would be beneficial across the business curriculum to identify the pathway to professional certifications in project management such as CAPM, while students are completing undergraduate credits.

Student assessment measures should evaluate not only the project deliverables but also evaluate the team process and project management skills. In each class outlined above, students are held accountable using project management planning and scheduling tools to facilitate efficient and effective team tasks and interpersonal processes. Team debriefs are also a critical component in each of our classes to reinforce lessons learned and continuously improve team processes and outcomes. Free online tools like ITP Metrics (https://www.itpmetrics.com/assessment.info) can help faculty measure team processes and facilitate team debriefs. Projects should be experiential in nature and include the application of key metrics critical for their future success in the business environment. The project management tools described outline a multidisciplinary approach that can be integrated across business schools and utilized as a platform to develop an interest in lifelong learning for our graduates.

Future Consideration

The field of project management is ever-changing and will continue to evolve. It is important for educators to stay up to date on the latest best practices and techniques to ensure that the curriculum continues to have merit. Partnering with professional organizations locally such as PMI (Project Management Institute) can help ensure this goal will be achieved. Identifying trends and updating curriculum to address industry standards and practices will continue to provide students with lifelong learning opportunities.

Indeed, exposing students to experiential project management components has increased knowledge of factors that are often uncertain, complex, and unpredictable. Classroom practice of these factors has better prepared our alumni for employability as evidenced by our job placement rates. We continue to monitor insight from career placement statistics and execute assignments that allow for practical application. The outcome of our work is that our students can walk into an interview with a portfolio of project deliverables that highlights not just what they know, but what they can do.

Limitations

We evaluated the course curriculum redesign within one university. While we believe our project process is unique in delivering an updated curriculum, we highlight data from our introductory management and capstone course that supports the claim that undergraduate course curriculum would benefit from enhancement of project management skills focus. It would be beneficial to identify best practices in course design, project management process, and skill development for future course design discussions across multiple departments and various schools, outside of the School of Business.

6. CONCLUSION

The inclusion of project management tools and application can increase efficiency in course design (Echkardt & Wetherbe, 2016). This pedagogy aligns with AACSB's Impact of Research Task Force report that argues, "By

bringing together practitioners and academics on focused topics, education holds enormous potential to strengthen the linkage between research and practice" (p. 37). Positioning graduates with lifelong skills that go well beyond the traditional classroom setting (Dirksen, 2015). Experiences using project management techniques and skills development provide students with opportunities to enter the workforce with hands-on experience managing projects, working with a team, analyzing data, and applying experiential knowledge (Eckhardt & Wetherbe, 2016), skill sets relevant to on-the-job requirements. This prescribed method has not always been a practice present. Project management tools can be consistently implemented across the curriculum to improve project-based student learning outcomes and workforce readiness.

7. APPENDIX: STUDENT SURVEY

1. Have you ever taken project management courses or workshops? If yes, which methodologies?
    a. General introduction
    b. Adaptive
    c. Agile
    d. Kanban
    e. Lean
    f. PMBOK (Project Management Book of Knowledge)
    g. Prince2
    h. Scrum
    i. Waterfall/Traditional PM
    j. None
    k. Other (please specify)
2. Do you have access to project management professional development opportunities or training materials?
    a. Yes
    b. No
    c. Unsure
3. Are you familiar with project management methodologies? If so, select the ones you are most familiar with:
    a. Adaptive
    b. Agile
    c. Kanban
    d. Lean
    e. PMBOK
    f. Prince2
    g. Scrum
    h. Waterfall/Traditional PM
    i. None
    j. Other (please specify)
4. Are you currently implementing any project management skills, such as time management, scope organization, milestone schedules, risk management, etc.? (Select all that apply)
    a. No
    b. Yes, in my class projects.
    c. Yes, in my student organization.
    d. Yes, in my internship.
    e. Yes, in my job.
5. If you answered yes, which project management methodologies are you currently using?
    a. Adaptive
    b. Agile
    c. Kanban
    d. Lean
    e. PMBOK
    f. Prince2
    g. Scrum
    h. Waterfall/Traditional PM
    i. None
    j. Other (please specify)
6. What level of project management skills do you feel you possess?
    a. Likert scale: 1 = none; 6 = expert
7. How confident do you feel managing a project?
    a. Likert scale: 1 = not at all; 6 = extremely
8. How many class projects have you participated in during your time as an undergraduate student?
9. In those class projects:
    a. Did you utilize a project management charter or contract?
        i. Yes
        ii. No
    b. Did you utilize a project schedule?
        i. Yes
        ii. No
    c. Did you utilize a project schedule software or tool?
        i. Yes
        ii. No
    d. did you complete a scope statement?
        i. Yes
        ii. No
10. Do you consider any of the following communications, risk, resource, or quality management at any level when working on your class projects?
    a. Yes
    b. No

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Enforcement of Prerequisites in Computer Science

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Abstract

This paper describes the study of enforcement of prerequisites in the Computer Science program at a regional university in the Southwest. Prerequisites are a significant factor in programs of study in higher education. Allowing students to register in courses may assume that they have existing knowledge and skills. Some programs treat prerequisites as advisory, while others consider them mandatory. In the latter case, procedures usually exist to make exceptions in the form of registration overrides. The state of prerequisite enforcement at our university over the years, and some factors that may have influenced adherence to the prerequisite structure over the years, will be discussed in this paper.

Keywords: enrollment, curriculum, prerequisites, scheduling, graduation.

1. INTRODUCTION

In higher education, courses may have prerequisites and/or co-requisites to ensure that students taking the course are sufficiently prepared. In reality, enforcement of these prerequisites may be difficult. For instance, enrollment systems cannot check prerequisites until after the semester end because course grades have not been awarded and enrollment for the next semester starts well before the current semester ends (Boyer & Bucklew, 2019). A variety of processes exist to deal with this timing problem.

The issue of enforcing prerequisites is especially important when the demand for a course exceeds the course capacity. Students who should not be taking the course (yet) take a seat that should have gone to students who do qualify (Soria & Mumpower, 2012).

This research will examine the compliance with successful completion of prerequisites and enrollment in co-requisites in the Computer Science program where the investigators teach. The paper is organized as follows. In the next section, we discuss the relevant literature. Next, we discuss the methodology of our study, data collection, and data analysis. We end with conclusions and recommendations.

2. LITERATURE REVIEW

Prior knowledge and skills needed to be successful in a course can take multiple forms. Prerequisites can be defined as courses or tests that must be successfully completed prior to registering for the target course. In some cases, special tests are given at the start of a course to identify students who need additional support to get caught up. Co-requisites are courses that must be taken at the same time as another course. In the case of labs partnered with lecture sections, the reason for the split is usually administrative – multiple lab sections with fewer students are needed to give all students sufficient individual attention in the lab. In other cases, the material in one course is supportive of the target course. For instance, Discrete Mathematics may

be co-requisite for Basic Computer Architecture to cover Boolean logic more in-depth in the mathematics course.

Rationale for expecting prior knowledge

Curriculum design involves combining multiple courses into an integrated program of study. Considering limitations of time and other resources, programs should maximize coverage of content while minimizing overlap. As Diamond (1998) states:

> "One of the most prevalent problems in course and curriculum design is the tendency of faculty to make false assumptions about the knowledge and skills that students bring to their courses. These incorrect assumptions lead to failure for the students who are ill prepared, boredom for their classmates who are often more than adequately prepared, and frustration for the faculty."

Performance in advanced courses depends on how the material in prerequisite courses is used and evaluated (Nelson et al., 2020). Lack of correct prerequisites and lack of continuity between courses in a sequence are specifically mentioned as causes of student failure (Babb et al., 2014). "Depth of knowledge" assumes a hierarchical structure of programs (Reynolds et al., 2016). This is not limited to a single program of study. If programs have more than one concentration, two or more sequenced courses within the concentration are required (Downey et al., 2008).

Babb et al. (2014) propose that students must "step-wise and incrementally, engage in the persistent and iterative pursuit of programming" of at least 15 out of 23 topics over the course of the curriculum. Longenecker et al. (2013) suggest a series of three programming courses with database as prerequisite for the last course. Decreasing the number of programming courses in the early 2000s backfired, and industry continues to demand technical skills (George & Marett, 2019).

Prerequisites do not come without drawbacks. Students can suffer delays in graduation, and universities may have to offer more courses with a deeper prerequisite structure (Reynolds et al., 2016). For some students, it can be a reason to select another major (Li et al., 2014). It is therefore important to impose only prerequisites that are necessary and effective.

Effectiveness

Much of the research on prerequisites has focused on their effectiveness in a program's curriculum. The effect of prior knowledge has been tested statistically through correlation of prior coursework and final grades in the target course, and by correlation with special pretests at the start of the target course.

Examples of studies that use final grades in the target course are Blaylock & Lacewell (2008), Krause-Levy et al. (2020), Liao et al. (2019), and Soria & Mumpower (2012). All found positive relationships between prerequisites and target courses.

Passing previous courses may not be effective. The use of proficiency tests instead of prerequisite courses has been described by Rondeau & Li (2009). Instituting the test created a backlog of students who failed the test, and the test did not fully cover the required knowledge. Also, not all prior knowledge can be obtained in a single course. Blaylock & Lacewell (2010) used a prerequisites test covering topics from multiple disciplines to demonstrate that prior knowledge led to better final grade results. Sargent (2013) used proficiency tests for Intermediate Accounting with good result. Abou-Sayf (2009) concluded that using entrance tests in the target course provided more accurate results than using final grades.

Higher education has become increasingly fluid. Whereas decades ago, students tended to complete degrees in one institution, the last decade has seen an increasing number of students who transfer from community colleges to four-year institutions to finish their degree. Transfer agreements between schools and state transfer guides (for instance OSRHE (2022)) help students to combine courses from multiple sources into a single degree. Needless to say, this assumes sufficient similarity of course contents to be successful. The effect of transfer guides on the number of prerequisites taken elsewhere is small, and mature students benefit more (Spencer, 2019). Furthermore, Catanese et al. (2018) found no significant difference in a third computing course between native students and transfer students who took the first two courses elsewhere.

Finally, some problems exist in quantitative measurement of the effect of prerequisites. Students are more mature in the target course, the students in the prerequisite and target course partially overlap, self-selection happens due to students not following up with the target course,

and a cause-and-effect relationship has not been demonstrated (Abou-Sayf, 2009).

Selection process

The second main area for prerequisites research is in the selection process. One of the first questions in delivering courses is the issue of prerequisite knowledge (Johnson et al., 2002). In some cases, this is easy. Database II should have Database I as direct prerequisite (Reynolds et al., 2016). Computer Science II should be preceded by successful completion of Computer Science I, and Object-Oriented Programming (in Java) might need the coverage of objects in C++. Model curricula may suggest this type of sequential prerequisites. In IS2010 and IS2020, Foundations of Information Systems is prerequisite for most other courses, and all other courses must be passed before culminating courses like the capstone course (Leidig et al., 2019; Leidig & Salmela, 2021).

Other prerequisites may be less intuitive. Some courses have non-sequential prerequisites from other disciplines. For instance, some programming courses may need the logical thinking from specific Mathematics courses. White found that prerequisites are needed to develop the proper cognitive style in order to be successful in Visual Basic programming (2012). In a follow-up study, White and Sivitanides suggested that freshman level mathematics courses are good indicators for success in Visual Basic (2003). To fully understand the issues round technology-based entrepreneurship, a course on information systems in business is essential (Jones & Liu, 2017).

Level of enforcement

Registration systems contribute to the problem of skipping prerequisites (Wilkerson et al., 2019). As mentioned before, course registration systems have difficulty enforcing prerequisites if registration for a future semester is allowed before grades in the current semester have been posted. Several solutions to this dilemma exist.

First, universities may use conditional enrollment pending successful completion of the prerequisite. Second, appropriate staff can issue overrides. Academic advisors may have permission to issue an override if transfer courses have not been posted in the transcript system yet, and faculty may override enrollment blocks in courses they teach if they deem the prerequisite unnecessary for specific students. Departments can give overrides for courses in their department. An example of this process can be found at OSU (2021) . Third, enrollment without prerequisites may not be blocked. Course descriptions may merely mention prerequisites, and students can not notice or ignore them. In that case, it would be up to faculty to check transcripts before or at the start of the course. Finally, the university may only open enrollment after grades in the current semester have been posted. This pushes enrollment back compared with early registration and is unattractive from an administrative point of view. Soria & Mumpower (2012) describe their university's switch to an automated, mandatory prerequisite enforcement system and found that it led to better academic outcomes.

The need to check grades does not exist for co-requisites. If the course has been taken before it is available in the transcript system, and if not must be taken in the same semester as the target course. Registration systems could check if the co-requisite is covered and either disable registration until it is met or issue a warning that the co-requisite course must also be registered.

In closing, student compliance with prerequisites and co-requisites is a multi-faceted issue. The literature indicates that they are effective, gives some guidelines for their selection, and that they may not always be followed. We have not been able to find literature indicating how often they are skipped, and that is the focus of this study.

3. METHODOLOGY

This section describes the methodology of measuring compliance with successful completion of prerequisites and enrollment in co-requisites for the Computer Science program.

Online university systems

Students register on Banner and transcripts can be checked on DegreeWorks.

Course registration system

The Banner system (Ellucian Company LP, 2022a) is a comprehensive suite that includes student course registration and instructor functions like generating course enrollment listings and grade entry. Enrollments are synchronized nightly with the course management system BlackBoard. The gradebooks in BlackBoard contain the student identifiers for each course.

Registration overrides may be customizable by the university, allowing different users and groups different permissions. At our university, overrides for undergraduate courses can be issued by faculty, department, and academic advisors (Figure 1). Prerequisites are not listed as

a reason. Academic advisors contact faculty for prerequisite overrides. This typically happens between Software Engineering and its target Capstone course.

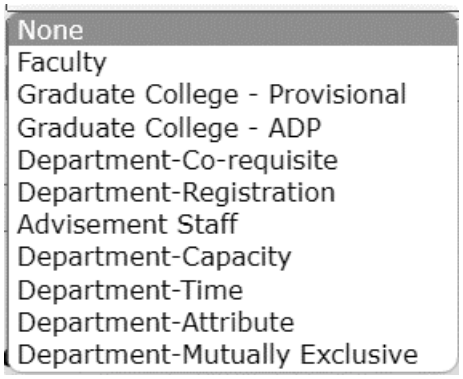


Figure 1 - Types of overrides

Transcript system

DegreeWorks (Ellucian Company LP, 2022b) allows selecting single students based on their N number (a unique number unconnected with other identifiers such as social security numbers) but also has a search function that includes searching on majors and minors. The results of each search are displayed in a popup window with name and N numbers.

The frequency of synchronization between grade entry on the Banner system and the transcripts in Degreeworks is not known but assumed to be frequent since both packages are sold by the same company. The "historic audit" dropdown shows multiple snapshots during the semesters, and the "date refreshed" field can be used to refresh the current transcript on the fly.

Transcripts show all required courses for the program of study, the semester when taken or scheduled, the course grade status, and special notes for course transfers and substitutions. Sample (anonymized) transcripts for are shown in Appendix A.

Prerequisites in the CS program

The Computer Science program has multiple courses with prerequisites or co-requisites. Some are sequential, such as Computer Science I and Computer Science II which even use the same textbook. Other courses are non-sequential, such as Object Oriented Programming and Software Engineering. The course content in the programming course is not used directly in the target course, but the intent is to ensure that students have sufficient programming background to start preparing for the Capstone course. A complete listing of common courses with prerequisites is provided in Table 1. Some courses with prerequisites in the course catalog are seldom or never offered, and we ignored those. We also omit courses restricted to instructor permission only.

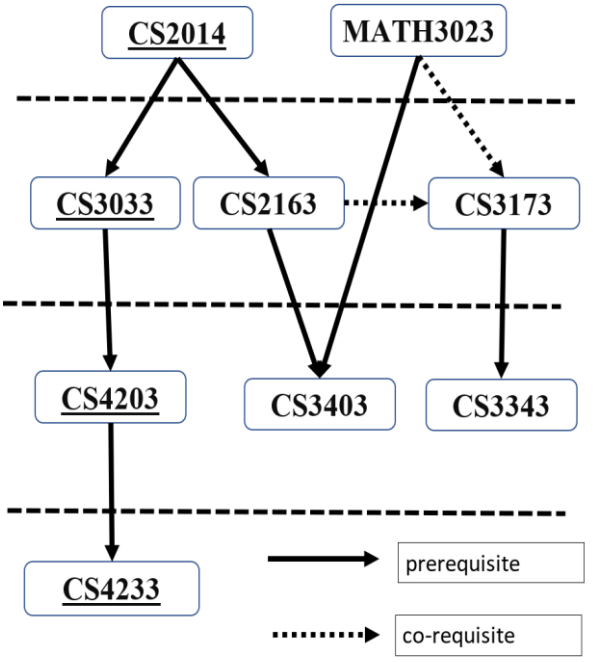
Course	Prerequisite/co-requisite
CS 2014 Computer Science I	Applied Mathematics (co) or College Algebra (co) or ACT >=23 and computer proficiency
CS 2163 Computer Science II	Computer Science I with C minimum
CS 3033 Object Oriented Programming	Computer Science I with C minimum
CS 3173 Basic Computer Architecture	Computer Science II (co) and MATH 3023 Discrete Mathematics (co)
CS 3343 Computer Operating Systems	Basic Computer Architecture
CS 3403 Data Structures	Computer Science II with C minimum and MATH 3023 Discrete Mathematics
CS 4343 Database Management Systems	Computer Science II and MATH 3023 Discrete Mathematics
CS 4203 Software Engineering	Object Oriented Programming with C minimum
CS 4233 Capstone	Software Engineering

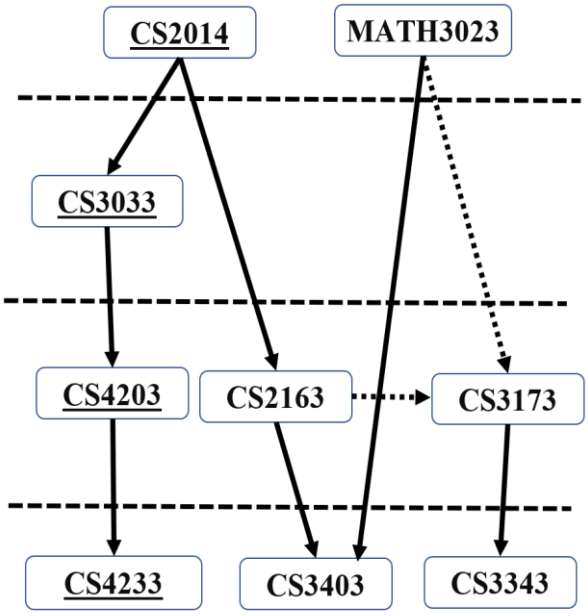
Table 1 - Courses and prerequisites

Based on prerequisites in required courses, the program has a critical path to graduate in four semesters after General Education requirements have been met. The critical path is shown in Figure 2. In all three versions, completing the upper division courses in four semesters is only possible with the sequenced prerequisites Computer Science I, Object Oriented Programming, Software Engineering, and Capstone (Professional Development in CS).

This critical path was shortened about six years ago. Before the change, the prerequisite for Object Oriented Programming was Computer Science II, not Computer Science I. The critical path at that time had a length of five courses with Computer Science I, Computer Science II, Object

Oriented Programming, Software Engineering, and finally the capstone course. Even though we felt that Computer Science II was a better prerequisite for Object Oriented Programming than Computer Science I, we decided to shorten the path. This demonstrates that some of the considerations in the use of prerequisites are political as noted by Abou-Sayf (2009).





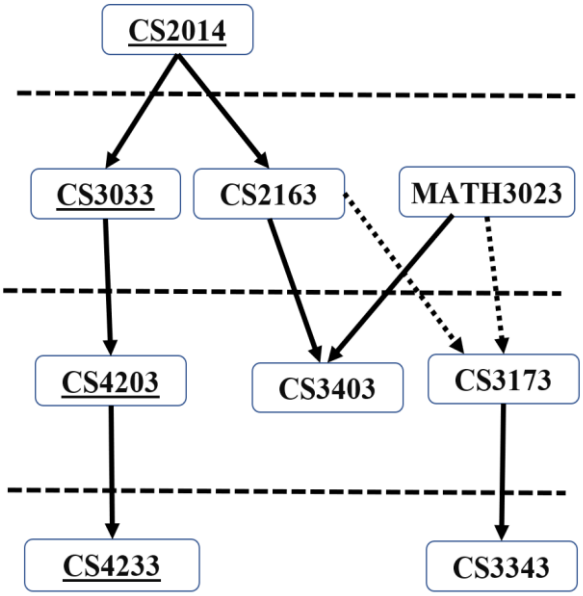


Figure 2 - Critical Path in CS

Course rotation

The CS program is offered on two campuses. In the past, courses were only offered face to face (f2f) on alternating campuses. With the advent of powerful online meeting tools like BlackBoard Collaborate and later Zoom, courses were increasingly split in two sections, with one section f2f and the other online concurrently. This allowed students to take courses each semester independent of their main campus, and the course rotation is shown in the first image in Appendix B.

Starting with the Fall 2021 semester, the course offerings were reduced to once a year, regardless of campus. Faculty could select the campus for the f2f section and stream the course to the other campus. The faculty with doctoral degrees were reduced from five to three by releasing two faculty on the tenure track and not replacing them. The road map with implicit course rotation is shown in the second image in Appendix B.

The road map for CS shows that CS courses are spread over four years and eight semesters. In our program, approximately half of the CS majors complete all four years at our university, but the other half consists of transfer students from community colleges. For those transfer students, and students who do not declare CS as their major until after completion of their General Education courses, students can combine the major and minor courses for the first and second years in the appropriate semesters, as well as

combining the third and fourth years. For all students though, most of the required courses are offered only once a year. This complicates proper course selection for our majors.

Scraping web data

All course registration data and all transcripts are accessible online at the university website. One of the current popular tools for collecting online data is a combination of the Python programming language and the Selenium module to automate user actions in web browsers (Chapagain, 2019). The Scrapy module (Zyte, 2022) is faster due to multithreading but does not render JavaScript and is not very user-friendly. BeautifulSoup (Richardson, 2015) needs additional modules for sending requests and parsing HTML pages. Selenium is easy to use, sends its own requests, and can pull data that is only available when JavaScript is loaded (Grimes, 2022).

4. DATA COLLECTION

We filtered the transcript system on Computer Science majors and copied the list of students to a text file. Student identification numbers are in the format Nxxxxxxxx, where x is a digit. The N numbers were extracted with regular expressions, and we used Python scripts with Selenium to download transcripts and test scores. Transcripts and test scores were saved with corresponding random numbers for file names and identifying information in the files was removed. Finally, we used Python scripts with Selenium and BeautifulSoup to extract the data we needed in csv format.

The csv file was used as the data source for the analysis spreadsheet. Separate tabs for each course reviewed extracted the data for the prerequisites and co-requisites and used lookup tables to convert semesters to sequential numbers. The semester numbers of prerequisites and co-requisites were compared with the number of the target course to check if they fell before or with the target course and stored in true/false format. Separate lookup tables were used to check for passing grades in prerequisites and co-requisites and stored in true/false format. Formulas with AND() and OR() were constructed to check if all rules were met.

We filtered first on target courses being taken, and then on meeting all the rules. Finally, we assigned categories for the reasons. Figure 3 shows an example for Basic Computer Architecture, which has two co-requisites with passing grades of D.

co_cs2163withD	co_math3023withD	ALL_RULES_MET	COMMENTS
FALSE	TRUE	FALSE	co-requisite(s) not taken
TRUE	FALSE	FALSE	co-requisite(s) failing grade
FALSE	TRUE	FALSE	co-requisite(s) not taken
TRUE	FALSE	FALSE	co-requisite(s) failing grade
TRUE	FALSE	FALSE	co-requisite(s) failing grade
TRUE	FALSE	FALSE	co-requisite(s) failing grade
TRUE	FALSE	FALSE	co-requisite(s) failing grade
TRUE	FALSE	FALSE	co-requisite(s) failing grade
FALSE	TRUE	FALSE	co-requisite(s) not taken

Figure 3 - Categorization

Finally, the data were summarized on a separate tab by semester and categories in tabular and graphical format for analysis.

5. ANALYSIS AND DISCUSSION

We will now discuss the CS major courses. We will start with a brief description of the course and its requirements, followed by the results and our interpretation. Appendix C shows graphs for the number of times requirements were not met, the occurrences relative to the total times the course was taken in the semester, and a breakdown of the reasons. The historical rate mentioned is the rate of unmet requirements over the history of the program, based on all available transcripts.

Computer Science I is the introductory programming course. The course presents the basics of programming in C++. Two Math courses can be taken as a co-requisite, or students can qualify with an ACT of 23 or higher. All students must have computer proficiency. The course has a substantial number of students who do not meet the requirements. The historical rate is 17.8%. One of the prerequisites is usually taken before the course, but a substantial number of students fail the MATH course. The main reason for failing the requirements is not taking them, with a strong second not passing when taken before. Very few students fail to get a passing grade when taken concurrently.

Computer Science II presents more programming in C++. In contrast to Computer Science I, it has a low historical rate of 4.1%. The course has Computer Science I with a minimum of C as a prerequisite. The majority of students not meeting it are transfer students from a Community College who either failed to get a C or took the courses concurrently.

Object Oriented Programming is taught in Java. The prerequisite is Computer Science II, which has to be passed with a C. The historical rate is extremely low at 2.5%, with more than half related to transfer students who fail to get a C or taking the prerequisite late.

Basic Computer Architecture presents the theoretical foundation of computers, including the basic hardware components and an introduction to assembly language. It has two courses that can be taken before or concurrently. The historical rate is 11.5%. About twice as many students fail to pass Discrete Mathematics as Computer Science II.

Computer Operating Systems follows Basic Computer Architecture, its only prerequisite. The course presents topics like concurrency, processes, and threads. The historical rate is lower at 7.9%. Both courses are taught in opposite semesters and taking the prerequisite two semesters later generally delays graduation.

Data Structures introduces both common data structures and algorithms used in Computer Science. The historical rate is 8.6%, of which more than three quarters is caused by not passing Discrete Mathematics and the rest by failing to pass Computer Science II or both.

Database Management Systems presents multiple forms of databases as storage and retrieval tools for data. It has a historical rate of 10.8%, with two thirds due to not meeting the Discrete Mathematics requirement and one third not passing Computer Science II.

Software Engineering presents the software development process including requirements analysis, modeling, and testing. Combining this course with previous programming courses prepares the students for the integrative Capstone course. The historical rate is higher again at 14.7%, with only a very minor part due to failing the prerequisite. The remainder is evenly split between taking the courses concurrently and taking the prerequisite after the software engineering course.

The capstone course has students develop an individual integrative project of their choice. The historical rate for not meeting the Software Engineering prerequisite is 16.0%, with virtually all due to taking the capstone and its prerequisite concurrently.

Table 2 presents a summary of the historical rate of unmet requirements. The rate appears to vary based on three factors. First, courses with Mathematics prerequisites tend to have higher rates. This is true for especially Computer Science I. Second, sequential courses tend to have lower rates. This is true for Computer Science I and II (4.1%), Computer Science I and Object Oriented Programming (2.5%), and Basic Computer Architecture and Computer Operating Systems (7.9%). Finally, courses later in the program tend to have higher rates. We attribute this to the pressure to graduate on time.

Course	Sequential	Percent Unmet
Computer Science I	no	17.8%
Computer Science II	yes	4.1%
Object Oriented Programming	yes	2.5%
Basic Computer Architecture	no	11.5%
Computer Operating Systems	yes	7.9%
Data Structures	no	8.6%
Database Management Systems	no	10.8%
Software Engineering	no	14.7%
Capstone	no	16.0%

Table 2 - Historical Rate of Unmet Requirements

6. CONCLUSIONS AND RECOMMENDATIONS

Our analysis shows a significant level of failing to meet requirements for courses in our Computer Science program. As involved faculty members, the results do not surprise us. We do see this as an opportunity to take actions that alleviate this problem.

The tools used for this study can be converted to multiple proactive tools. We can generate lists for academic advisors with students needing to take the specific courses in the following semester. These lists can be used in advising sessions, to contact students proactively by email or text message, and to check courses needed against actual enrollments. The same lists can be used by the department to estimate demand for the next semester so an adequate number of course sections can be scheduled. Finally, we can generate faculty lists with checked prerequisites and co-requisites at the start of the semester to maximize the enrollment of eligible students by eliminating non-eligible students.

Finally, our study does not address the effect of unmet prerequisites on student performance in the target course. We plan to make this a separate study.

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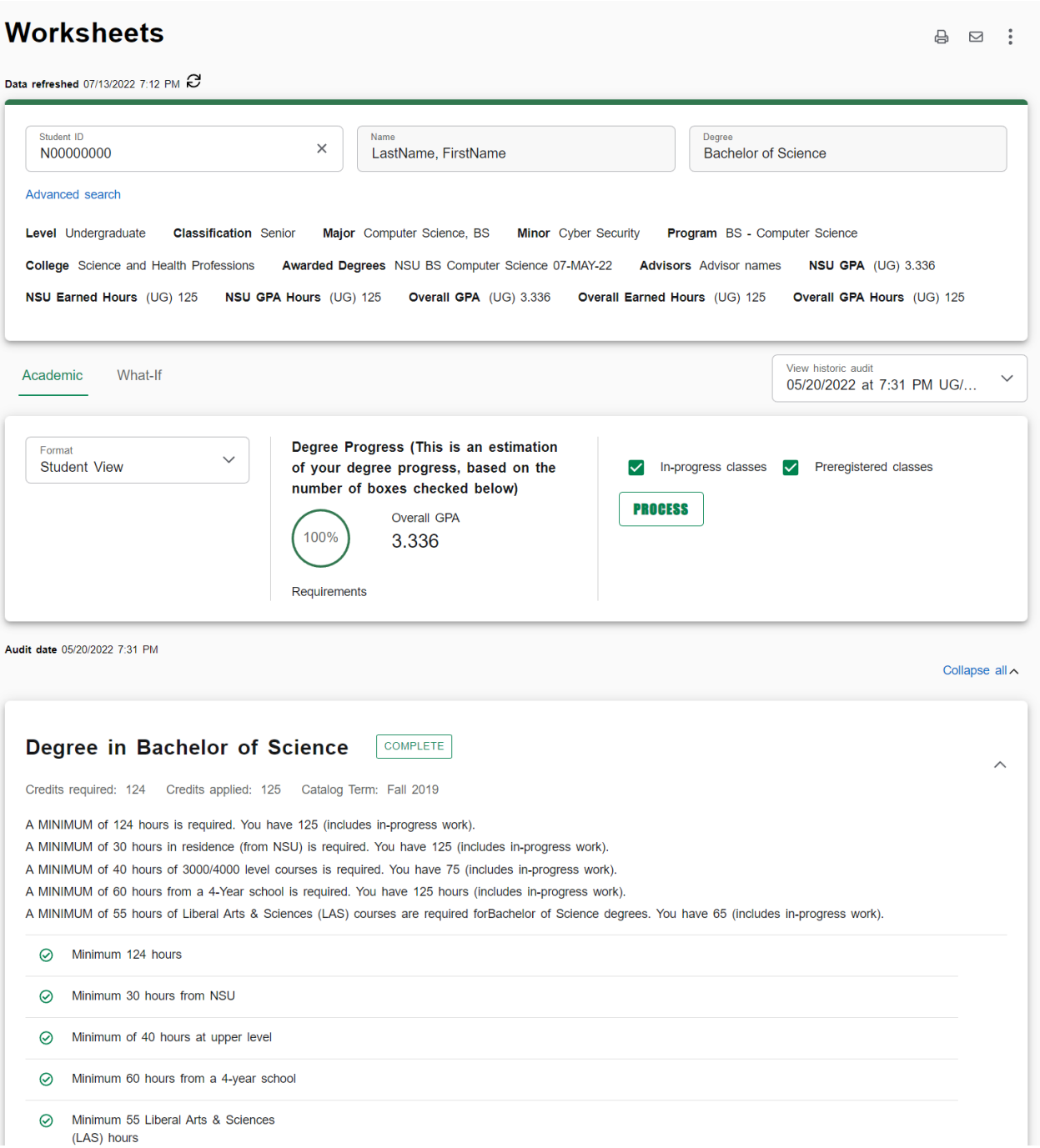
Appendix A – Sample anonymized transcripts

Graduated student



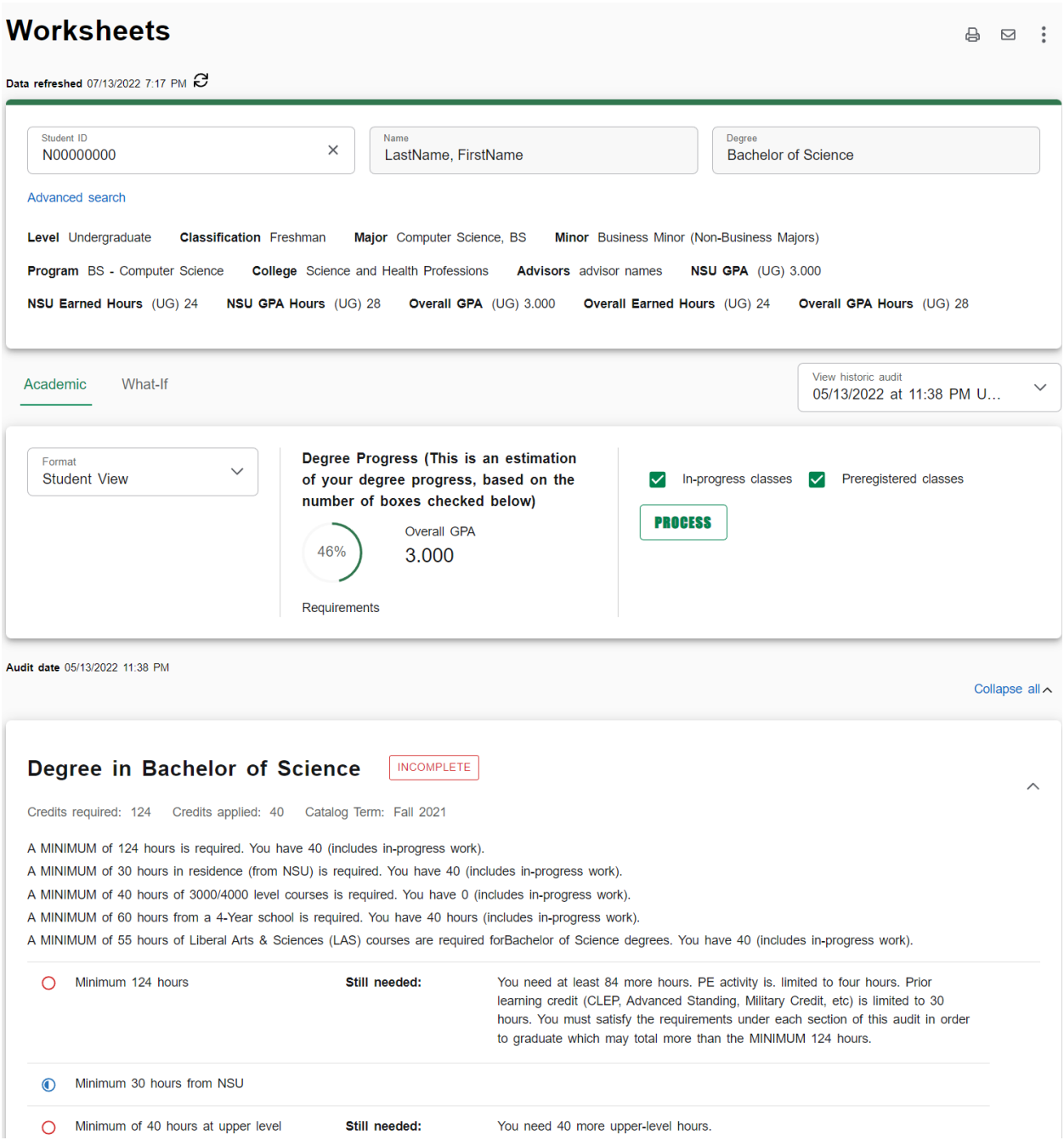
Major in Computer Science, BS COMPLETE

Credits required: 42 Credits applied: 43 Catalog Term: Fall 2019

Your current major GPA is 3.348.

	Course	Title	Grade	Credits	Term	Repeated
Computer Science I	CS 2014	COMPUTER SCIENCE I	B	4	Fall 2018	
Computer Science II	CS 2163	COMPUTER SCIENCE II	A	3	Spring 2019	
Object Oriented Programming	CS 3033	OBJECT ORIENTED PROGRAMMING	A	3	Spring 2020	
Basic Computer Architecture	CS 3173	BASIC COMPUTER ARCHITECTURE	D	3	Fall 2019	
Computer Operating Systems	CS 3343	COMPUTER OPERATING SYSTEMS	A	3	Spring 2020	
Data Structures	CS 3403	DATA STRUCTURES	C	3	Fall 2019	
Software Engineering	CS 4203	SOFTWARE ENGINEERING	B	3	Spring 2021	
Professional Development in Computer Science	CS 4233	PROF DEV IN COMPUTER SCIENCE	C	3	Spring 2022	
Database Management Systems	CS 4343	DATABASE MANAGEMENT SYSTEMS	A	3	Spring 2020	
Professional & Technical Writing	ENGL 3083	PROF & TECHNICAL WRITING	A	3	Fall 2020	
6 Hrs-Group A or B Electives	CS 3023	OBJECT BASED VISUAL PROG	A	3	Fall 2021	
	CS 3203	APPLICATION DEVELOPMENT IN C++	A	3	Fall 2019	
5 Hrs-Group B Electives	CS 4103	LT: ADVANCED JAVA	A	3	Fall 2021	
	CS 4553	PARALLEL PROGRAMMING	A	3	Fall 2020	

Ongoing student



Major in Computer Science, BS INCOMPLETE

Credits required: 45 Credits applied: 3 Catalog Term: Fall 2021

Unmet conditions for this set of requirements:

45 hours are required. You have 3, (includes in-progress work) and you need at least 42 more hours.
A minimum of 21 hours must be taken in residence. You have 3 (includes in-progress work) and you need 18 more hours. Hours in residence (from NSU) EXCLUDE prior learning credit such as CLEP, Advanced Placement, Advanced Standing, Military Credit, etc.
A minimum of 21 upper level hours are required. You have 0 (includes in-progress work) and need 21 more hours.
Minimum GPA unsatisfied

Your current major GPA is 0.000.

	Course	Title	Grade	Credits	Term	Repeated
○ Computer Science I	**Still needed:**	**1** Class in **CS** 2014				
◐ Computer Science II	CS 2163	COMPUTER SCIENCE II	IP	(3)	Fall 2022	
○ Object Oriented Programming	**Still needed:**	**1** Class in **CS** 3033				
○ Basic Computer Architecture	**Still needed:**	**1** Class in **CS** 3173				
○ Computer Operating Systems	**Still needed:**	**1** Class in **CS** 3343				
○ Data Structures	**Still needed:**	**1** Class in **CS** 3403				
○ Software Engineering	**Still needed:**	**1** Class in **CS** 4203				
○ Professional Development in Computer Science	**Still needed:**	**1** Class in **CS** 4233				
○ Database Management Systems	**Still needed:**	**1** Class in **CS** 4343				
○ Professional & Technical Writing	**Still needed:**	**1** Class in **ENGL** 3083				
○ Discrete Mathematics	**Still needed:**	**1** Class in **MATH** 3023				
○ 6 Hrs-Group A or B Electives	**Still needed:**	**6** Credits in **CS** 1033 or 2023 or 3023 or 3101 or 3102 or 3103 or 3203 or 3223 or 3623 or 3633 or 3643 or 3663 or 4023 or 4101 or 4102 or 4103 or 4113 or 4143 or 4223 or 4233 or 4253 or 4363 or 4463 or 4553 or **IS** 3053 or **MATH** 4223 or 4233				
○ 5 Hrs-Group B Electives	**Still needed:**	**5** Credits in **CS** 3223 or 4023 or 4101 or 4102 or 4103 or 4113 or 4143 or 4223 or 4233 or 4253 or 4363 or 4463 or 4553 or **MATH** 4223 or 4233				

Appendix B – Course rotations

Campus 1 - Computer Science

CS 2013 Computer Science I	F, S
CS 2163 Computer Science II	F, S
CS 3023 Object Based Visual Prog.	F, S
CS 3033 Object Oriented Programming	S
CS 3173 Basic Computer Architecture	F
CS 3203 Application Development in C++	Odd fall (ITV to Campus 1)
CS 3343 Computer Operating Systems	S
CS 3403 Data Structures	F
CS 4203 Software Engineering	F
CS 4233 Professional Dev. in CS	F, S
CS 4343 Database Mgmt	S

Even Fall	Odd Spring
CS 3623	CS 3663

Odd Fall	Even Spring
CS 3643	CS 3633

Campus 2 – Computer Science

Even Fall	Odd Spring
CS 3033, evening	CS 3173, evening
Group B Elective, evening	CS 3403, evening
MATH 3023, Evening	CS 3623, evening
CS 3633, evening	
	CS 4343 (ITV to Campus 2)
CS 4203 (ITV to Campus 2)	Group B Elective (ITV to Campus 2)
Group B Elective (ITV to Campus 2)	Group B Elective (ITV to Campus 2)

Odd Fall	Even Spring
CS 3343, evening	CS 4203, evening (ITV to Campus 1)
CS 4343, evening	Group B Elective, evening
CS 3663, evening	CS 3643, evening
CS 3203, evening (ITV to Campus 1)	

CS 3173 (ITV to Campus 2)	CS 3033 (ITV to Campus 2)
CS 3403 (ITV to Campus 2)	CS 3343 (ITV to Campus 2)
MATH 3023 (ITV to Campus 2)	

Note that CS 4233 is an arranged course and can be offered as needed.

September 30, 2016

B.S. Computer Science Road Map

First Year

Fall Semester	Spring Semester
CS 2014 Computer Science I	CS 2163 Computer Science II
H ED 1113 Personal Health or NUTR 1653 Basic Nutrition	MATH 3023 Discrete Mathematics
MATH 1513 College Alg. (if necessary) otherwise free elective	***Physical Science
ENGL 1113 Freshman Composition I	ENGL 1213 Freshman Composition II
UNIV 1003 University Strategies	Free Elective (3 hours)
Total Hours 17	**Total Hours 15**

Second Year

Fall Semester	Spring Semester
CS 3403 Data Structures	CS 3033 Object Oriented Programming
CS Group A or B Elective	Minor Course
Minor Course	***Humanities (First Course)
***Biological Science	***Communications Course
POLS 1113 American Federal Government	HIST 1483 or 1493 American History
Total Hours 15	**Total Hours 15**

Third Year

Fall Semester	Spring Semester
CS 3173 Basic Computer Architecture	CS 3343 Computer Operating Systems
CS Group A or B Elective	CS 4343 Database Management System
Minor Course	ENGL 3083 Technical Writing
***Humanities (Second Course)	Minor Course
***Global Perspectives Course	Free Electives (3 hours)
***Social and Behavioral Sciences Course	
Total Hours 18	**Total Hours 15**

Fourth Year

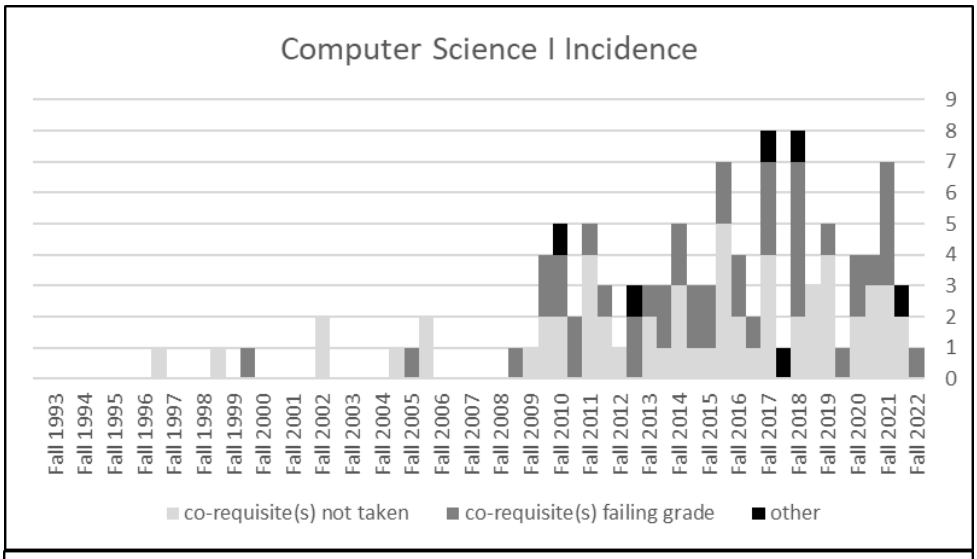
Fall Semester	Spring Semester
CS 4203 Software Engineering	CS 4233 Professional Development in CS
CS Group B Elective	CS Group B Elective
Minor Course	Minor Course
Free Electives (6 hours)	Free Elective (5 hours)
Total Hours 15	**Total Hours 14**

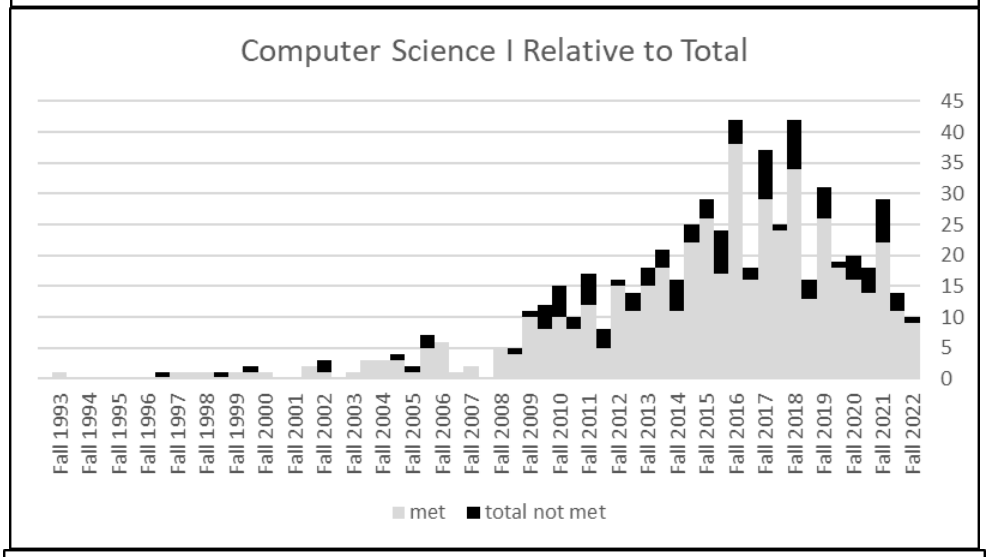
Total Degree Plan Hours 124

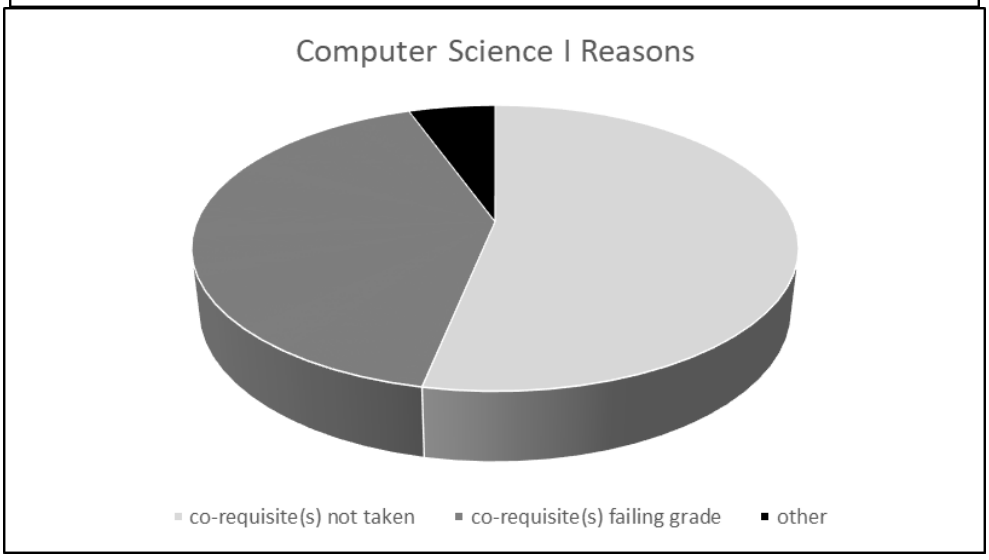
*** See current catalog "General Requirements" for selection.
Note: Courses which *may* be offered during the fall and spring based on need include CS 2014 and CS 2163.

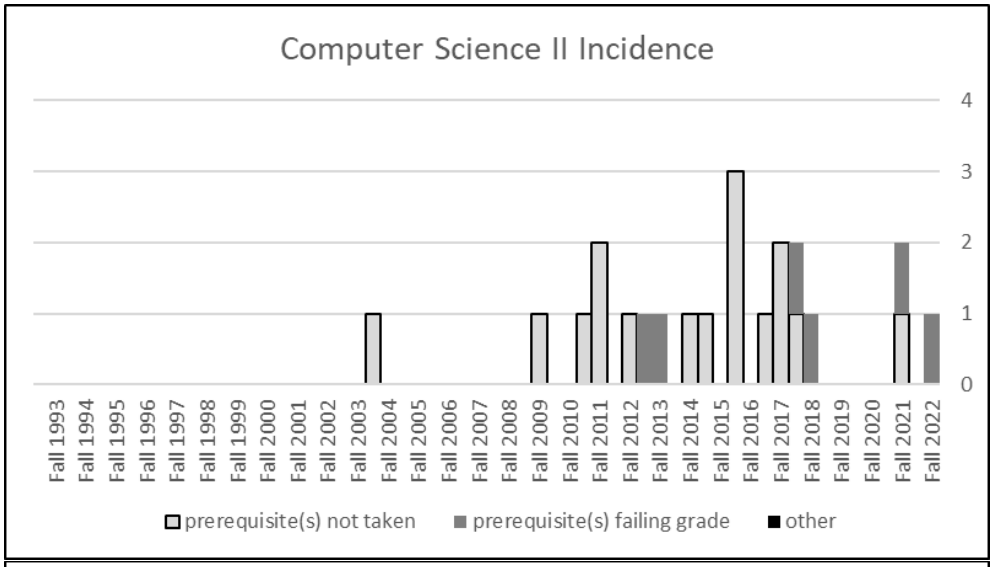
June 2021

Appendix C – Results by Course








Computer Science II Incidence
4
3
2
1
0
Fall 1993
Fall 1994
Fall 1995
Fall 1996
Fall 1997
Fall 1998
Fall 1999
Fall 2000
Fall 2001
Fall 2002
Fall 2003
Fall 2004
Fall 2005
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Fall 2011
Fall 2012
Fall 2013
Fall 2014
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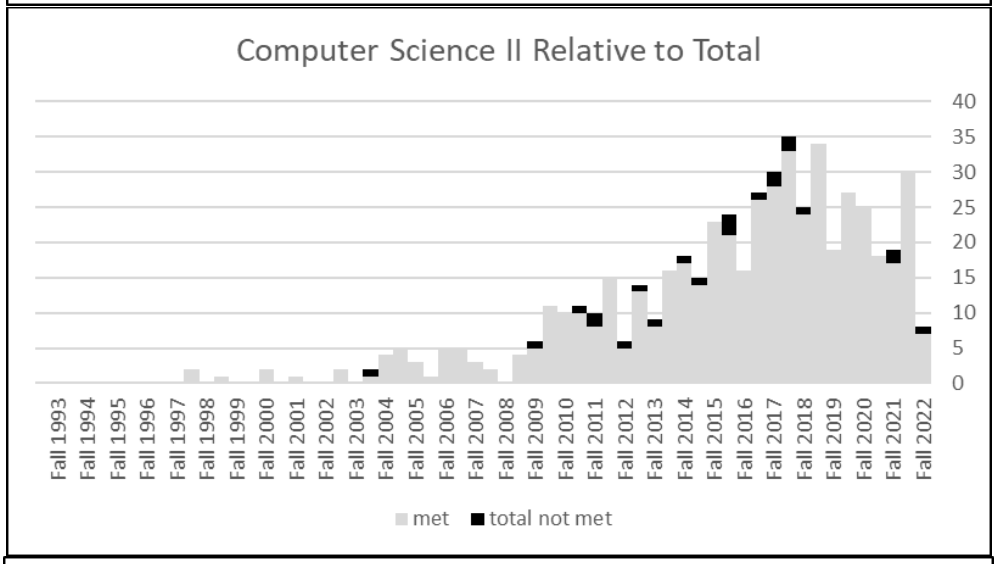
Fall 2016
Fall 2017
Fall 2018
Fall 2019
Fall 2020
Fall 2021
Fall 2022
prerequisite(s) not taken
prerequisite(s) failing grade
other


Computer Science II Relative to Total
40
35
30
25
20
15
10
5
0
Fall 1993
Fall 1994
Fall 1995
Fall 1996
Fall 1997
Fall 1998
Fall 1999
Fall 2000
Fall 2001
Fall 2002
Fall 2003
Fall 2004
Fall 2005
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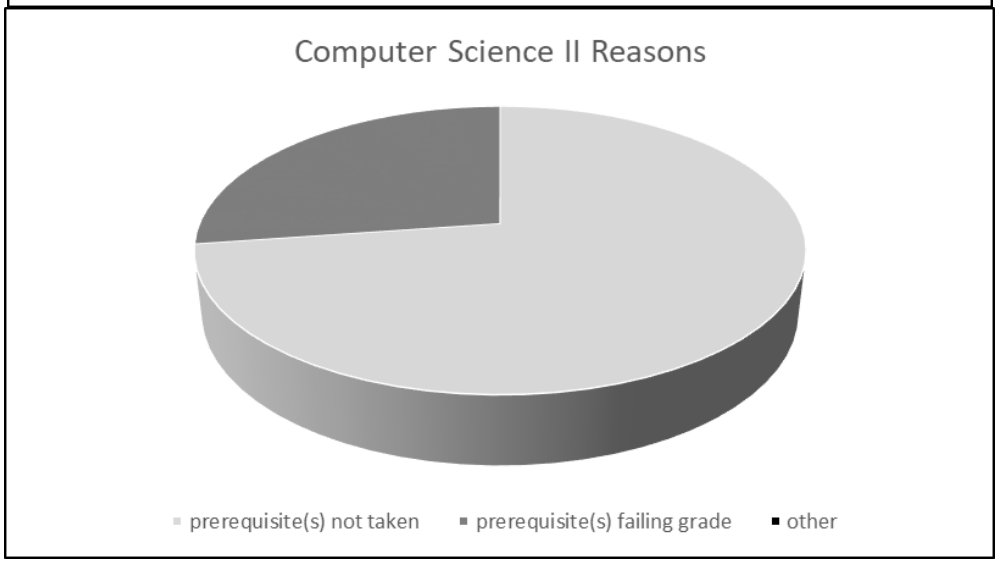
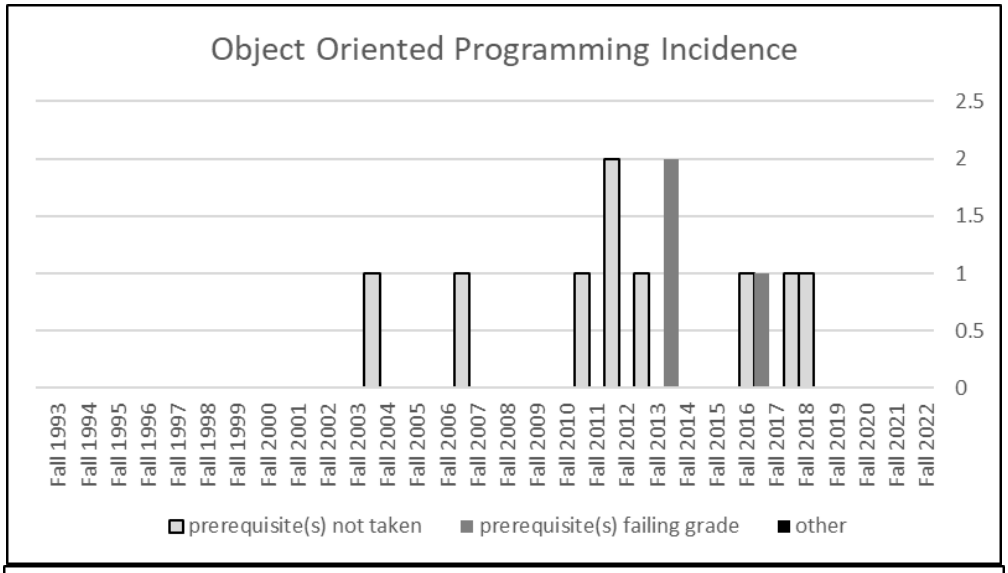
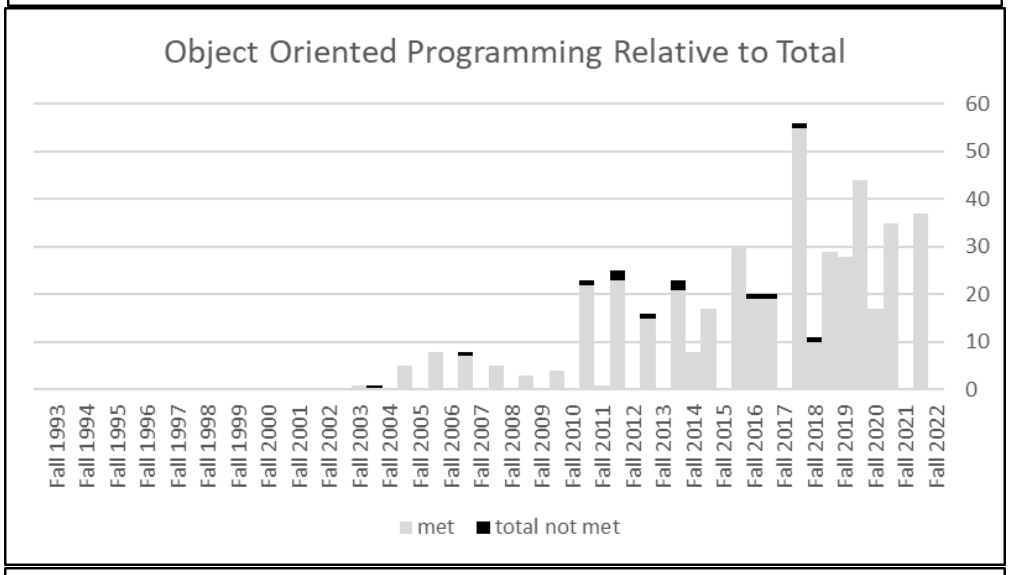
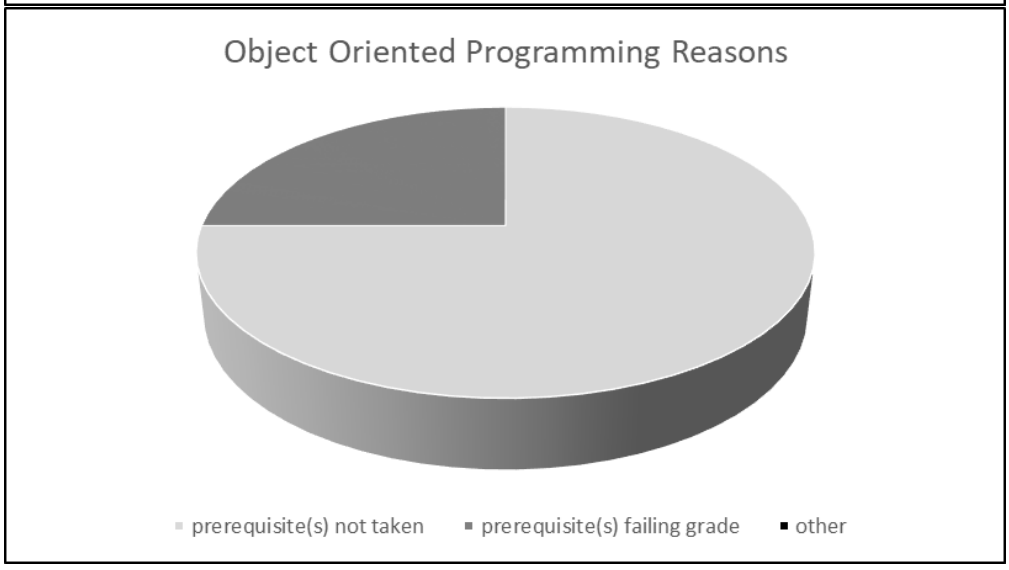
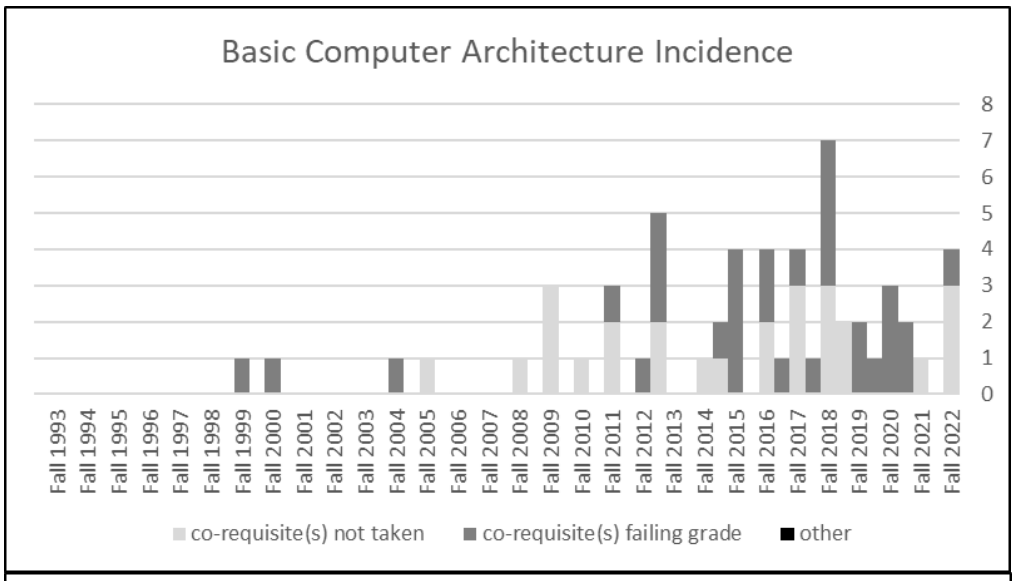
Fall 2016
Fall 2017
Fall 2018
Fall 2019
Fall 2020
Fall 2021
Fall 2022
met
total not met


Computer Science II Reasons
prerequisite(s) not taken
prerequisite(s) failing grade
other


Object Oriented Programming Incidence
2.5
2
1.5
1
0.5
0
Fall 1993 Fall 1994 Fall 1995 Fall 1996 Fall 1997 Fall 1998 Fall 1999 Fall 2000 Fall 2001 Fall 2002 Fall 2003 Fall 2004 Fall 2005 Fall 2006 Fall 2007 Fall 2008 Fall 2009 Fall 2010 Fall 2011 Fall 2012 Fall 2013 Fall 2014 Fall 2015 Fall 2016 Fall 2017 Fall 2018 Fall 2019 Fall 2020 Fall 2021 Fall 2022
prerequisite(s) not taken
prerequisite(s) failing grade
other


Object Oriented Programming Relative to Total
60
50
40
30
20
10
0
Fall 1993 Fall 1994 Fall 1995 Fall 1996 Fall 1997 Fall 1998 Fall 1999 Fall 2000 Fall 2001 Fall 2002 Fall 2003 Fall 2004 Fall 2005 Fall 2006 Fall 2007 Fall 2008 Fall 2009 Fall 2010 Fall 2011 Fall 2012 Fall 2013 Fall 2014 Fall 2015 Fall 2016 Fall 2017 Fall 2018 Fall 2019 Fall 2020 Fall 2021 Fall 2022
met
total not met


Object Oriented Programming Reasons
prerequisite(s) not taken
prerequisite(s) failing grade
other


Basic Computer Architecture Incidence
8
7
6
5
4
3
2
1
0
Fall 1993
Fall 1994
Fall 1995
Fall 1996
Fall 1997
Fall 1998
Fall 1999
Fall 2000
Fall 2001
Fall 2002
Fall 2003
Fall 2004
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Fall 2014
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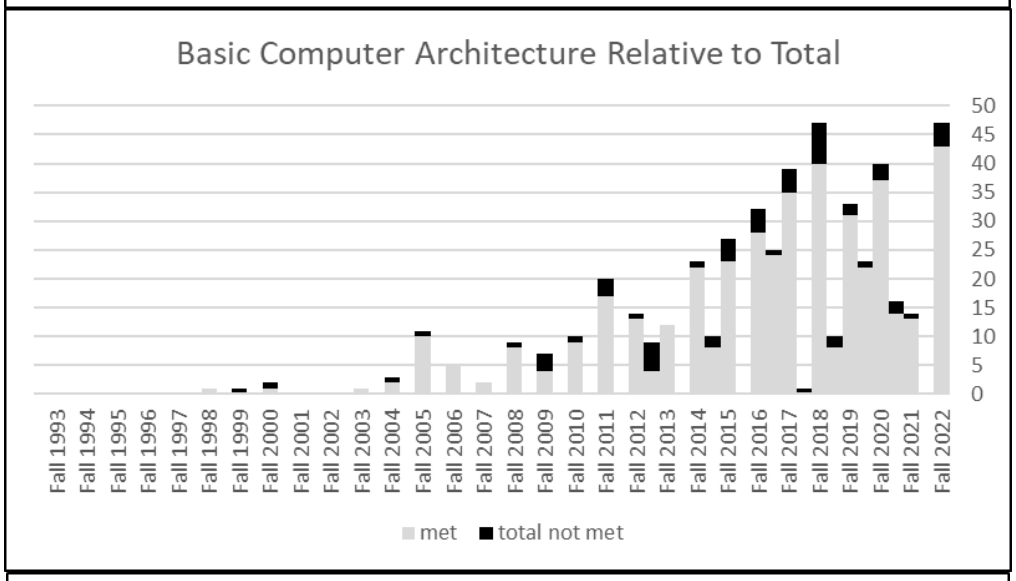
Fall 2019
Fall 2020
Fall 2021
Fall 2022
co-requisite(s) not taken
co-requisite(s) failing grade
other


Basic Computer Architecture Relative to Total
50
45
40
35
30
25
20
15
10
5
0
Fall 1993
Fall 1994
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Fall 1997
Fall 1998
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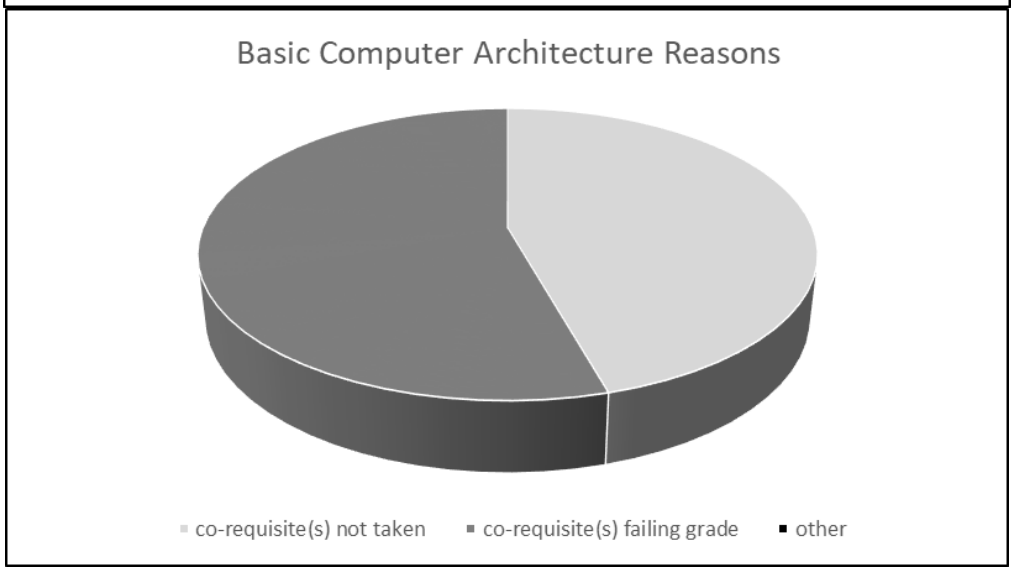
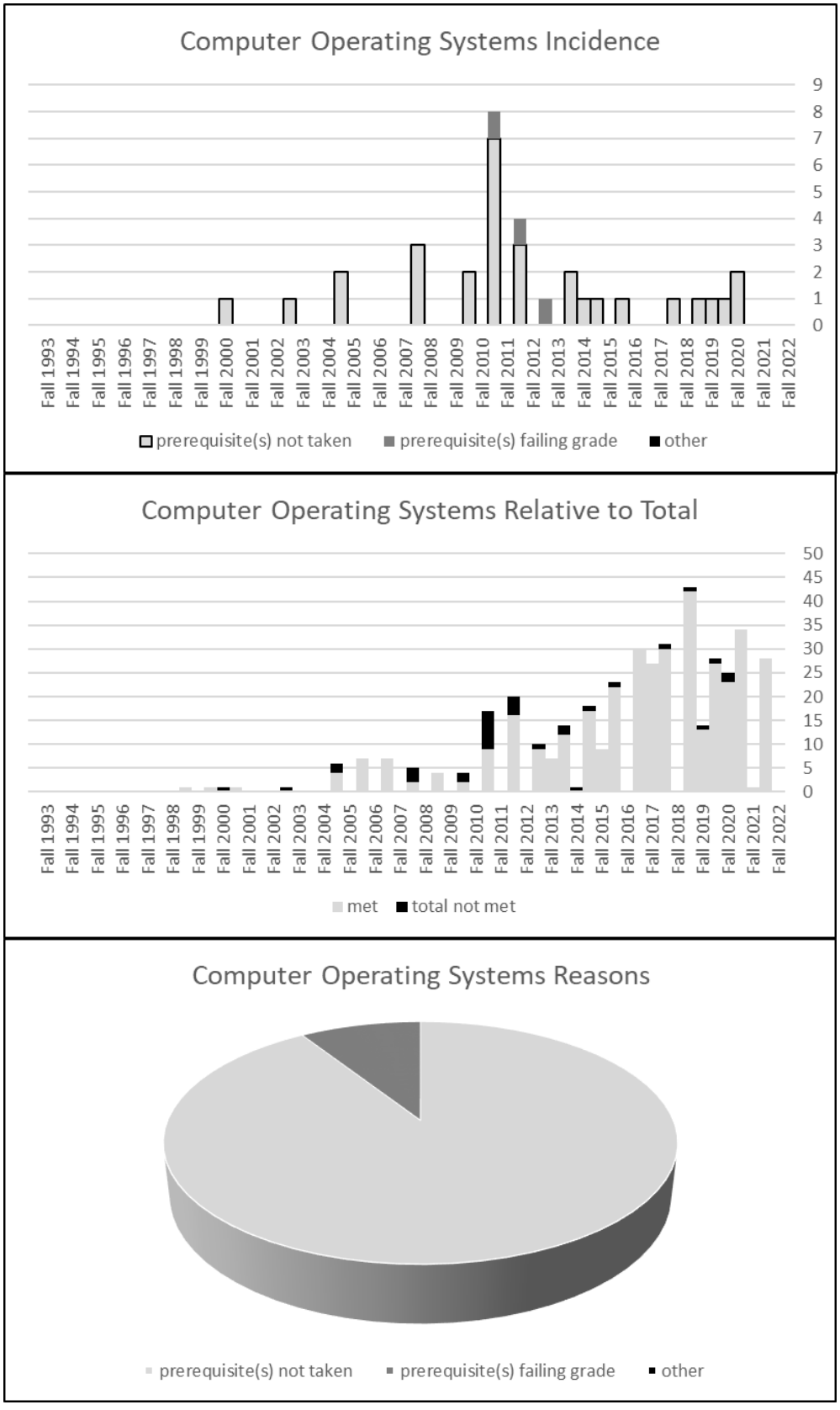
met
total not met


Basic Computer Architecture Reasons
co-requisite(s) not taken
co-requisite(s) failing grade
other


Computer Operating Systems Incidence
9
8
7
6
5
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3
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1
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Fall 1993
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Fall 1999
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Fall 2001
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Fall 2018
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Fall 2020
Fall 2021
Fall 2022
prerequisite(s) not taken
prerequisite(s) failing grade
other
Computer Operating Systems Relative to Total
50
45
40
35
30
25
20
15
10
5
0
Fall 1993
Fall 1994
Fall 1995
Fall 1996
Fall 1997
Fall 1998
Fall 1999
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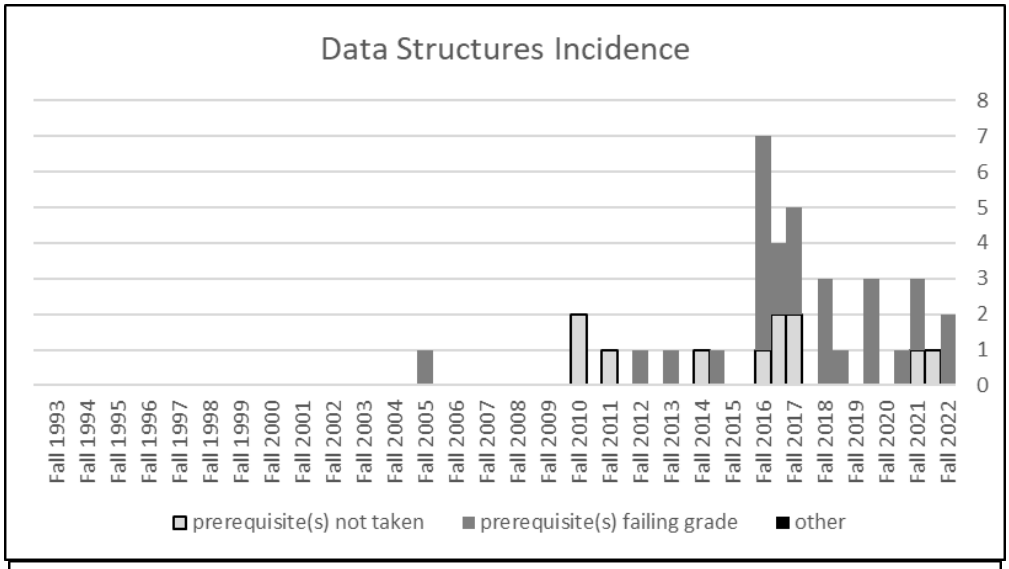
total not met
Computer Operating Systems Reasons
prerequisite(s) not taken
prerequisite(s) failing grade
other


Data Structures Incidence
8
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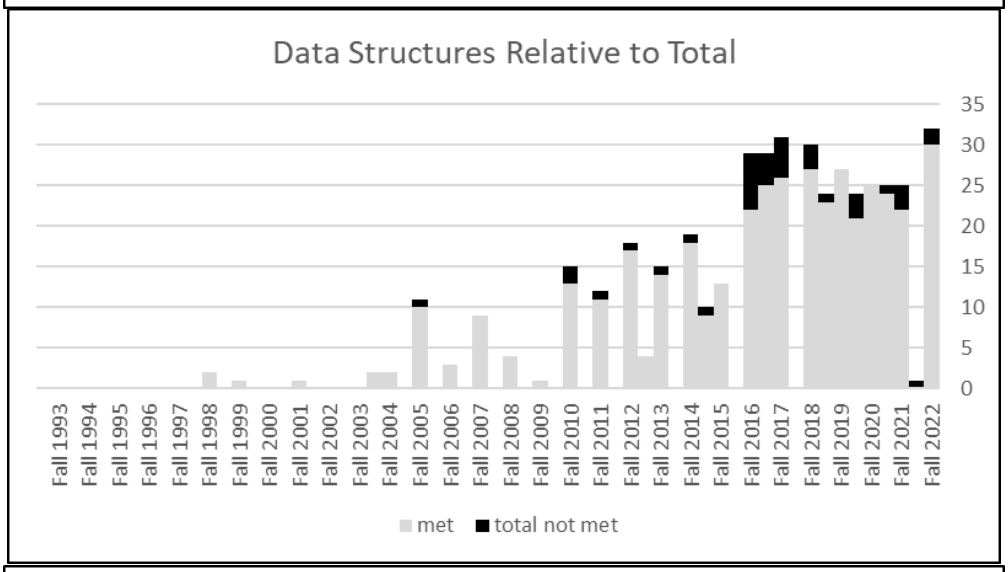
Fall 2022
prerequisite(s) not taken
prerequisite(s) failing grade
other


Data Structures Relative to Total
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Fall 1993
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Fall 2000
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Fall 2002
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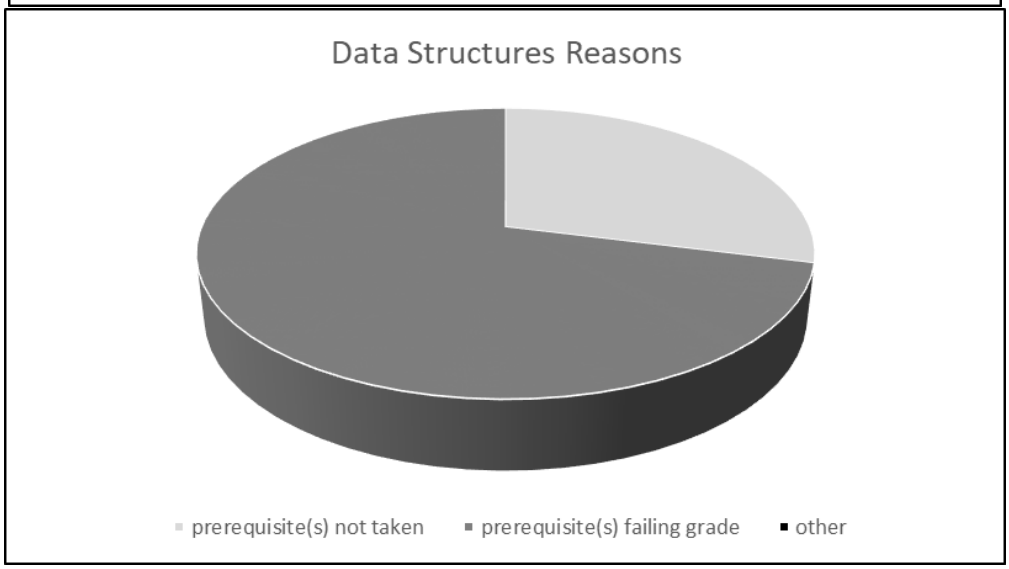
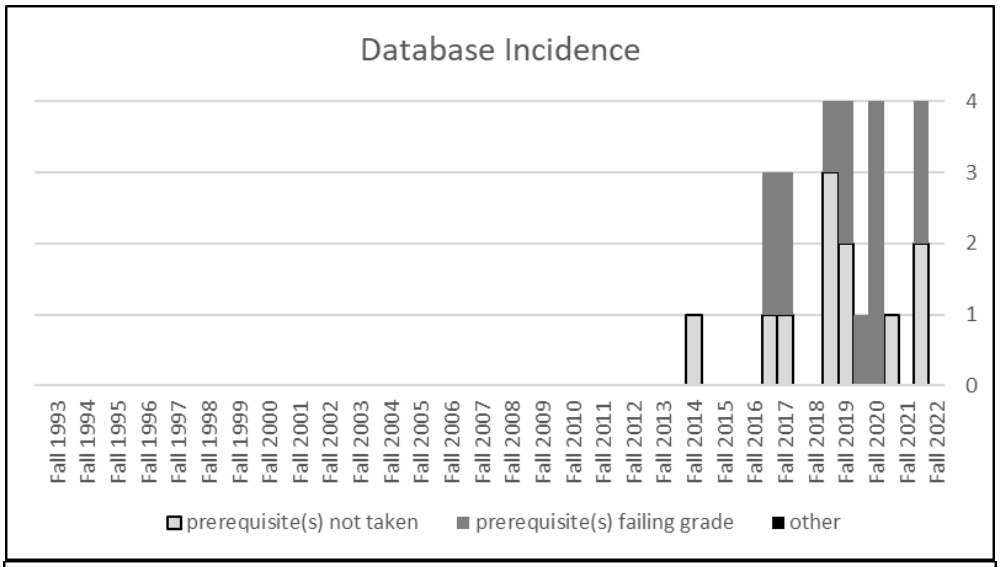
Fall 2021
Fall 2022
met
total not met


Data Structures Reasons
prerequisite(s) not taken
prerequisite(s) failing grade
other


Database Incidence
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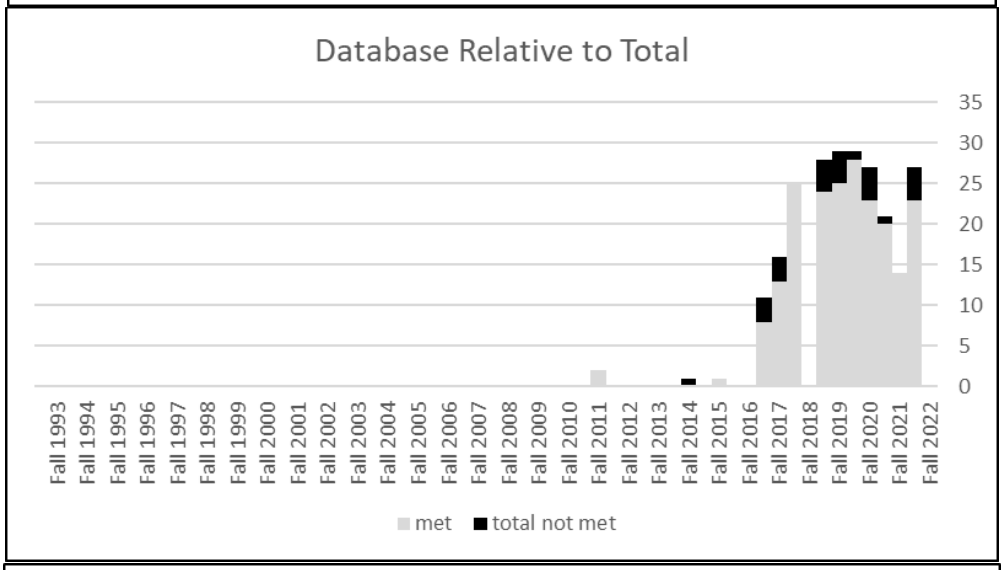
Fall 2022
prerequisite(s) not taken
prerequisite(s) failing grade
other


Database Relative to Total
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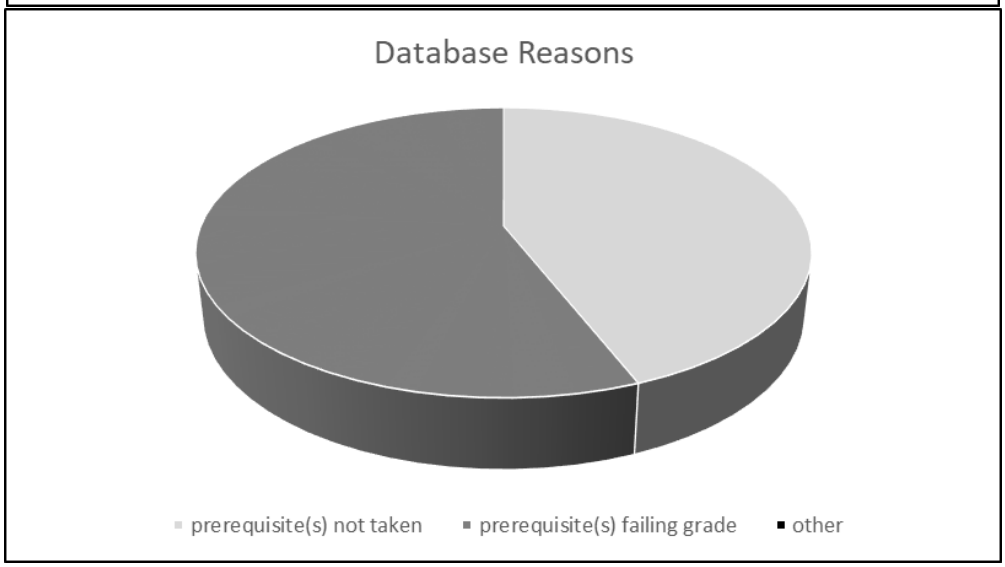
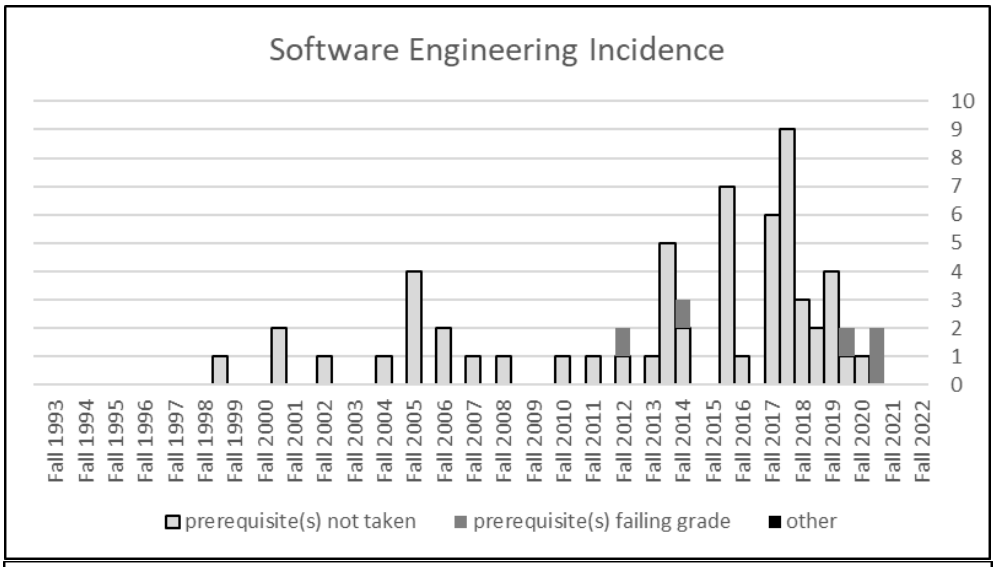
Fall 2021
Fall 2022
met
total not met


Database Reasons
prerequisite(s) not taken
prerequisite(s) failing grade
other


Software Engineering Incidence
10
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7
6
5
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Fall 1993
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Fall 1998
Fall 1999
Fall 2000
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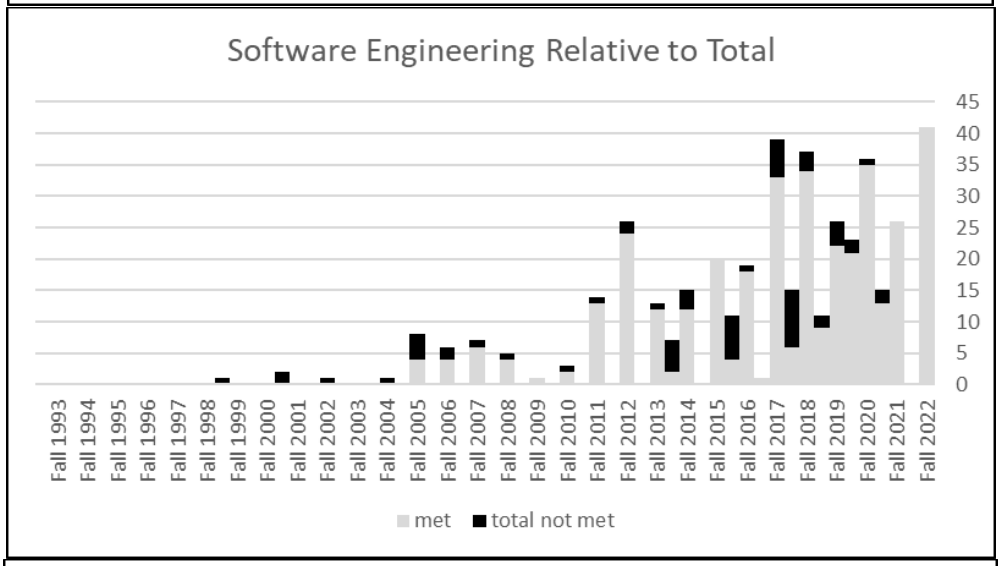
Fall 2021
Fall 2022
prerequisite(s) not taken
prerequisite(s) failing grade
other


Software Engineering Relative to Total
45
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35
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25
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Fall 1993
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Fall 1998
Fall 1999
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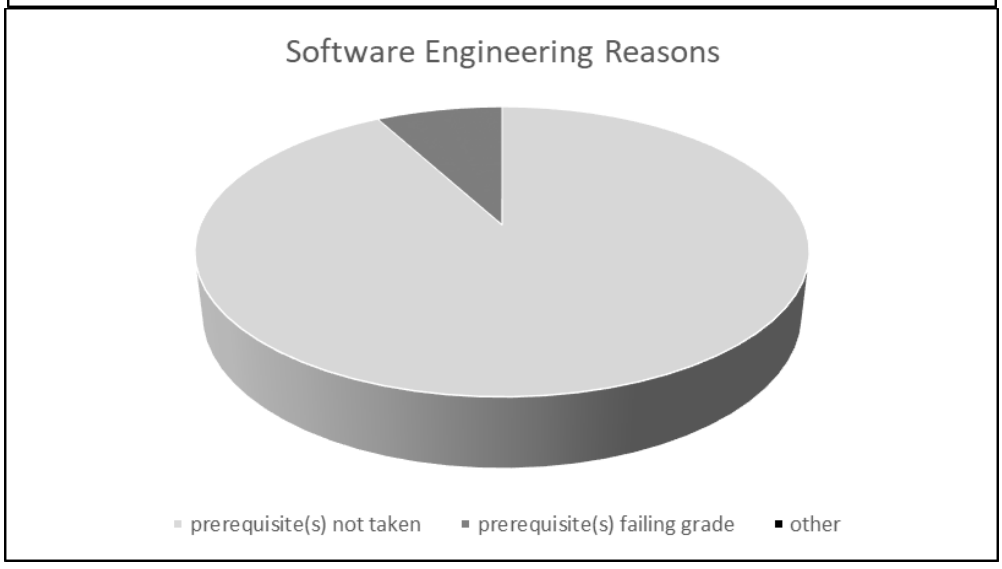
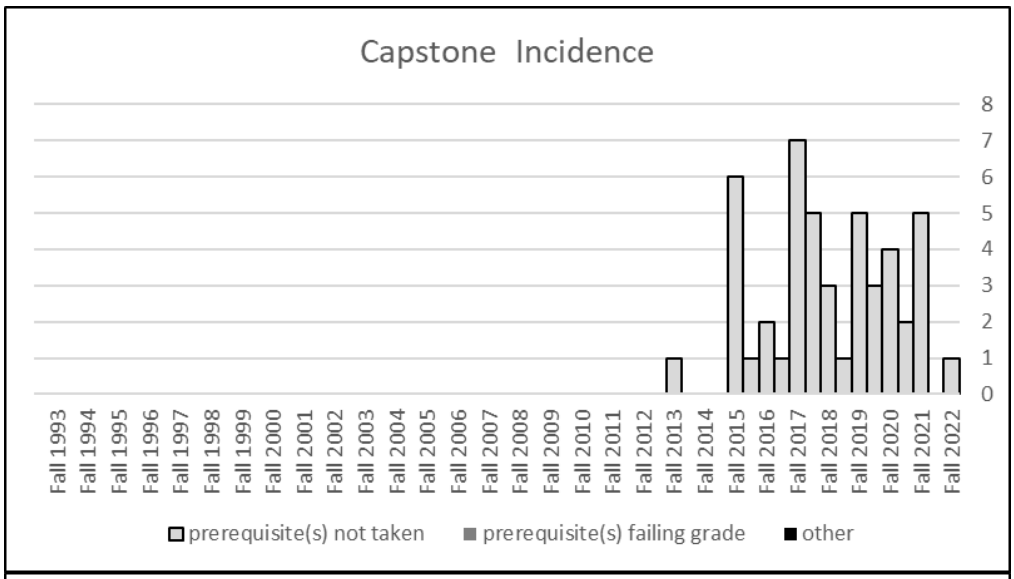
Fall 2018
Fall 2019
Fall 2020
Fall 2021
Fall 2022
met
total not met


Software Engineering Reasons
prerequisite(s) not taken
prerequisite(s) failing grade
other


Capstone Incidence
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Fall 1993
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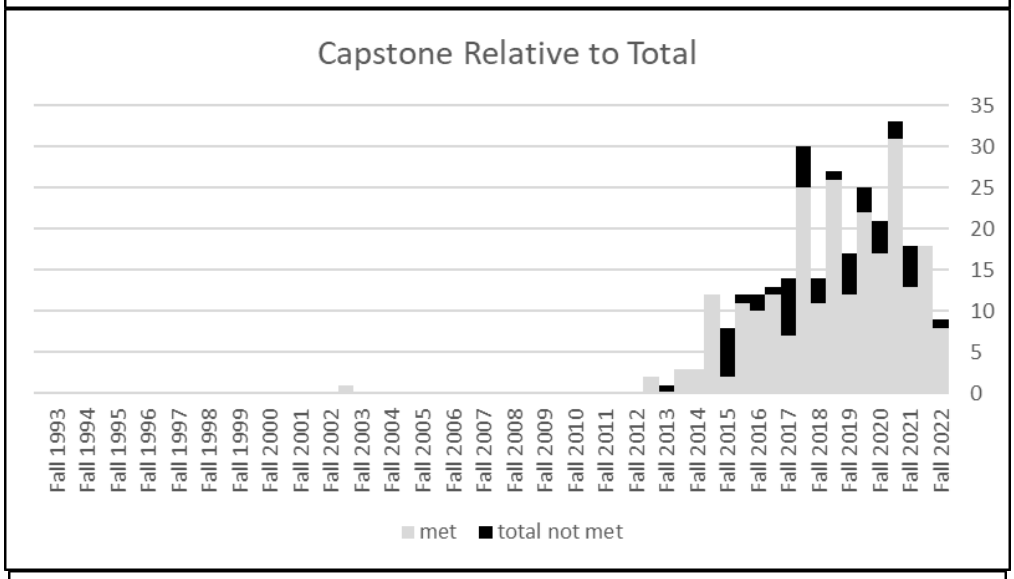
Fall 2020
Fall 2021
Fall 2022
prerequisite(s) not taken
prerequisite(s) failing grade
other


Capstone Relative to Total
35
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15
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0
Fall 1993
Fall 1994
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Fall 1996
Fall 1997
Fall 1998
Fall 1999
Fall 2000
Fall 2001
Fall 2002
Fall 2003
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Fall 2021
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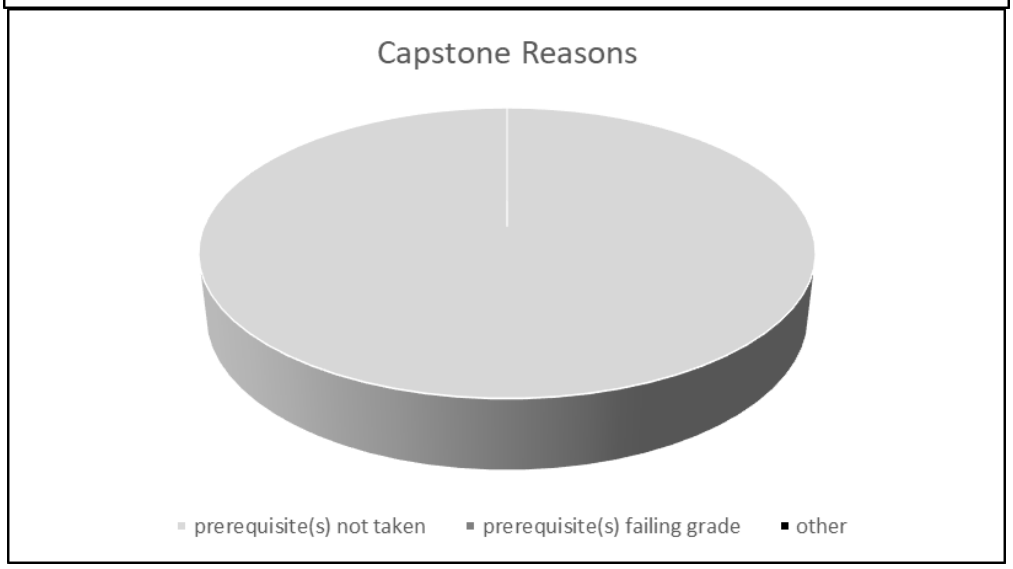
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Mid-Pandemic Impact on Mobile Learning Motivation Factors

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Abstract

The study examines the motivating factors driving mobile information systems use (MISU) for mobile learning. The primary objectives include comparing attitudes of students and faculty towards the influence of perceived usefulness (PU), perceived playfulness (PP), and perceived enjoyment (PE) on MISU. Additionally, the influence of personal innovativeness (PI) on PU, PE, and PP is also assessed. The previous study examined these attitudes prior to the pandemic. This study focuses on the attitudes existing mid-pandemic, when new strategies toward m-learning were by necessity applied much more broadly than at any other time historically. The method used is a survey of quantitative constructs. Research contributions, limitations, and implications for future research are also discussed. Though student participants felt perceived usefulness led to mobile learning use mid-pandemic, faculty did not. Furthermore, neither group felt perceived usefulness yielded perceived usability.

Keywords: motivation, mobile learning, pandemic, m-learning, COVID-19

1. INTRODUCTION

Organizations of all types have benefited from the development and use of information systems ("Measuring Digital Development Facts and Figures 2021," 2021). With the explosion of mobile applications, also known as mobile information systems, new uses are emerging. One such application of mobile information systems is mobile learning, referred to as m-learning hereafter. M-learning has found its ways in the corporate world for employee training and development, and in higher education for teaching and student learning. However, m-learning has historically not seen the same extent of usage as distance learning and e-learning, often attributed to technological limitations.

Motivational factors, though, may also contribute to the slow adoption of m-learning. But quarantine on a global scale produced a new level of motivation. With schools no longer in person, participation in learning required online interaction. If the problems of m-learning usage are not well understood and addressed, then usage may possibly decrease and the opportunities inherent in m-learning may be missed. Extant literature includes numerous m-learning studies explicitly focused on student use and perceptions of m-learning. Faculty members, on the other hand, have not been the focus of many studies, despite the integral role that faculty motivation likely plays in the use of m-learning. In this study the attitudes of both faculty and student are examined mid-pandemic and compared to a previous study on attitudes pre-pandemic (Bhatnagar, 2019).

2. LITERATURE REVIEW

In the literature several key themes are evident regarding the intersection of the pandemic and

the evolution of m-learning. This section discusses those key works, the definitions used in the context of the study, and theories that have previously been used to determine attitudes. The literature points to the validity of the approach and the importance.

The pandemic shaped key trends on usage of the Internet. Though mobile broadband usage was originally expected to peak at 85 percent in 2020, instead now 95 percent has access to a mobile broadband network ("Measuring Digital Development Facts and Figures 2021," 2021). In spite of this coverage, blind spots persist in rural areas. In developing countries, the cost of connecting to mobile broadband remains high, which restricts access.

M-learning mainly involves the use of mobile devices and wireless technologies (Pereira & Rodrigues, 2013) for training, learning, and teaching purposes (Sarrab, Elgamel, & Aldabbas, 2012) and this is the definition that was used in the context of this research study. Eteokleous and Ktoridou (2009) referred to m-learning as a successor of e-learning. They defined e-learning as learning that takes place with the use of digital electronic tools and media. The relationship between these similar concepts is diagrammed by Pereira & Rodriguez (2013) and shown in Figure 1.

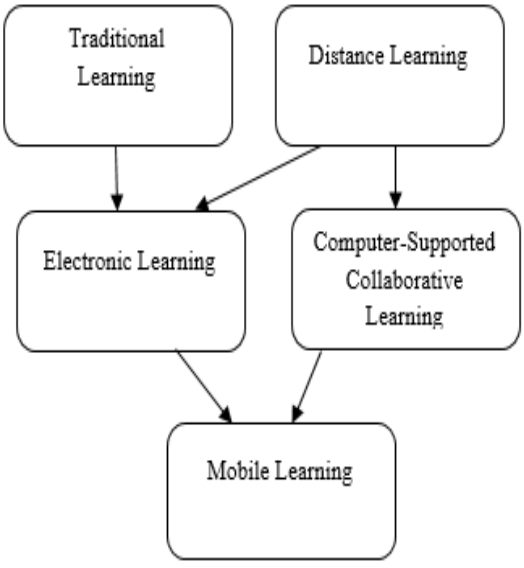

Figure 1: Illustration of the evolution of learning models (Pereira & Rodrigues, 2013)

E-learning moved from being part of the informal education system to mainstream in learning delivery ("78 Essential LMS and eLearning Software Statistics: 2022 Data Analysis & Market Share," 2022). Widespread acceptance of online learning is expected to continue post-pandemic. Cloud-based Learning Management System (LMS) have enabled the rapid adoption of the technology. The millennial population in the workforce is also a driver in the increased use of m-learning tools.

Some studies have started tracking the pandemic's impact on m-learning. In the study of m-learning for medical education, the importance of connecting stakeholders (both students and faculty) and using meaningful interaction with m-learning was exposed (Kalantrion et al., 2022). A study of online learning students in Macao suggests that learning motivation, even in the case of forced adoption of online, is key to success (Zhang, Lam, & Su, 2021). A study of m-learning in the less developed country of Libya points out the importance of good Internet connectivity to acceptance even during the forced adoption caused by the pandemic (Maatuk, Elberkawi, Aljawarneh, Rashaideh, & Alharbi, 2022).

Though the steps for making radical changes in organizations have been previously studied (Cameron & Green, 2019), most organizations did not have the option of controlled change during the pandemic. The typical mitigating actions that would have cushioned the migration to m-learning such as leading communications, satisfying needs for emotional security, etc. (Weiss & Li, 2020) were abbreviated at best. Furthermore, the assault of change was felt not just on learning, but in all aspects of existence.

Various theories have been used to explore attitudes and experiences related to m-learning. The Technology Acceptance Model (TAM) is frequently used in industry and in university settings (Buabeng-Andoh, 2021). The m-learning paradigm has even inspired the Mobile Technology Acceptance Model (MTAM) which adds personal innovativeness and usefulness as constructs driving adoption (Yuan, Tan, Ooi, & Lim, 2021). In a study focused on pedagogy and motivation, a combination of Bloom's taxonomy and Malone and Lepper's Taxonomy of Intrinsic Motivations for Learning was used as the study framework (Troussas, Krouska, & Sgouropoulou, 2022).

Similar to Bhatnagar (2019), perceived usefulness and perceived playfulness has been

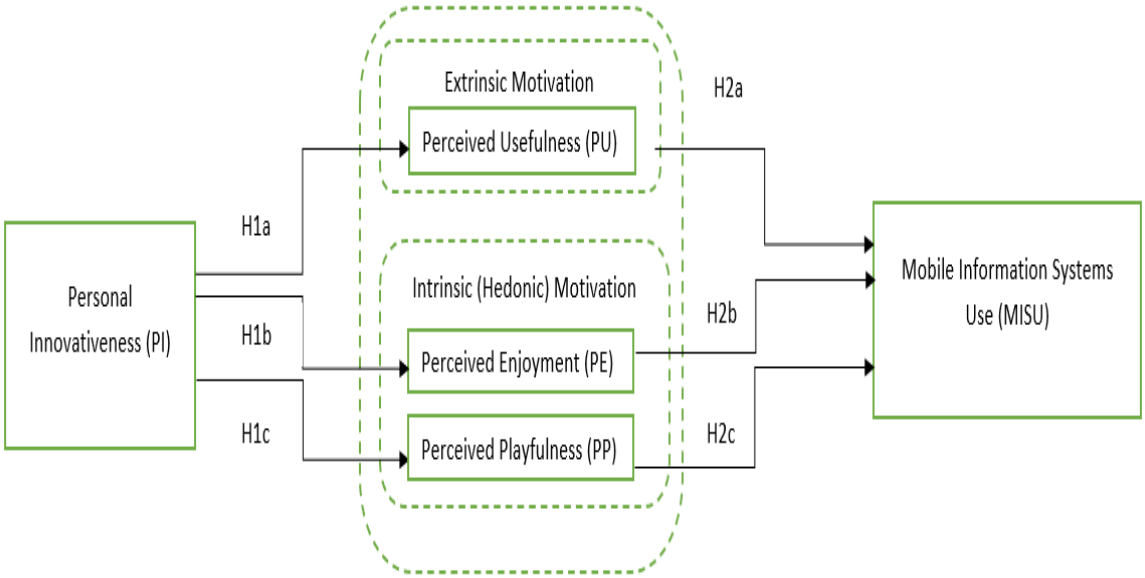

Figure 2: Proposed Theoretical Model adopted from Hwang (2014)

used to explore student acceptance and rejection of the mobile learning apps (Al-Bashayreh, Almajali, Altamimi, Masa'deh, & Al-Okaily, 2022). This study was created very early in the pandemic. It was noted in future directions in Al-Bashayreh et al. (2022) that though pre-pandemic conditions validated the relationships between playfulness and intent to use, the pandemic created an atypical situation where acceptance may have been forced on students.

3. THEORY

As seen in Al-Bashayreh et al. (2022), the influence of both intrinsic and extrinsic motivation factors on mobile information systems use (MISU) was tested. Intrinsic motivation factors assessed included perceived enjoyment (PE) and perceived playfulness (PP). One extrinsic motivator factor was assessed, perceived usefulness (PU). Additionally, the influence of personal innovativeness (PI) on PU, PE, and PP was also assessed.

The central research question that emerged from the current state of m-learning research was how to determine effective use of mobile devices in the context of mobile information system applications such as m-learning. Exploring how to integrate m-learning effectively (Crow, Santos, LeBaron, McFadden, & Osborne, 2010; Lam, Yau, & Cheung, 2010) is an important issue that lacks understanding (Eteokleous & Ktoridou, 2009) and is a major barrier for its use. It is not enough to look only at how mobile devices can be integrated.

Previously Hwang (2014) looked at personal innovativeness as it related to usage of Enterprise Resource Planning (ERP) systems. The factors of PU, PE, and PP were proposed to predict eventual system usage. This model was adapted as shown in Figure 2 to predict Mobile Information Systems Usage (MISU) based on PI, PU, PE, and PP. This lead to the first research question.

RQ1: What are the motivating factors driving m-learning use?

The goal was to examine which if any of the motivating factors of PU, PE, and PP were impacting MISU. Therefore, the following hypotheses were tested using the proposed theoretical model in Figure 2 to answer RQ1.

$H_0$1: PU, PE, and PP positively and significantly influence MISU.
H1a: PI will positively and significantly influence PU.
H1b: PI will positively and significantly influence PE.
H1c: PI will positively and significantly influence PP.

H2a: PU will positively and significantly influence MISU.
H2b: PE will positively and significantly influence MISU.
H2c: PP will positively and significantly influence MISU.

The second research question looks at what is being included in MISU. Particularly in the mid-pandemic timeframe, the range of activities included in m-learning expanded drastically, as did the participating population in comparison to pre-pandemic. This reality incited the second question.

RQ2: How is m-learning being used for teaching, learning, and training?

RQ2 was answered via four questions in the survey instrument. These can be seen in Appendix A & B.

The hypotheses, graphically displayed in Figure 3, were tested using the theoretical model (Figure 2) to answer both research questions via the survey instrument. PI will positively and significantly influence PU, PE, and PP (H1a, H1b, H1c) and PU, PE, and PP will positively and significantly influence MISU (H2a, H2b, and H2c).

4. METHODOLOGY AND PROCEDURE

Institutional Review Board approval was received at the primary investigator's institution prior to commencing the study. An online survey was created using Qualtrics and analyzed using Structural Equation Modeling. The questions replicated those used in a study of pre-pandemic attitudes towards mobile learning (Bhatnagar, 2019). The survey also contained questions to help understand how m-learning is being used for teaching and learning. For details, please see Appendix A (Faculty Survey Instrument) and Appendix B (Student Survey Instrument).
Participants were contacted via email and requested to participate in the study. Whereas the previous study focused only on faculty teaching in the disciplines of computer science, information systems, and business at 60 institutions of higher education (both public and private) who are members of the Association of American Universities (AAU) in the United States, this study was expanded to also include students. Faculty and students at a regional campus of an R1 university in western Pennsylvania along with international students at a European university took the survey. This provides a sample set with wider cultural representation.

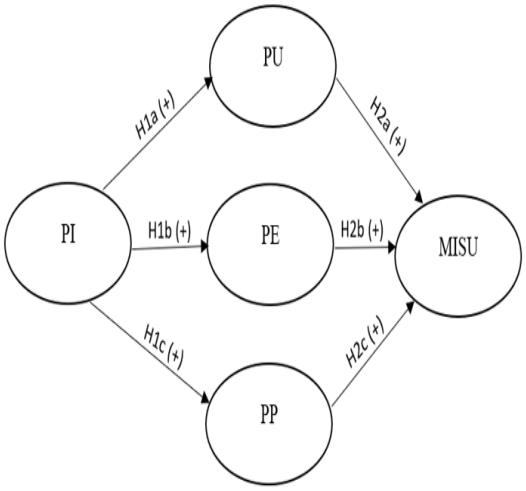

Figure 3: Conceptual Map of the Research Model

The initial email was sent to a total of 959 undergraduate students, 16 graduate students and 186 faculty. A reminder email was sent after one week to 979 undergraduate students and 187 faculty. Additional students had been added to the shared email list in the time since the initial email, so more students were contacted in the reminder. The response rates for both faculty and students were significantly low at 9% and 4% respectively.

The data was first cleaned by removing blank records, and incomplete responses. The data was then coded. Microsoft Excel, SPSS and SmartPLS were used for the data analysis.

In addition to the questions of the original survey (Bhatnagar, 2019), a measurement of usability was also taken using the System Usability Scale (SUS) metric. The importance of student satisfaction during the pandemic forced adoption (Uthman & Ahmed, 2022) seemed to be a critical factor. Usability measures like SUS indicate how users feel about the experience of using the system. Though previous studies of the effect of Computer Anxiety (CA) had not shown a direct relationship between CA and the intention to use (Ball & Levy, 2008), studies during the pandemic have shown otherwise (Alsubaie, Alzarah, & Alhemly, 2022). The amount of change induces technostress which means more attention needs to be paid to the student and faculty experience.

The reliability and validity of SUS has been documented by 20 years of SUS Scores (Sauro,

2011). Reliability refers to the consistent response to the items. SUS detects differences in smaller sample sizes (as few as two users) and generates reliable results. Validity refers to whether an instrument measures the target, which for SUS is perceived usability. SUS has been shown to effectively distinguish between unusable and usable systems and correlates highly with other questionnaire-based measurements of usability. These characteristics combine to make SUS an improvement to commercial alternatives and home-grown questionnaires (Sauro, 2011). The SUS provides a comprehensive measure in addition to the dimensionality measures of the original instrument.

The discussion of key results is divided into two sections. The first section provides a comparison of the results between the pre-pandemic and mid-pandemic findings. The second section looks at the student data results.

5. COMPARISON PRE/MID PANDEMIC RESULTS FOR FACULTY

SPSS was used to perform pre-analysis data screening. Outliers, or extreme cases, in the data were evaluated for all datasets using both the univariate and multivariate techniques. Since the data was coded on a 7-point Likert scale, a visual inspection of the data showed no univariate outliers. With 24 items, the degrees of freedom is 24 and the critical value for chi-square at $p<.001$ equals 51.179. For the current study, the analysis called for the elimination of one case, but it was not removed. In the pre-pandemic study six cases had to be removed since the Mahalanobis distance was greater than 51.179.

Structural model analysis was done in two parts. The measurement model focuses on internal consistency reliability, convergent validity, and discriminant validity. The structural model is assessed by evaluating collinearity, the significance of path coefficients, the level of R^2 values, the f^2 effect size, the predictive relevance (Q^2), and the q^2 effect size (Hair Jr, Hult, Ringle, & Sarstedt, 2013).

Measurement Model

Internal consistency reliability is measured by evaluating composite reliability and Cronbach's alpha. Composite reliability ranges between zero and one. The higher the number, the higher the composite reliability. Cronbach's alpha greater than 0.8 are good. The model showed strong internal consistency reliability for both the pre-pandemic and mid-pandemic studies.

The two most common measures of construct validity are convergent and discriminant validity. Any reflective indicator whose outer loading is below 0.4 should be removed. However, indicators with outer loadings between 0.4 and 0.7 should be further analyzed by looking at the impact on composite reliability and average variance extracted (AVE) before any elimination takes place (Hair Jr et al., 2013).

In the pre-pandemic study, MISU7 had an outer loading of -0.358, in this study it is 0.044. Since

Model	Pre-Pandemic	Mid-Pandemic
Measurement	Strong internal consistency reliability	Strong internal consistency reliability
	Convergent validity achieved after removing MISU7, PP1, and PP2	Convergent validity achieved after removing MISU7, PP1, and PP2
	Discriminant validity was achieved	Discriminant validity was achieved
Structural	No collinearity issues were found	No collinearity issues were found
	All paths except H2c were positive	All paths except H2c were positive
	H2b and H2c were rejected as they were not significant	H2a, H2b, and H2c were rejected as they were not significant
	R^2 values showed weak predictive accuracy	PI did not appear in the results, R^2 values for remaining constructs show moderate predictive accuracy
	Effect size (f^2) was small for H1a and H2a, medium for H1c, and large for H1b	Effect size (f^2) was small for H2c, medium for H2a and H2b, and large for H1a, H1b, and H1c
	Q^2 values indicated model has minimal predictive relevance	Q^2 values indicated model has a strong predictive relevance
	q^2 effect size very small for PE, PU, and PP.	q^2 effect size medium for PE and PU and small for PP

Table 1: Comparative Analysis of Results for Faculty

it is below 0.4, it should be removed. PP1 and PP2 have outer loadings between 0.4-0.7, 0.681 and 0.697 respectively (in the previous study with 0.641 and 0.495 respectively). These were further examined by looking at the impact on composite reliability and average variance extracted (AVE) before their elimination. As was the case in the previous study, composite reliability, Cronbach's alpha, and AVE are greatly improved by removing MISU7, PP1, and PP2. These three indicators were removed prior to completing the remainder of the analysis. The indicator reliability is the squared value of an indicator's outer loading.

Discriminant validity is assessed by examining the indicator cross loadings and the Fornell-Larcker criterion. In both studies these were met without any issues.

Structural Model

The structural model is assessed by evaluating collinearity, the significance of path coefficients, the level of R^2 values, the f^2 effect size, the predictive relevance (Q^2), and the q^2 effect size (Hair et al., 2013). These are discussed next.

SPSS was used to assess collinearity. Collinearity involves examining tolerance levels and the variance inflation factor (VIF). Tolerance levels below 0.2 and VIF above 5.0 are indicators of collinearity. In both studies the results indicate no collinearity issues.

Structural model path coefficients should be between -1 and +1. Coefficients that are close to +1 represent a strong positive relationship, -1 a strong negative relationship, and close to zero a weak or nonsignificant relationship (Hair et al., 2013). Since the hypotheses for the study are unidirectional, this implies a one-tailed test. In the pre-pandemic study, two of the paths were not significant, from PE to MISU (rejecting H2b) and from PP to MISU (rejecting H2c). In this study besides these two, the path from PP to MISU is also not significant (rejecting H2a).

The coefficient of determination, R^2, value ranges from 0 to 1 and there is no agreed upon value for an acceptable R^2 value (Hair et al., 2013). However, Hair et al. stated that values of 0.75 (substantial), 0.50 (moderate), and 0.25 (weak) can be used as a rule of thumb. Based on the results, MISU, PE, PI, and PP had weak predictive accuracy in the pre-pandemic study. In this study, PI did not appear in the results and the remaining constructs have a moderate predictive accuracy.

According to Hair et al. (2013), effect size (f^2) values of 0.02 (small), 0.15 (medium), and 0.35 (large) are the effect sizes that should be used to evaluate the structural model. In the previous study, PI had a large effect on PE, a medium effect on PP. and a small effect on PU and PU had a small effect on MISU. In this study, PI has a large effect on PU, PE, and PP whereas PU and PE have medium effects on MISU and PP has a small effect on MISU.

Blindfolding is a method used to calculate predictive relevance (Q^2). Q^2 indicates the model's predictive relevance (Hair Jr et al., 2013). Assessment of Q^2 uses the same values for small, medium, and large as f^2. While the pre-pandemic study showed the model to have some predictive relevance, even if minimal, in the current study the model has a stronger predictive relevance.

Just as f^2 effect size is used to assess R^2 values, relative impact of predictive relevance can be compared by means of the measure to the q^2 effect size (Hair Jr et al., 2013). The equation to calculate the q^2 effect is seen below.

(Q^2 included – Q^2 excluded) / (1-Q^2 included)

The values of 0.02, 0.15, and 0.35 show small, medium, or large predictive relevance. MISU is the endogenous variable. By removing each of the latent variables (PE, PU, and PI) one at a time, and calculating the predictive relevance, determines the effect size of each latent variable on the endogenous variable. In the previous study it was determined that all predictor variables had a very small effect size. In this study, PE and PU have a medium effect size while PP has a small effect size. Table 1 summarizes the

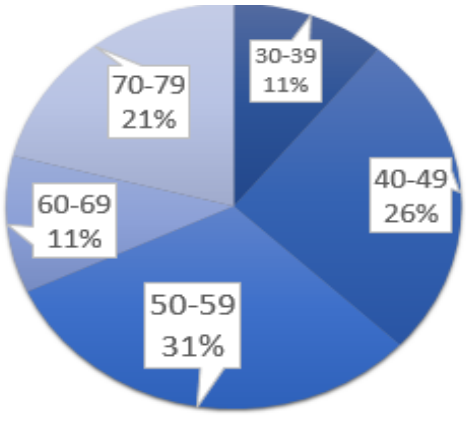

Figure 4: Faculty age range

findings of the mid- and pre-pandemic data results for faculty.

Faculty Demographics

In the current study, analysis of the faculty demographics showed that the survey was completed primarily by females (56%) in the age ranges shown in Figure 4. Overwhelmingly 81% have earned doctorate degrees and teach in disciplines other than Information Systems, Business, and Computer Science. The disciplines in which participants obtained their higher degree was wide ranging. All participants (100%) teach at the undergraduate level. It was interesting to find that 31% of them teach on-campus (i.e. in-person, face-to-face) and hybrid in spite of the pandemic.

The average number of years of teaching experience is 22 years and the average number of years in higher education is 20 years. A majority are employed full-time (75%) and teach at a public university (94%). The average years of teaching on-campus are 19, online 5, and hybrid 3. Most are not on tenure track (62%).

Pre-Pandemic M-Learning Uses

The uses of m-learning (which address RQ2) showed that 18% of the participants using m-learning (n=87) used four of the five options provided: in-class and out-of-class activities, online and hybrid course. Around 8% used one or more combinations of the options provided. The types of activities being used for m-learning in teaching were wide ranging. See Appendix C for the types of activities surveyed.

Of the 87 participants who identified themselves as users of m-learning, three (3%) stated that they had been using m-learning for less than one year, 55 (63%) started using m-learning between 1 to 6 years ago, seven (8%) between 7 to 10 years, and 22 (25%) had started using it over ten years ago. Seventy-six (87%) use it anywhere from several times a day to 3-5 days a week. The remaining 11 participants (or 12%) use it less frequently. Sixty-three (72%) of the 87 participants stated that they felt moderately or very comfortable using m-learning.

Teaching resources provided on a mobile device resulted in 61 combinations of choices. The top three choices accounted for 17% of the resources used. These include using a combination of lecture PPT slides, audio, and video recordings, print content, eBooks, hyperlinks to course-related reference material, and Blackboard. Some participants also provided information on other resources provided to students on a mobile device. The most commonly listed system was Canvas.

In general, most participants (86%) expressed a level of satisfaction in using m-learning that ranged between somewhat to mostly satisfied. Hardware used for m-learning primarily includes generic laptops, phones, video cameras, computers, and e-readers. Next would be all the Apple products (iPhone, iPad, mac, MacBook). The predominant software used is Canvas. Others used are wide-ranging (Bhatnagar, 2019).

Mid-Pandemic M-Learning Uses

Faculty are currently using m-learning for all of the following options (in various types of combinations): in-class and out-of-class activities, online course, hybrid course, as well as for professional development/training. All 16 participants started using m-learning over a year ago, eleven (70%) have been using it between 1 to 6 years, two (12%) have been using it between 7 to 10 years, and the remaining three (18%) have been using it over 10 years. Sixty-two percent use it anywhere from several times a day to about once a day. Twenty-five percent use it 3-5 days a week, twelve percent use it 1-2 days a week, twelve percent use it every few weeks or less often, and only six percent has never used it. Two new questions were added to the survey. The first asked if participants were given a choice other than mobile learning during the pandemic. Thirty-seven percent said yes, and sixty-three percent said no.

Of those that stated they were not given a choice, all participants stated that they did not choose to not teach to avoid mandatory mobile learning. Almost seventy percent stated they are moderately or very comfortable in using m-learning. Teaching resources provided on a mobile device resulted in 14 combinations from the choices that were provided. Some of these choices included lecture PPT slides, audio, and video recordings, among others. A majority (87.5%) expressed a level of satisfaction ranging from neither satisfied nor dissatisfied to somewhat satisfied. Participants were asked to identify how frequently they engaged in various types of activities using their mobile devices to support teaching. See Appendix C for a breakdown of the responses. In a follow-up question most participants (68%) said they did not engage in any other activities using mobile devices to support teaching.

Hardware used for m-learning primarily includes phones and laptops. Canvas is the learning management system used at the regional campus

where the survey was administered and chosen by majority of the participants. There were a myriad of other software programs identified, some discipline specific.

6. MID-PANDEMIC STUDENT RESULTS

As discussed earlier, students were added to the study for the mid-pandemic study. In the conditions of the mid-pandemic, it was felt student results, though not part of the previous study, were also relevant. This section analyzes the student data.

Measurement Model
There were no outlier cases with a value greater than 51.179 that had to be eliminated. The model showed strong internal consistency reliability for all constructs except PP. Convergent validity analysis showed the outer loadings for PP1 between 0.4 and 0.7 and below 0.4 for MISU7 and PP2. As such composite reliability, Cronbach's alpha, and AVE greatly improve by removing MISU7, PP1, and PP2. These indicators were removed before proceeding the remainder of the analysis. Indicator cross loadings and the Fornell-Larcker criterion were met without any issues indicating no issues with discriminant validity.

Structural Model
Analysis of the constructs showed collinearity issues with PP in terms of tolerance and VIF. Based on the structural model and path coefficients, two of the paths were not significant, from PI to PE (rejecting H1b) and from PP to MISU (rejecting H2c). The coefficient of determination (R^2) values for PE, PI, and PP indicate weak predictive accuracy. In terms of effect size (f^2), PU and PE have a large effect on MISU, PI has a medium effect on PE, PU, and PP, and PP has a small effect on MISU. Blindfolding and predictive relevance (Q^2) showed that the model does have predictive relevance. Effect size (q^2) indicates that all predictor variables have a medium to large effect size.

Student Demographics
Analysis of the student demographics questions shows that the average age of the participants is 20 years old. The survey was completed by more females (48%) than males (46%). A majority of the students were undergraduates (78%) and 19% were graduate students. The graduate students were primarily pursuing business degrees while the undergraduate students represented a variety of disciplines such as business, management, biological sciences, information technology/cybersecurity, nursing, psychology, among others. Some of the disciplines were listed as double majors.

7. DISCUSSION

Several important conclusions emerge from the analysis. The results of the study related to the hypotheses are shown in Table 2.

Hypotheses	Construct	Pre	Mid
H1a	PI → PU	Accept	Accept
H1b	PI → PE	Accept	Accept
H1c	PI → PP	Accept	Accept
H2a	PU → MISU	Accept	***Reject***
H2b	PE → MISU	Reject	Reject
H2c	PP → MISU	Reject	Reject

Table 2: Summary of Hypotheses (Faculty)

Pre/Mid Pandemic (Faculty)
In both the pre-pandemic and the current study, PI did positively and significantly influence PU, PE, and PP. This led to accepting H1a, H1b, and H1c. Hwang's (2014) research had explored testing the impact of personal innovativeness of IT (PIIT) on the intrinsic motivation factors perceived enjoyment (PE) and perceived ease of use (PEOU) and the extrinsic motivation factor of perceived usefulness (PU) as it related to the use of ERP systems. Hwang arrived at similar conclusions with PIIT influencing PE, PEOU, and PU. In the context of both studies, the fact that PI positively and significantly influences PE, PU, and PP implies that the participants are willing to try using new technologies, such as mobile information systems, because they find these systems to be useful, enjoyable, and like interacting with these.

Also in the pre-pandemic study, PU was found to positively influence MISU, but this is not the case for the mid-pandemic study. Prior to the pandemic, this implied that participants are using mobile information systems (m-learning) because they find m-learning to be useful for teaching and student learning. Even earlier studies of the impact of PU on IS continuance intention using Blackberry hardware showed PU positively impacted IS use (Chen, Meservy, & Gillenson, 2012).

For the mid-pandemic, in spite of perceived usefulness, the participants did not find that a motivator for MISU.
Third, in the previous study, PE and PP did not influence MISU which meant that using mobile

information systems for m-learning was not perceived to be enjoyable or interesting to use or that enjoyment and playfulness were not the reasons that would influence using mobile information systems, such as m-learning. This is also true for the current study.

Fourth, based on R^2 and Q^2 values, the model has a weak predictive accuracy and minimal predictive relevance, whereas in the current study, the model shows moderate predictive accuracy and a strong predictive relevance.

Fifth, in the pre-pandemic study, the f^2 of PE and PP has no effect on MISU, which also confirmed the rejection of H2b and H2c while the other effect sizes confirm accepting H1a, H1b, H1c, and H2a. In the current study, there were no f^2 values which had no effect on MISU even though the structural paths indicate that H2a, H2b and H2c should be rejected.

Lastly, in the previous study the q^2 effect size showed little to no significance for PE, PU, and PP while in the current study the significance is small for PP and medium for PE and PU.

Mid-Pandemic (Student)
As seen in Table 3, the student results matched the faculty response for H1a, H1c and H2c. The effect of PI on PE was rejected by the students (H1b). Unlike the faculty in the mid-pandemic result, the effect of PU and PE on MISU were accepted.

Hypotheses	Construct	Result
H1a	PI → PU	Accept
H1b	PI → PE	Reject
H1c	PI → PP	Accept
H2a	PU → MISU	Accept
H2b	PE → MISU	Accept
H2c	PP → MISU	Reject

Table 3: Summary of Hypotheses (Student)

The students do feel enjoyment will encourage MISU. But they do not feel that playfulness will encourage MISU. Considering that these results were obtained in a time period where adoption of MISU was mandatory due to the pandemic, students may be expressing a frustration with the lack of options.

SUS
Examining the SUS data from both the faculty and student revealed the perception of a lack of usability in the m-learning applications. Analysis of the SUS data typically yields a letter grade of A-F. The participants rated the usability of m-learning at a solid D, or barely acceptable.

This finding is interesting, in light of the contrast between student and faculty results for perceived enjoyment. Student results did support that PE positively influenced MISU. Faculty results did not. But neither rated the usability of m-learning favorably. Once again, this points to the technostress induced by the intense and rapid implementation due to COVID-19 (Uthman & Ahmed, 2022). The stress on both faculty and students did not make them feel m-learning systems were usable.

In addition, the 81% of the faculty participants were not teaching the more technological subjects of Information Systems, Computer Science, or Business. The low usability score may also be affected by lesser expertise in technology.

8. CONTRIBUTIONS, LIMITATIONS, AND FUTURE RESEARCH

Contributions
The results achieved from the study are valuable and provide significant contributions to the body of knowledge. The research helped 1) identity motivation factors driving the use of mobile information systems for m-learning, 2) understand how m-learning is being used for teaching, learning, and training. The research extends prior research on m-learning which has been deficient in understanding faculty use of m-learning.

No prior research studies were found that looked at motivation factors for the use of m-learning and were limited on understanding faculty use with most research focused on student use. Research on information systems use is ample but research focusing on mobile information systems use is limited or nonexistent. Finally, research on motivation to use m-learning during forced adoption due to a global health crisis is non-existent. This is the unique contribution of this research to the fields of Human Computer Interaction/User Experience (HCI/UX), Information Systems, and M-learning.

Limitations
Limitations of both the pre-pandemic and mid-pandemic studies include the limited participants who were contacted to participate in the study, affecting the generalizability of the studies. The mid-pandemic study had a specific window of time to gather results before conditions shifted again. Additionally, the low response rate and self-reporting by participants completing an online survey may have introduced bias in the

responses received.

Future Research

Given the limited scope of the study, it is evident that more research is needed. It should also be expanded to include more institutions of higher education and additional disciplines. Non-response rate and the generalizability of the study must also be accounted for. Grounding the study in other information systems theories that may better explain use or non-use is also suggested. This would allow investigating other factors beyond PI, PU, PE, and PP, such as resistance to use. Finally, as suggested by Ball and Levy (2008), research on methods to encourage instructors in the use of emerging technology would benefit both the researchers and practitioners. Such research could address the technostress (Uthman & Ahmed, 2022) experienced by both students and instructors.

It is hoped the results of this study may be compared to future research that repeats these questions in a post-pandemic world. In the future study the constructs PP1, PP2, and MISU7 (as seen in Figure 1) should not be included because composite reliability, Cronbach's alpha, and AVE are improved when they are removed. Further comparison of the data to a reality without forced adoption may reveal insights on motivations. The forced adoption may be a key factor in motivation and user satisfaction.

9. CONCLUSION

The data for motivating factors shows some differences between faculty and student attitudes towards m-learning. Some shift in perception is also shown based on pre-pandemic to mid-pandemic. As the situations surrounding the implementation of m-learning continue to shift, it will be of interest to see how this influences the attitudes of faculty and student. Information System (IS) educators should be aware of the negative attitudes towards perceived usefulness and perceived usability of m-learning systems.

10. ACKNOWLEDGEMENTS

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APPENDIX A
Faculty Survey Instrument

1 Which of the following best describes YOUR use of m-learning at your current institution? Please check all that apply.

For in-class activities
For out-of-class activities
For an online course
For a hybrid course (combination of in-class and online)
For professional development/training

Scale for items 2 through 6:

[1] strongly disagree, [2] disagree, [3] strongly disagree, [4] neither agree or disagree, [5] slightly agree, [6] agree, [7] strongly agree

2 Personal Innovativeness (PI) - "willingness of an individual to try out any new information technology." (Agarwal & Prasad, 1998, p. 260)

PI1. If I hear about new information technology, I will look for ways to experiment with it.
PI2. Among my faculty peers, I am usually the first to try out new information technologies.
PI3. In general, I am not hesitant to try out new information technologies.
PI4. I like to experiment with new information technologies.

3 Perceived Usefulness (PU) - "degree to which a person believes that using a particular system would enhance his or her job performance." (Davis, 1989, p. 320)

PU1. Using m-learning makes it easier to teach.
PU2. Using m-learning enhances my teaching effectiveness.
PU3. Using m-learning gives me greater control over teaching.
PU4. I find m-learning to be useful in my teaching.

4 Perceived Enjoyment (PE) - "extent to which the activity of using the computer is perceived to be enjoyable in it's own right, apart from any performance consequences, that may be anticipated." (Davis et al., 1992, p. 1113)

PE1. Using m-learning is fun.
PE2. Using m-learning is enjoyable.
PE3. Using m-learning is very entertaining (pleasant).
PE4. Using m-learning is interesting.

5 Perceived Playfulness (PP) - "the extent to which the individual finds the interaction intrinsically enjoyable or interesting." (Moon & Kim, 2001, p. 219)

PP1. When using m-learning, I will not realize the time elapsed.
PP2. When using m-learning, I will forget the work I must do.
PP3. Using m-learning will give enjoyment to me for my teaching.
PP4. Using m-learning will stimulate my curiosity.
PP5. Using m-learning will lead to my exploration.

6 Mobile Information System Use (MISU) - involves the use of mobile devices to use an information system to "...carry out tasks and activities on the job for which the information system is designed to support" (Sun & Teng, 2012). Examples would include using learning management systems such as Blackboard and Banner.

MISU1. I use mobile information systems on a regular basis.
MISU2. I will continue to use mobile information system in the future.
MISU3. I intend to continue using mobile information systems.
MISU4. I want to continue using mobile information systems rather than discontinue.
MISU5. I predict I will continue using mobile information systems.
MISU6. I plan to continue using mobile information systems.
MISU7. I will stop using mobile information systems in the future.

7 Rate each of the following statements:

[1] strongly disagree, [2] disagree, [3] neither agree or disagree, [4] agree, [5] strongly agree

I think that I would like to use mobile learning frequently.
I found mobile learning to be simple.
I thought mobile learning was easy to use.
I think that I could use mobile learning without the support of a technical person.
I found the various functions in mobile learning were well integrated.
I thought there was a lot of consistency in mobile learning.
I would image that most people would learn to use mobile learning very quickly.
I found mobile learning very intuitive.
I felt very confident using mobile learning.
I could use mobile learning without having to learn anything new.

8 How long ago did YOU start using m-learning?
Less than 1 year
1-2 years
3-4 years
5-6 years
7-8 years
9-10 years
More than 10 years

9 How often do YOU use m-learning? Please check all that apply.
Several times a day
About once a day)
3-5 days a week
1-2 days a week
Every few weeks
Less often
Never

10 Were you given a choice other than mobile learning during the pandemic?
Yes
No

11 Did you choose to not teach to avoid mandatory mobile learning?
Yes
No

12 What is your level of comfort in using m-learning?
Very uncomfortable
Moderately uncomfortable
Slightly uncomfortable
Neutral
Slightly comfortable
Moderately comfortable
Very comfortable

13 Which of the following teaching resources do YOU provide on a mobile device? Select all that apply.
Lecture PPT slides
Audio recordings (e.g. recordings of lectures, school information)
Videos (e.g. course-related, recordings of lectures, school information)
Print content
Ebooks
Flashcards and other interactive educational games
Hyperlinks to course-related reference material
Blackboard
Other: please specify

14 Rate your level of satisfaction with the use of m-learning.

Completely dissatisfied
Mostly dissatisfied
Somewhat dissatisfied
Neither satisfied or dissatisfied
Somewhat satisfied
Mostly satisfied

Completely satisfied

15 How frequently do you engage in the following activities using your mobile device(s) to support teaching?
[1] Never, [2] Rarely, [3] Occasionally, [4] Sometimes, [5] Frequently, [6] Usually, [7] Always

Emailing students	Ordering textbooks
Emailing colleagues	Searching the internet
Texting students	Providing tutoring services
Texting colleagues	Preparing lessons
Posting grades	Conducting seminars
Posting to discussion boards	Collecting content for coursework
Accessing course site	Reading ebooks
Accessing library resources	Taking pictures or making videos to include in your courses
Accessing social networking	

As a follow-up to the previous question, do you engage in any other activities using your mobile device(s) to support teaching?

Yes, please specify:
No

16 What technologies do you use for m-learning (hardware, software)?

17 To which gender identify do you most identify?

Male	Gender variant/non-conforming
Female	Not listed
Transgender female	Prefer not to answer
Transgender male	

18 Please indicate your age group

20-29	60-69
30-39	70-79
40-49	80 and over
50-59	

19 Your number of years of teaching experience:

20 Your number of years in higher education:

21 Your academic rank

Lecturer	Professor
Instructor	Emeritus
Assistant Professor	Other: please specify
Associate Professor	

22 Please indicate highest education level achieved.

Master's	Professional degree: please specify:
Doctorate	Other: please specify

23 Please indicate the discipline in which you obtained your highest degree:

24 Please indicate your program area/discipline in which you are currently teaching:
Information Systems
Business: please specify
Other:

25 What college level are you teaching?
Undergraduate
Graduate
Both undergraduate and graduate

26 Do you teach courses for students? Select all that apply.
On-campus (in-person, face-to-face)
Off-campus (purely online)
Hybrid (on-campus and online)

27 How long have you been teaching on campus? (i.e. in-person, face-to-face) courses?

28 How long have you been teaching online courses?

29 How long have you been teaching hybrid courses?

30 Do you teach full-time or part-time?
Full-time
Part-time

31 Please indicate the type of university you are currently affiliated with.
Public
Private

32 What is your tenure status?
Currently hold tenure at this institution
Currently on tenure-track at this institution
Not on tenure-track at this institution
Tenure is not available at this institution

APPENDIX B
Student Survey Instrument

Scale for items 1 through 5:

[1] strongly disagree, [2] disagree, [3] strongly disagree, [4] neither agree or disagree, [5] slightly agree, [6] agree, [7] strongly agree

1 Personal Innovativeness (PI) - "willingness of an individual to try out any new information technology." (Agarwal & Prasad, 1998, p. 260)

PI1. If I hear about new information technology, I will look for ways to experiment with it.
PI2. Among my student peers, I am usually the first to try out new information technologies.
PI3. In general, I am not hesitant to try out new information technologies.
PI4. I like to experiment with new information technologies.

2 Perceived Usefulness (PU) - "degree to which a person believes that using a particular system would enhance his or her job performance." (Davis, 1989, p. 320)

PU1. Using m-learning makes it easier to learn.
PU2. Using m-learning enhances my learning effectiveness.
PU3. Using m-learning gives me greater control over learning.
PU4. I find m-learning to be useful in my learning.

3 Perceived Enjoyment (PE) - "extent to which the activity of using the computer is perceived to be enjoyable in it's own right, apart from any performance consequences, that may be anticipated." (Davis et al., 1992, p. 1113)
PE1. Using m-learning is fun.
PE2. Using m-learning is enjoyable.
PE3. Using m-learning is very entertaining (pleasant).
PE4. Using m-learning is interesting.

4 Perceived Playfulness (PP) - "the extent to which the individual finds the interaction intrinsically enjoyable or interesting." (Moon & Kim, 2001, p. 219)
PP1. When using m-learning, I will not realize the time elapsed.
PP2. When using m-learning, I will forget the work I must do.
PP3. Using m-learning will give enjoyment to me for my learning.
PP4. Using m-learning will stimulate my curiosity.
PP5. Using m-learning will lead to my exploration.

5 Mobile Information System Use (MUSE) - involves the use of mobile devices to use an information system to "...carry out tasks and activities on the job for which the information system is designed to support" (Sun & Teng, 2012). Examples would include using learning management systems such as Blackboard and Banner.
MISU1. I use mobile information systems on a regular basis.
MISU2. I will continue to use mobile information system in the future.
MISU3. I intend to continue using mobile information systems.
MISU4. I want to continue using mobile information systems rather than discontinue.
MISU5. I predict I will continue using mobile information systems.
MISU6. I plan to continue using mobile information systems.
MISU7. I will stop using mobile information systems in the future.

Scale for question 6:

[1] strongly disagree, [2] disagree, [3] neither agree or disagree, [4] agree, [5] strongly agree

6 Rate each of the following statements:
I think that I would like to use mobile learning frequently.
I found mobile learning to be simple.
I thought mobile learning was easy to use.
I think that I could use mobile learning without the support of a technical person.
I found the various functions in mobile learning were well integrated.
I thought there was a lot of consistency in mobile learning.
I would image that most people would learn to use mobile learning very quickly.
I found mobile learning very intuitive.
I felt very confident using mobile learning.
I could use mobile learning without having to learn anything new.

7 To which gender identity do you most identify?
Male
Female
Transgender female
Transgender male
Gender variant/non-conforming
Not listed
Prefer not to answer

8 I am a (n)
Undergraduate student
Graduate student

If I am a (n) = Undergraduate student

9 What is your level?
Freshman
Sophomore
Junior
Senior

10 What is your age?

11 What is your major?

APPENDIX C
Mid-Pandemic Faculty M-Learning Activities Usage

* See section 5 for a detailed discussion of Appendix C

Activity	Never	Rarely	Occasionally	Sometimes	Frequently	Usually	Always
Email students	1	1	3	1	5	1	4
Email colleagues	1	1	3	0	6	1	4
Text students	5	4	2	4	0	0	1
Text colleagues	2	4	0	3	6	0	1
Post grades	3	3	2	3	2	0	3
Post to discussion board	3	3	3	6	1	0	0
Access course site	0	4	0	2	7	0	3
Access library resources	2	2	1	5	3	3	0
Access social networking	2	2	0	1	7	2	2
Order textbooks	7	2	2	2	1	1	1
Search internet	0	0	1	1	3	5	6
Provide tutoring services	6	5	1	3	1	0	0
Prepare lessons	4	1	2	4	1	2	2
Conduct seminars	7	2	1	4	0	2	0
Collect content for coursework	2	2	2	4	2	2	2
Read eBooks	2	3	2	4	1	3	1
Take pictures or make videos for course	2	2	2	4	4	2	0
Other (please specify)	5	11	0	0	0	0	0

Table 1: Mobile Device Use for M-Learning Activities for Teaching

A Proposal for Combining Project Based Learning and Lean Six Sigma to Teach Robotic Process Automation Development and Enhance Systems Integration

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Abstract

This paper proposes a Project-based team instruction methodology with open-ended projects to teach students critical analysis, design and implementation steps of developing Robotic Process Automation (RPA) for information systems. The use of project-based learning is appropriate for teaching RPA analysis and design with lean Six Sigma tools because of its experimental approach and documentation of logical steps needed to learn how to implement RPA successfully. The approach systematically documents work currently performed and defines future actions of the process while ensuring significant benefits are achieved with the RPA enhanced process. This methodology is important because the application of RPA is not commonly taught in Management Information System (MIS) programs. MIS students may not understand the significance of combined methodology, RPA tool, and usefulness of RPA until they enter the workforce where RPA is rapidly becoming available and easier to implement. The lecture sessions and exercises are valuable because it is easy to communicate the value of RPA in terms of time, quality, volume of transactions, etc. using Lean Six Sigma analytic approaches. The exercises involve hands on activities to make this learning experience interesting for students to readily associate the theoretical process improvement agreement and visualize the practical value of RPA enhanced projects. The paper discusses the need for process changes (and new development approaches) in organization to match the properties and functions within enterprise systems and ERPs that has led to criticism of the enterprise systems. This criticism is attributable to the ERPs' many sub-functions and operations that have limited adaptability and reduced functional and operational flexibility. The RPAs require limited prior knowledge of ERPs or their sub-processes for the improvements that are made in the performance of the organization. Thus, students do not have to "learn" how these enterprise or ERP systems operate to make changes or task improvements. This paper presents a project-based methodology and design approach focusing on development of RPAs that help students learning how to make the improvements using the RPS tools. The students learn that projects can deliver significant and tangible benefits to organizations while engaging students in key activities of the analysis, design and development process from a low code-no code perspective.

Keywords: Robotic Process Automation, Six Sigma, Project-based, PBL, Process

1. INTRODUCTION

This paper proposes a Project-based team instruction methodology for information systems education using RPA. The discussion proposes that a Project-based methodology can be used to combine Learn Six Sigma and Robotics Process Automation in an educational program. The education value is to enable students to integrate systems and improve wok processes without low-code or no-code tools. It also provides a literature-based history of the relevant concepts.

The objective is to improve students' education by teaching them how to advance performance with analysis using lean six sigma techniques. These techniques are applied to document and target needed system improvements and integration. Students can learn how to deliver great benefits by performing functional system tasks and enhancing operations as part of a PBL development project.

RPA may be loosely defined as using software technologies designed to facilitate devising and managing software robots to behave like humans when interacting with systems and software. Here, we discuss how Lean Six Sigma and Project Based Learning (PBL) synergistically add value when combined to teach students RPA concepts.

Information Systems Integration
Systems integration is a critical part of enabling the paradigm of using Lean Six Sigma and PBL to yield value to development projects and operations. Although it may be seen as a side topic, a prerequisite for efficient collaboration within and between organizations units is this integration of information systems. Although it is often viewed as simple from a holistic standpoint, the inability of systems to interoperate remains a consistent problem in the enterprise. As information systems proliferate, opportunities for IT systems integration have increased greatly, and these must be leveraged to add value.

However, difficulties with integration continue, due to a lack of systems interoperability and data definition and formatting related problems. Despite intensive research on integration issues, organizations continue to encounter significant challenges. Schmidt, Otto, & Österle (2010) developed a research framework, categorizing concrete integration cases from business practices.

This framework was developed by examining integration cases from the literature. The work proposed 9 problem categories and 21 integration problems plaguing those efforts. The authors suggest that detailed problems inhibiting integration vary by business segment, goals, and roles. Semantics, data object heterogeneity, data value mismatches and attribute differences also affect these problems. The conclusion from this work and the literature is that there are many open integration challenges in the Information Systems discipline (Schmidt, Otto, & Österle, 2010).

It can be seen from this discussion that while there are many blocks and challenges to integration, there are also an increasing number of opportunities to foster improved integration, and it is essential to consider these as we help students develop skills using Lean Six Sigma and RPA.

Low-code/ and No-code Tools
Low-code/no-code development approaches are terms that describe the uses of software tools and templates to integrate system and process operations. No-code/base-code tool platforms may be guided platforms with a drag-and-drop process or more automated incorporating machine learning services. (Villegas-Ch, García-Ortiz, & Sánchez-Viteri, 2021). Low-code and no-code approaches employ visual software development tools and environments. Robotics Process Automation (RPA) tools are categorized among the low-code/no-code approaches. These tools allow developers and end-users to select, drag and drop application components. The components are then connected with the applications to create enhanced applications or augment programs with previously unavailable functionality.

The RPA technology may be seen as an evolution of the low-code/no-code environments developed following the Computer Assisted Systems Engineering (CASE) tool failures of the 80's and 90's (Kuhn, 1989; Dias, 2017). RPA became a development alternative because few case tools were successful for complete database application generation. The case tools were costly and difficult to implement and maintain, requiring extensive training for developers and systems maintenance personnel (Schmidt, 2006). Jones (2002) notes that as much as 70 percent of CASE tools were not being used by the end of the first year.

This generally accepted software failure figure (believed to be based on the 1994 Standish Chaos study) has been questioned by Glass (2005). He

argues that the failure rate is assessed from varying perspectives such as cost over runs, functional performance, etc., and that the true rates are even lower. Regardless, there is no question that failure rates during this period were sub-optimal.

RPA's no-code characteristics and drag/drop technology are similar to other low-code/no-code development environments such as Mendix, a low-code Model Driven Development (MDD) platform that also grew from the Computer CASE tools of the eighties and nineties.

Tools like these enable system development to occur at higher levels of abstraction, generating fully functional applications from a model driven environment (Hailpern & Tarr, 2006). The higher levels of abstraction are achieved by automating and simplifying development steps using the context of domain models. The tools employ templates, generate code, and in many cases, generate fully functional applications.

Hyun (2019) provides a useful example of this approach with a discussion of an environment-based low-code and no-code execution platform and an execution method that combines hybrid and native apps, offering the advantages of each. The environment enables the use of iPhones, Android devices, and operation templates. The development platform is a visually integrated environment that enables drag and drop components by non-technical developers. The environment to construct modules can be dynamically loaded when called. The system provides functionality for authentication, user authorization, commerce, messaging, social publishing, and vision.

Early releases of RPA sought to minimize coding. Many of these tools are approaching a high level of ease of use today. However, it is marketing jargon to say that they are truly low code or no code. The users of the early RPA tools were required to incorporate logic and instruction programming to complete the automation process. Avoiding marketing jargon, the low-code RPA automates straightforward processes through a drag & drop user interface that executes a user's activities. Coded bots can still complete more complicated or complex processes. The low/no code tools are presently used to complete and automate standard work tasks, such as Excel operations, email responses, report creation, and authorization recoding. Full no-code RPA is currently not available or in use. However, user prototyping and testing of RPA tools can assess readily the ease of use and amount coding required. Progress toward a more complete low-code/no-code target environment is being made.

Although the low-code/no-code development approach has become an increasingly important factor and tool for current software development challenges, it is not always adopted. Global trends do not always represent the popularity, adoption, and use of the low-code/no-code development approach. This was assessed in the Slovenian environment with regard to one specific toolset, Power Automate. The results showed that use of this low-code/no-code development approach in Slovenian organizations is low because of limited usability and functionality concerns (Beranic, Rek, & Heričko; 2020).

The need for RPA is couched in the integration required to improve legacy systems regardless of the environments available for system operations. The movement of systems to the cloud, combined with integration difficulties, promulgates the lift/shift approach of cloud migration. In this migration approach, information systems and applications are migrated into a cloud environment without making process changes even when systems are moved into cloud environments with available resources (Engelsrud, 2019).

As seen in cloud-computing adoption, many large organizations are struggling to obtain the full value of the migration to the cloud. This is because the cloud migration (especially lift/shift) simply moves information systems to the cloud without the integrating functions and possibly transforming processes with new strategies needed to obtain full cloud value. Utilities can simplify the packaging, migration, and deployment of applications for the cloud whether the target is AWS, Google Cloud, Oracle Cloud, or other cloud infrastructure.

However, without improvements or resolving process integration concerns associated with systems integration, taking legacy applications and moving them to the cloud does not automatically yield the benefits that cloud infrastructure and support systems can provide, because the work processes are still not integrated. The information technology architectures that are the result of these migrations may be complex, difficult to manage, and costly (Bommadevara, Del Miglio, & Jansen, 2018). It is critical that systems not be simply migrated to the cloud, but that work processes be integrated to the cloud infrastructure.

A PBL educational approach is an appropriate teaching method for students who *must* learn about cloud migration and how to integrate systems. As PBL is implemented in the classroom, students design, build and employ solutions to a problem through a hands-on, collaborative methodology. The true objective is to improve performance with analysis using lean six sigma techniques to document and target system improvements that will deliver great benefits by performing functional system tasks and improving operations as part of the PBL development project.

2. EDUCATION FOR INTEGRATION

To foster integration in their PBL projects, students must understand the underlying importance of the work and the task performed in the processes to integrate systems. In large projects and organizations with decentralized work packages and task areas, it is important to integrate properly the various outputs to provide the customer with a coherent deliverable.

MIS students who join organizations that design and support information systems see first-hand how the work performed by organizational information systems is subdivided into segments for system execution, functional performance and completion. This concept – the division of labor (specialization) is evident in the segmentation of systems that are consistently used by various divisions, departments, and offices of organizations.

The individual tasks contribute to productivity increases by focusing effort on the tasks and data used by each functional area. For example, in the field of manufacturing, use of business applications has expanded significantly over the years. This expansion has increased both the availability and volume of planning and execution information for managers and decision makers.

The information enables decision makers to assess and monitor performance at all levels of the organization. Developed applications let end users obtain predefined management reports including information needed for managerial execution. The information is of significant value for strategic planning, increased productivity, reducing service cycles, reducing product development cycles, reducing marketing life cycles, and increasing the understanding of customer's needs, thus facilitating business and process reengineering (Sharma, 2012: 553). This breaking up of work elements is essential to delivering large projects. However, the breaking up and decentralization make it difficult to assemble and integrate tasks for a coherent deliverable to the customer.

Managers and organizations remain faced with the significant task of assembling and integrating the divided work elements to produce the output desired by the customer. Further, managers must deal with migrating into business and organization environments that lead to changes in the data, knowledge information systems and business strategy.

To gain the greatest benefit from information systems, one must also understand the relationship between knowledge and information system strategies, and their overall impact on firm performance. It is important that the dynamic capabilities of knowledge strategy and planning result in necessary changes in systems to enable dynamic and innovative capabilities to be developed.

Findings from a study of 234 Brazilian companies support this logical argument. It finds performance is positively impacted through alignment between knowledge strategy planning and information systems strategy. Managers must recognize that the work of the firm is dynamic, and that alignment between information systems and the strategic actions of the organization is important to success (Yoshikuni, Galvão, & Albertin, 2021). It can be deduced that knowledge and information system strategies must also be reconciled and integrated.

Research and improvement attempts have focused on business processes supported by information systems (and the data, information, and knowledge derived from the systems) for many years. Business has been designing and integrating processes as business and industrial organizations evolve to offer systems that are more complex, with useful data, insights, and knowledge for decision makers. The systems also seek to meet the information requirements of highly complex stakeholder demands and governance regulations.

It is therefore important for students entering the workforce to understand these concepts in order to integrate work segments and processes so the information presents a coherent whole from a holistically consistent system.

How to Integrate Systems in the Age of Processes and Computerized Information Systems

Porter and Millar (1985) discussed linkages between computerized information systems and

the integration mission, and projected a future role that information technology would play in the value chain. They argue that information technology and information that businesses create would enable management to employ this information in executing work processes. These combined factors provide an advantage derived from the information-processing component that executes steps required to capture, manipulate, and channel the data.

This support enables managers to perform the value chain activity. The data handling improvements they describe are attributable to barcodes for error handling reductions, databases for knowledge and experience storage, management of services with data, improved weather satellite data uses, financial analysis through data, transfer of data between suppliers and manufacturers, data for improved designs for manufacturing coordination, uses of office support data, and communication data.

The value chain framework addresses the role of computer information systems in achieving helpful integration. White and Person (2001) suggest this as a framework for integrating a firm's activities within a supply chain. They recognize the requirements for integrating customer service activities into the decision-making process of manufacturing organizations. These authors also discuss the dynamic nature of the organization, and argue that just-in-time computer systems and new product process combine with information technologies to provide the mechanisms for integration of the various supply chain task activities.

The tasks and processes are conceptualized as frameworks containing steps in a sequence. The processes have many components, agents, and outcomes.

The many authors and managerial perspectives indicate that difficulties with the integration of organizational processes have always been challenging. As these references summarize, within the last 40 years, information systems implemented with electronic technology through computer information systems and electronic data processing technologies have been "inserted" into this essential mission of attempting to manage processes and their data, and improve the coordination and integration of the work within and between organizations. As Schmidt, Otto, & Österle (2010) discuss, this "levied" integration requirement for information systems is a prerequisite for efficient collaboration within and between organizational units that results in substantial tasks.

Information systems have grown and become ever more complex to meet the needs of large organizations. The large category of enterprise information systems has become standardized with more carefully pre-defined data and processes to meet broadly the needs of many large organizations, and for wider marketability. This tendency to force process changes on organization (to match the properties and functions within enterprise systems) has led to criticism of the enterprise systems. This criticism is attributable to their many sub-functions and operations that have limited adaptability and reduced functional and operational flexibility.

Information systems such as Enterprise Resource Planning systems are caught in this dilemma. It is exacerbated by the large enterprises and matrix structures of originations that utilize federation (decentralized control and local unit development of some functionality) as their information systems implementation approach.

The standardized enterprise systems are thus less flexible and adaptive, and the decentralized enterprises are incapable of exchanging and making information available in many instances. This creates a situation where managers lack visibility into the results of processes, or where data from one process are simply not accessible to another work unit. A large adaptive enterprise requires information systems to meet a business strategy that can deliver information visibility across the enterprise, and that are flexible for use in new and innovative ways (Evgeniou, 2002). Thus, integration is critical for the large enterprise.

General Problem with Major Applications

The need for change after implementation was addressed by Gattiker, & Goodhue, (2005). They offer the theory, supported by their research, that because these systems include data and effect greater process integration, an ERP will be a relatively better fit, requiring fewer changes, when interdependence is high and differentiation is low among/between the subcomponent of the company using the ERP. If differentiation is high at the subunit level of the organization (business function or location, such as a manufacturing plant) ERP customization will be required. Further, the amount of time since ERP implementation will increase the need for further customization (supported by a large number of manufacturing plants).

A comprehensive discussion of ERP systems published by Sheik, & Sulphey (2020) discussing Enterprise Resource Planning (ERP) failures and limitations over the past 20 years indicates that implementation is still difficult, and changes after implementation are still required. It identifies the reasons for failures documented in numerous ERP studies. The literature recognizes many types of failures associated with information systems project implementation, planning, management support, culture and management process.

The work is useful because it notes that even overcoming these issues does not assure success for an ERP system or the organization seeking to obtain value from this effort. These authors discuss the tendency of organizations to underestimate the efforts needed to handle change in the organizations. In these initial implementations, ERP systems can affect any functional area of the company's basic business model, and require systemic modifications. Integration is required.

In discussing the problems in large scale ERP implementations, research studies of integrated supply chains show that effective operations and integration are achieved by linking information from suppliers, partners and customers within and across national borders. This can be by implementing information technologies and systems such as ERPs to facilitate the desired level and details needed for integration. There are cases of successful and unsuccessful implementations. The principal reason for failure is often associated with poor management of the implementation process (Sheik, & Sulphey, 2020).

This paper identifies the different types of issues that can arise and require adaptation for ERP systems within a large manufacturing organization. The core issues to confront for successful implementation of enterprise information system according to this case study were addressed by piloting a small portion of the enterprise implementation to assess and demonstrate how business principles, processes, procedures, role definitions and behaviors (as well as software, hardware and data transfers) would influence the organization.

The initial problems experienced in the attempt to *go live* included user authorization and clearance levels, work routing and tracking (via cards), incorrect data values existing between the legacy systems and the new system, incorrect inventory levels and WIP data, and incorrect MPR transactions (Yusuf, Gunasekaran, & Abthorpe, 2004). They conclude that adaptation is necessary throughout the development lifecycle.

User Developed Apps and Desktop Tools Proliferate with Increased Workforce Mobility

Development frameworks are necessary. Large enterprise systems and changes are not the only forces driving information systems today. User empowerment, education, and the widespread use of technology have influenced the organizational end user. Workers are not afraid to develop apps and seek to access information needed in their work activities through user development and the widespread proliferation of desktop tools.

Coronado, Mastrogiovanni, Indurkhya, & Venture (2020) addressed this increasing demand for tools and expansion of interest in user developed information systems. Individuals in social situations will trust robots (automated programs performing a work function or task) to execute work in industries and in scenarios where the robot is directed by an information system (perhaps some form of AI) to interact with humans. These authors surveyed user development environments that might foster application development involving robots with social capabilities, features that could support social research goals, and serve professional employees not educated or trained in more traditional programming languages and techniques.

The work identified and assessed sixteen programming environments with modeling approaches, Component-Based Software Engineering, and web technologies. The research found that few of the environments enable end users to be independent from high-tech support. Their work calls for objective and comparative evaluations, usability studies, and design validations of the tools for designing working applications. Engaging robot-based applications requires the availability of usable, flexible and accessible development frameworks that can be adopted and mastered by practitioners who are truly adult end users.

3. METHODOLOGY

This educational experience applies a Project Based Learning (PBL) approach to the learning experience. In project-based learning the instructional focus is student-centered. The experiences are based the principles that (1) learning is context-specific, (2) learning

processed actively involved those learning, and (3) goals are reached through social interactions and Knowledge sharing (Jalinus, Nabawi, & Mardin, 2017, September; Cocco, 2006). It is considered to be a particular type of inquiry-based learning where the context of learning is provided through authentic questions and problems within real-world practices

The learning experience is agile based. It involves an introduction to the requirements for changes and adaptations for enterprise information systems, data and process integration, and the continued need for user developed applications that work in the desktop environments and in mobile applications. In this paradigm, use of Lean Six Sigma in the analysis and development sections of the PBL project adds value and improves integration.

Analysis: Lean Six Sigma Designs Steps for Value

The goals of improving flexibility and supporting operations have contributed to the Six Sigma approach to process improvement and selecting changes to implement in organizations. It is a strong foundation for improvements and innovations because it involves doing the work better and actually improving the work to be accomplished in many instances. It is applicable to processes used to produce products and services, expand markets, and deliver operational performance. The work focuses on customer needs, detailed data analysis and facts about performance levels, errors, and required actions.

Analysis of organization results derived from the application of Six Sigma programs show improvements in broad-based innovation and financial performance. The key characteristics of these approaches include an improvement - innovation vision based on data (from customers, insights, and analytic studies), clear objectives, organizational commitment to the change objectives or vision, alignment across the organization, training, and target processes to demonstrate the Six Sigma program.

Lean Six Sigma is a combination of lean methods (analysis, documentation, and analytic tasks that are performed within the organization) and Six Sigma approaches that organizes the tasks in an understandable and executable fashion. Lean Six Sigma utilizes knowledge (from the experience of many organizations that have followed the approach), methods designed to elicit specific data and understanding of activities and operations, and tools derived from operational improvement research and implementations.

The *lean* portion of the approach targets cost reductions through process optimization. The six-sigma portion focuses on meeting customer needs and stakeholder expectations. It seeks to improve quality, via measurement and defect or error elimination. This is accomplished by both eliminating the opportunities for errors in a process and improving the steps, materials, and performance of a task. The simultaneous goals are to achieve both effectiveness and efficiency (Byrne, Lubowe, & Blitz, (2007).

There are five major steps in a lean six-sigma process as shown in table 1. It is labeled "DMAIC", an acronym for the five sequential phases: Define-Measure-Analyze-Improve-Control. These phases flow logically from defining a problem through implementing solutions. The changes introduced are directly associated with causes (George, Maxey, & Upton, 2004).

Step Name	Value
Design	Review, validate charter; define: customer, problem, benefits sought, financial objectives, plan, schedule
Measure	Build value stream map, inputs, operational definitions, data collection plan, measurements, process capability, measure gate
Analyze	Determine critical inputs, potential root causes, reduce root cause list, estimate root cause effects on outputs, prioritize root causes
Improve	Develop potential solutions, analyze and evaluate solutions, develop "To-Be" value stream map, develop pilot solution, confirm attainment of project goals, develop full scale implementation plan
Control	Implement mistake proofing, SOPs, training. Set process controls, implement solution and on-going process measurements, develop opportunities to apply project lessons, transition to monitoring control office

Table 1. Summarized Lean Six Sigma Steps

Analysis Results: A New Process Design

The result of the analysis using the steps outlined is a process that will perform more effectively and efficiently. Further, the approach and tools employed document the pre – post outcome

metrics that will be used to demonstrate to stakeholders that there are real benefits and improvements from the process changes.

4. RPA: IMPLEMENTING THE AUTOMATION

The objectives of this learning experience are to deliver students a clear understanding of the technology and methods. Students will understand the actions and sequence of steps needed to apply lean six sigma methods and RPA tools that enhance processes and information systems. The lessons focus on RPA tools (after a full analysis) and use various product offerings to provide a hands-on set of educational exercises. This section discusses RPA and how the tools implement the designs documented. It also provides an overview of the tools that will be used in the exercises.

Robotic Process Automation

This paper argues that Robotic Process Automation (RPA) is a recent improvement (evolving in the past ~10 years) in computer information systems. This technology is applied in organizations to achieve integration between systems and to perform mundane and repetitive tasks without altering or modifying the information systems that are the targets or sources of the data required. RPAs execute rule-based, routine, and predictable tasks in combination with structured, understood, and stable data in a semi-automated and automated manner. (Primer, 2015).

RPA Functionality and Operation

How does RPA perform integrative and productive tasks? RPA moves data and information seamlessly between systems and processes. RPA technology can be implemented across many functions. It is a practical linkage technology for many different process focused tasks (definable, repeatable, and rules-based). It can be optionally executed at the explicit direction of employees and can therefore assist them in their work. RPA can assist with diagnosing when decisions are not always clear (the data do not legitimately fit) and the business rules-base is not complete for all situations (present and those introduced by business changes). In these instances, the "error" or unaddressed states can be recorded and handed directly by the user. New "rules" or actions can be added to the RPA automation to handle the situation when it is encountered in the future.

RPA has multiple operating modes. It can function in attended mode where an employee "triggers" the bot for day-to-day operations or automatically with the employee watching for exceptions and alerts (correct execution or failure to execute). The bot can also function in an "unattended mode" on a server based on user-determined triggers such as a date and time. For example, a bot could be programmed to trigger automatically to execute at 12:00 a.m. on Friday, or when 1,000 cases have been received in a queue. Thus, the RPA bot can serve as an independent automated process that does not demand human intervention in order to execute a work process. It can make or execute a decision if all the data and rules are clear and the outcome decisions are predetermined.

RPA is very adaptive and fits many situations because of its internal capabilities. The RPA has several essential features that provide it competencies beyond those found in code written for scripting, screen scraping, and sequential process management. 1) RPA development utilizes straightforward dropping and dragging via icons that represent steps in a process. RPA process code is then produced automatically without extensive programming, computer training or expertise. 2) The RPA bot accesses data produced by other computer systems or programs. It emulates exactly how an employee accesses this data (because the bot is created to do just this task). 3) RPA has important security and operational controls.

The RPA assumes only that logon ID and password of the user. This is required to access what is normally seen or obtained by the worker from the target or other system's presentation layer. Therefore, the RPA bot is non-interfering or invasive for organization work beyond the explicit instructions executed by the bot's design. 4) Finally, RPA is a secure and scalable technology that executes on the enterprise-protected platform. It can be configured, audited, and managed at the enterprise or organizational level that utilizes this technology.

The output of a bot appears to be the product of code that functions "like a macro," but with more capabilities, options, and functionality that is not restricted to an application like Word or Excel. It can be visualized as a very smart, tireless, and sophisticated desktop assistant. The bot appears as a powerful worker or "aid" that performs scripting and screen scraping (record and replay), acts quickly, and is able to record (without error) what it is doing. The bot replicates the assigned task repeatedly (tirelessly) – like a true robot. It is trained by watching a user's selections (of data or decisions), recording mouse clicks, matching inputs from the keyboard and completing the

process as the user does. However, the bot is not intelligent – and does not know why it is doing this work since it only performs the assigned set of actions when called upon. (Madakam, Holmukhe, & Jaiswal, 2019; Peláez, & Kyriakou, 2008; Schmitz, Dietze, & Czarnecki, 2019).

RPA Products

Product Provider	Product name and Description
Power Automate	Power Automate is a business tool (Microsoft code) that automates business processes, sends task reminders, move business data between systems on a schedule, connects data sources or and publicly available APIs, can automate tasks on a local computer.
Automation Everywhere	Automation Anywhere consists of three core components – Bot Creator (drag and drop method to create rule-based automations), Control Room (hub for RPA robots start, paused, stop, or scheduling), and Bot Runner (run robots. provides the end-to-end status of the bot's execution back to the control room). The core components are used in tandem to build and deploy a successful automated workforce.
UiPath	UiPath offers complex and highly featured automation for more complex automation products (standalone end user - not integrated, hosted – on premise, cloud) corresponding to the user deployment requirements. Products include two development environments – Studio and StudioX (with limited capabilities), automations called assistant (bots), and an Orchestrator for management and control of the assistants. The cloud and hosted product link together and can exchange data when installed as Automation Suite.

Table 2: RPA Tools

There are a number of RPA products available in the market today. Three examples of these tools are provided in Table 2 to help students, readers and businesses understand the varying capabilities that can affect the choice of a tool for specific industry and target process. Students can use the prosed methodology with any of the tools. However, the ability of the tool to perform more complex task automation will depend upon the capabilities and functions available in a specific tool.

5. Project Based Learning (PBL) EDUCATION EXPERIENCE

What is Project Based Learning (PBL)?

Project-based learning (PBL) is a learning experience that engages students in experiential activities. The students are able to learn and develop skills while working in teams. This teaching approach stresses real-world projects that can be understood readily and have significance for the students. Larmer & Mergendoller (2010) propose the project be a task that matters and one that the students will want to do well. The project must be well designed and well implemented to serve its educational purpose.

Larmer & Mergendoller (2010) propose seven essential characteristics for these PBL experiences. The criteria listed in Table 3 are conceptual ways of engaging students in the exercise.

1	A Need to Know	Relevance of the information
2	A Driving Question	How to improve, reduce, speed up, etc.
3	Student Voice and Choice	How to reduce tedium, improve situation, minimize errors),
4	21st Century Skills	Collaboration, communication, sharing
5	Inquiry and Innovation	Gathering information, alternatives, suggestions for improvement
6	Feedback and Revision	Critiques, reviews, examinations of project work
7	Publically Presented Product	Exhibit and present the solution
	(Larmer & Mergendoller, 2010)	

Table 3: Essential Exercise Characteristics.

Amaral (2021) described how projects taught by using the PBL approach could have different goals, and actively involve students so they get their hands dirty. This work notes that students might learn and discover skills and materials required to complete the project. They will also reassess their learning process at the end of a project.

Value of PBL

The project technique is effective in imparting the

educational understanding and hands-on learning experience to students. Alacapınar (2008) assess how the delivery of a course using the project-based learning technique affects student opinions on cognitive, affective and psychomotor domains using questionnaires and semi-structured interviews. The results report on project technique effectiveness. The interview feedback results are that the project technique enhanced student creativity, helped them acquire high-level information, target domain skills, appreciation of group work and collaboration, and that separation into groups during the work consolidated affinity, trust, and friendship.

How PBL Works for Lean Six Sigma and RPA

The projects used in the class sessions apply the seven essential project design elements as a framework. The interesting and relevant problem is how to complete the work required of an administrative assistant in demanding situations. The situations are those where the work is tedious, repetitive, with manual steps, error prone and required to have very high accuracy. The work may also require display, moving (copy or cut/paste), reformatting and/or validating data submitted by emails, and through spreadsheets, and audits with summary reporting.

The project is meaningful for students because it is work derived from real world tasks, and essential to the job and eventual promotion. The project deliverable is a working system utilizing the RPA tool.

Appendix A lists the steps a student will execute to complete the analysis, design, and coding of an automation (bot) using two different RPA tools. The first exercise provides the steps for the use of Power Automate, a simpler and easier to use RPA tool with basic product features. The second exercise utilizes UiPath Studio to perform the task. This tool has more features and functionality. Appendix B lists the task actions a student will execute to complete an RPA project with straightforward output objectives. Appendix B task actions can be perfumed with either tool.

6. CONCLUSIONS

This paper describes the use of project-based learning to teach design skills for RPA development to management information system students. A Project-based team instruction approach is followed using open-ended projects to teach students critical analysis, design, and the implementation steps of developing Robotic Process Automation (RPA) for information systems. It describes why the project-based learning method is appropriate for teaching RPA analysis and design, and uses lean Six Sigma tools to perform the analysis needed to support a low-code/no-code development project. Lean Six Sigma is an important analysis step because of its analytical approach and complete documentation of logical steps needed to understand how to select and implement successful RPAs. The general issues considered in the design of class sessions emphasize the use of Lean Six Sigma and RPA in improving organization tasks. Consideration of the literature on the application of PBL suggests many skills, including problem solving, task design innovation, group-work and collaboration skills desired by employers can be improved with this approach. The paper discusses factors involved in the development of problem-based leaning (PBL) sessions, and summarizes exercises planned for the educational experience.

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8. Product Appendix A

Product Exercise - Simple Exercise – Power Automate.

Tool Action Summary:

- Sign up and obtain Documentation. Sign up and sign in - Power Automate
- Power Automate, you can explore a diverse set of templates and learn about the key features for Power Automate. You can get a quick sense of what is possible and how Power Automate could help your business and your life.
- Analyze the desired process, to find an appropriate template (e.g., templates for sending you a text message, adding Twitter leads, backing up files...)
- Analyze the tasks and set conditions that trigger the flow and the action that result from that event (adjust, add, or delete actions).
- Select an appropriate flow type based upon the Lean Analysis (cloud flow, desktop, business process, etc.
- (Optional) Examine code by viewing code generated for all actions and triggers (for a clearer understanding of the data that's being used by triggers and actions) [Action or trigger > Peek code].
- Select a connector. Connectors are proxies or wrappers around an API that allows the underlying service to talk to Microsoft Power Automate. A user connects to build their app and workflow from software as a service (SaaS) connectors. This connects apps, data, and devices, etc.)
- Test and validate that the new actions and data were created.
- Execute or Run the new workflow. After creating and tested a desktop flow, run it from an event, schedule, or button.
- Manage the flow in Power Apps > select Flows in the left navigation pane

Product Exercise – Complex Exercise – Power Automate.

- Install the UiPath Studio (development tool) from UiPath, or local network.
- Enter required information (name device ID – if not present, > Activate
- 2. Open and select a project, activity (press a key, enter a number, etc.) and sequence (combined task) designation.

  >Choose from: Plan, Simple (template/flow hart – for different sequence of activates), Agent (shortcut for improvement), Transactional (uses states – e.g., loading, execute shut-does – not moving until all tasks for the project are completed

- Build the project. Create a name,

  Add a function (record, scrape, user event, value), >Run, test
  Scrape (screen or web), user event (keyboard or mouse entry). Set variables
  Create file (separate parts of the automation)
  Activity – drag and drop into the activity program (pane).
- Domains (7) – UI domain – keyboard, mouse. (drag/drop activates according to the project logic),
- User events (triggers); orchestrator – depending upon edition; system (delete, open); condition programs (fi. Else); workflow - sequencing
- Properties – set addresses, locations
- Control bar – Used to create the components for variables, arguments, imports.
- Create an automation.
- Test and install in production

9. Project Activity Appendix B

1. Create file output from Excel (Task assignment, Excel file, output required)

2. Create email upon task completion. (Task assignment, Excel (or other source file), email message - output required)

3. Create message of data arrival, update file. (Trigger for automation, Excel (or other record file), email message - output required)

Teaching Case

Alexa, Help Me Learn About the Internet of Things!

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Abstract

The Internet of Things (IoT) is a network of objects that can exchange data with other devices also connected to the Internet. One of the most common consumer examples of IoT is home automation, as a variety of smart devices, including doorbells, lightbulbs, thermostats, and refrigerators are now available which users can control remotely using mobile apps or smart speakers. In this hands-on activity, students will apply their basic skills in accessing wireless networks and using mobile devices to connect an Amazon Echo smart speaker to a home network, configure smart plugs to communicate with the Echo, and develop routines to interact with the smart plugs, smartphones, and other smart devices.

Keywords: Internet of Things, Amazon Echo, Automation, Digital Literacy, Active Learning

1. INTRODUCTION

The Internet of Things makes it possible to connect devices in everyday objects, often equipped with software and sensors, to send and receive data over the Internet. Devices have an IP address allowing them to connect to the Internet, usually through a wireless network, enabling communication between other connected devices. A smart device is one that can connect to the Internet.

An Amazon Echo ("Echo") is a smart speaker developed by Amazon that is commonly used in homes to perform automated tasks and control smart devices. Echo devices are widely available in a variety of formats, including audio speakers (Echo Dot), video displays (Echo Show), devices to connect additional sensors (Echo Flex), and devices for use in vehicles (Echo Auto).

Echo devices use the Alexa intelligent personal assistant service to respond to a user's voice commands, that typically begin with the wake word, "Alexa." Users commonly interact with Alexa to set alarms and timers, perform Internet searches, play music, manage lists, and obtain current news and weather information. Alexa skills are software modules that perform tasks such as playing games, setting timers and reminders, and listening to music or audio books. Alexa routines are sequences of tasks that you can configure to perform in response to a voice command.

Echo devices can connect to several smart devices to perform home automation tasks, such as turning on and off lights and adjusting thermostats.

In this lab activity, you will interact with the Internet of Things by connecting an Echo device to a wireless network. You will control smart devices using mobile apps and voice commands, and create skills and routines to automate tasks, add capabilities, and perform actions when triggered by specific events.

If you do not have access to an Echo or Alexa-enabled device, you can use the Alexa mobile app on a smartphone or tablet to complete the steps in this activity that specifically do not refer to configuring or interacting with an Echo device.

Learning Objectives
By completing this lab activity as part of your information systems / technology literacy course, you will be able to:

- Define what is meant by the Internet of Things (IoT)
- Describe how to accomplish home automation using connected devices
- Control smart plugs or devices using a smart phone and the Alexa personal assistant app on your Amazon Echo
- Identify sources of data and providers that can share data over the Internet.
- Create routines with Amazon's Echo to automate home tasks
- Describe the role of a home network in connecting devices
- Explain the role of APIs (application programming interfaces) in sharing data

2. THE AMAZON ECHO INTERNET OF THINGS LAB ACTIVITY

Prerequisites
While no programing knowledge is required to complete this activity, several digital literacy and information technology skills are required:

- Create, edit, and share a document on Google Drive or OneDrive
- Capture and share screenshots from a computer or mobile device
- Transfer files from a mobile device to a laptop using cloud storage
- Create a video using your computer or mobile device
- Connect a computer or mobile device to a wireless network
- Locate a device's MAC and IP address

Preparing For The Activity
You will work in teams of three or four to complete the activity. Each person in your team will have a different role, so decide who is going to do what. It is fine to change roles throughout the project so each person can experience more than one role.

- Reader: Reads the instructions aloud at each step for the group to discuss and conduct
- Recorder: Summarizes the group's conversation about each task or discussion question in the lab report
- Connector: Downloads apps to smart phone, connects and configures devices
- Multimedia Producer: Records video, photos, and gathers screenshots and other multimedia as required

Your group will create a shared online document or presentation to contain your screen shots and answers to several discussion questions. Your group also will create a short video and post it to Flip, a collaborative video recording and sharing platform, to demonstrate that your connected devices and routines function correctly when you speak voice commands. (Visit http://flip.com.)

You can work together on the project, but each student should reflect their own learning and then answer the open-ended questions individually. Also consider the technology skills you used when completing is activity.

Complete these steps before working on this activity:

- Read this description before coming to class so that you will be familiar with the steps required. Doing so will save time when you work on this in class!
- Identify three or four group members
- Create a lab report document on Google Drive or OneDrive as directed by your instructor. Share it with your instructor and the members of your group.

Equipment
Your instructor will provide the equipment as shown in Figure 1, for your use during this lab activity:

- An Echo Dot smart speaker
- A smart plug (outlet)
- A light switch socket
- A lightbulb

Figure 1. IoT Lab Equipment

You will also need a laptop and smartphone. You will need access to the network name and password on a wireless router.

3. COMPLETE THE LAB ACTIVITY

To complete this lab activity, you will accomplish these tasks:

- Install the necessary apps on your phone
- Connect your Echo as a device on a wireless network
- Set up a smart plug with an app on your phone to turn on/off a light
- Set up Amazon Echo to turn on/off a light using a voice command
- Create a routine for Alexa to follow
- Interact with and respond to external data or events using If This Then That
- Bonus: Use Amazon Blueprints to create custom skills

Set Up Your Phone
One person in each group, the "Connector", should download and install the mobile app for the smart plug, and the Alexa app on their phone. Install the Alexa app on your phone so you can configure your Echo device. If using GoSund smart plugs, download the SmartLife App. If using Amazon brand plugs, you can use only the Alexa app. Figure 2 shows the icons for the apps to locate in your app store:

Figure 2. Alexa and SmartLife App icons.

If using other third-party smart plugs, download the app associated with those plugs.

Create an Amazon Account
If a member of your group already has an Amazon account, please feel free to sign in with your personal credentials that you use with your own Echo. After the completion of this lab activity, you will remove the Echo device used for this project from your account.

Open the Alexa app. If no one in the group has an Amazon account, create a new Amazon account for this activity (which you can delete later). You should not need to provide a credit card or phone number. Search for instructions online for how to set up an Amazon account without having to provide a credit card.

Configure the Smart Plug
These steps describe how to configure a third-party smart plug using its app installed from the Google Play or Apple App Store.

Connect your phone to the wireless network on your router. (If you are configuring the router yourself, set an SSID and password. If your instructor is providing one router for the entire class, use the SSID and password provided. Do not connect to the 5G Network.

Open the app associated with your smart plug. For GoSund plugs, open the SmartLife app. For Amazon plugs, use the Alexa app; for other third-party plugs, follow similar steps using their app,

Create a new account in the app using the same credentials as the Amazon account. In the app, allow permission for the app to access your location, then identify the device ("socket/wifi") you want to add to the network, as shown in Appendix I, Figure 5.

Enter the wireless network name and password to connect the device to the network. Then follow the instructions on the app to set up the plug as shown in Appendix I, Figure 6. You will need to press and hold the RESET button on the plug, watch for a blinking light, and then check the app to ensure that the plug connected to the Wi-Fi network.

Note: When doing this step in a classroom with other groups at the same time, make sure that only one group's plug is in set-up mode at a time (The RESET button is blinking). Otherwise, the app will connect to all plugs that are in set-up mode. If one team is setting up their plug, wait until they have finished, and then proceed with configuring yours (by pressing the RESET button for 5 seconds again).

Once connected, plug the light switch containing the lightbulb into the smart plug. Test turning on and off the light switch using the app, as shown Appendix 1, Figure 7.

To verify the plug has an IP and a MAC address, click 'Mini Smart Plug' in the app, click the pencil icon in the top right, then click Device Settings to see the IP and MAC address.

Set Up Amazon Echo
Install the Amazon Alexa app to your phone if you do not have it already or sign out from your personal Amazon account.

Press and hold the action button on the Echo Dot (the solid circle button) until an orange ring appears putting you in setup mode.

Follow steps in Alexa app to configure the device. In the Devices tab, click the '+' button in the top right corner. Click Add Device, locate Amazon Echo and your model. Select the wireless network and enter its name and password. Follow the prompts to choose a language, set the device's location, and skip through any introductory offers or videos that appear while configuring the device. in your home. See the screenshots in Appendix 1, Figure 8.

Set Up Echo To Work With The Smart Plug
In your smart plug's app, select the device, and look for a third-party control option. Select Alexa and sign in with your Amazon credentials to allow access.

In the Alexa app, click Devices, click the '+' button to add a device, and select the brand of your plug. Click Discover Devices, and Alexa will look for devices and connect to the plug. Note: For GoSund plugs, choose SmartLife (not GoSund).

Give the device a name (such as "Red Light"). Speak the command to ask Alexa to turn on or off the Red Light and verify that it works.

Set Up A Routine
A routine is a set of steps to perform when you speak a trigger word, such as "good morning." You might have Alexa perform several actions in sequence, such as turn on the light and play music, news, traffic, or weather when you say "good morning." Follow the instructions at https://www.amazon.com/alexa-routines/ to build your own routine. Then save and test your routine.

Automation with If This Then That
If This Then That (ifttt.com) is a web-based or mobile development platform that allows you to build automation applets that connect data from different sources without writing any code. IFTTT hosts more than 700 apps and services to integrate data from social media sites, a few of which are shown in Figure 3.

You can access IFTTT in a browser or by installing the IFTTT app from Google Play or Apple's App Store. The free plan allows you to create up to five applets. One person from each group should install the IFTTT app on their phone and create an account.

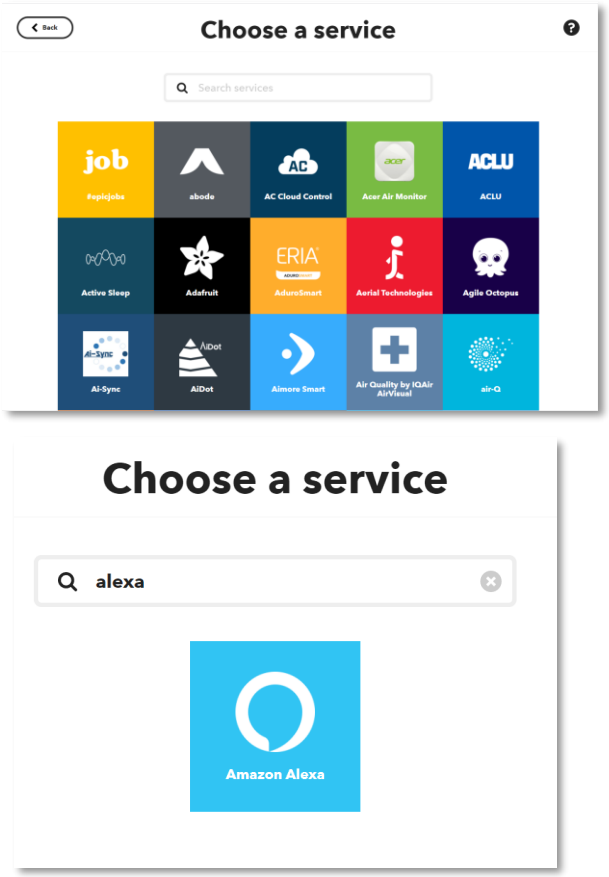

Figure 3. IFTTT Services

To create an applet, select a trigger condition ("if this") that needs to be true for the associated action to run. For example, you can check if the light connected to your smart plug is turned on.

Next, create the action ("then that") to run when the trigger condition is true. Select "Phone Call" and enter your phone number to create the action to call your phone when the trigger condition is true. IFTTT will verify your phone number by calling it and sending you a code to enter.

Test the applet by asking Alexa to turn on the light and wait momentarily for your phone to ring. Follow the steps in Appendix 1, Figure 9 to create an applet that calls your phone when the light is turned on.

Using this as an example, make your own applet using IFTTT.

You should be able to configure your Echo and smart plug and create a routine and an IfThisThenThat applet during one 60-minute class period. After completing these tasks, create a short video introducing your group members, and

demonstrating the voice commands, routines, and applets that your group created.

Create Your Own Alexa Skills With Amazon Blueprints (Extra Credit)

Alexa skills are applications that run within the Alexa app. Amazon provides an on-line tool called Amazon Blueprints to simplify the process of creating skills to leave messages for people at home, play quizzes, flashcards, and games, tell stories, create custom news briefings, and more. You can select a template for the application type you wish to create, such as a multiple-choice trivia quiz, and then add the information that you would like to use in your game. After testing your skill, you can share or publish your skill so others can use it. For an additional challenge, use Amazon Blueprints to create your own Alexa skill. Try this in class if you have time or complete it outside of class.

Visit https://blueprints.amazon.com/, as shown in Figure 4, to create your own Alexa skills by selecting and customizing one of the templates. As you complete your skill, consider the steps involved in creating, testing, and deploying it, and how they relate to publishing software.

Clean-Up

If you are no longer going to use the Echo and smart plug devices, remove the devices from your Amazon account. In the Alexa app, select the Echo device and deregister it from your account. Remove the smart plug from your account.

In the Smart Life app, select the plug and remove the device.

Uninstall any unwanted apps that you added to your phone for this activity.

Reset your Echo device to factory settings. For 2nd Generation Echo devices, press the microphone on/off and volume down buttons at the same time until the light ring turns orange. Steps may vary for other models of Echo devices.

In addition to the video showing that your devices worked properly, create a lab report document online and share it with your group members and your instructor. Your lab report will contain three sections: screenshots, group responses, and individual reflections.

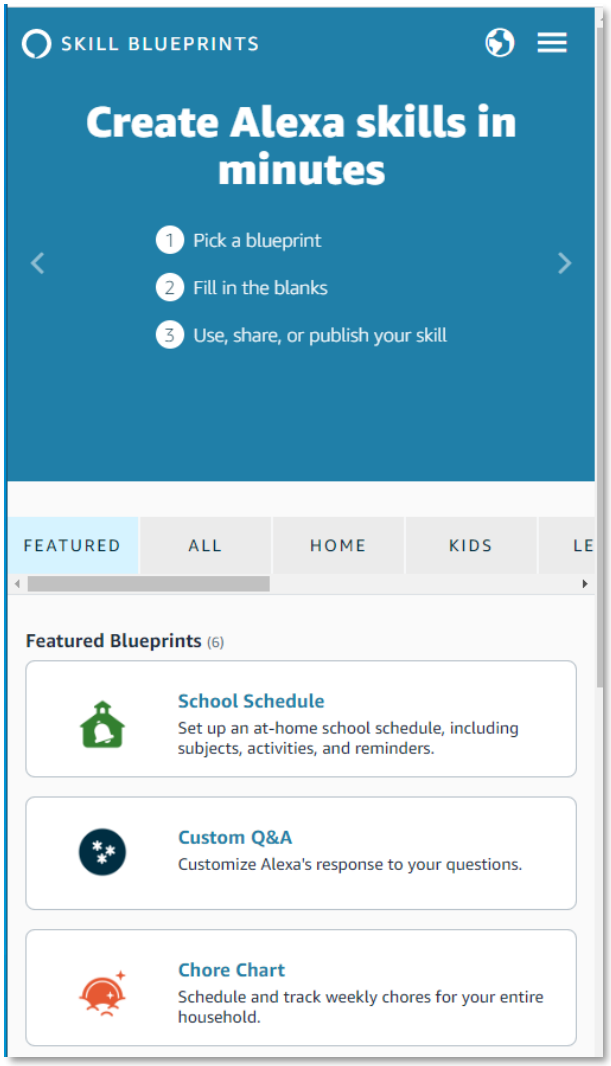

Figure 4. Amazon Blueprints

4. LAB REPORT

Screenshots

Add (at least) these screenshots to your group's lab report. Provide a caption or brief description of each.

1. Showing the IP and MAC addresses of your smart plug
2. From the smart plug app, showing your plug is connected your wireless network
3. From the Alexa app, showing your plug is connected to your Echo.
4. From the Alexa app, showing the steps in your routine
5. From IfThisThenThat, showing the steps to configure your applet

Group Responses

With your group, discuss and write responses to these questions:

1. What is the approximate cost of a smart plug such as the one you are using? Provide a link to where you can purchase one.
2. What are the MAC and IP addresses of the smart plug?
3. Why do you have to set up the plug before connecting it to the Echo?
4. To which wireless network are you connected?
5. Why do you need to be on 2.4Ghz rather than 5 GHz?
6. How are advances in 5G technology impacting the use of IoT?
7. Describe the role of APIs (application programming interfaces) in sharing data, and the services whose APIs you used in this activity. Why would companies provide access to their data through APIs?

Individual Reflections

Each student should answer these questions individually.

1. Have you previously used a smart speaker or connected smart devices to it?
2. How might you use a smart speaker and smart devices in your room or home?
3. What other devices have you seen or used that are connected to the Internet?
4. What concerns do you have about the use of IoT related to privacy and security of your data?
5. What did you learn by completing this activity? Did anything surprise you?
6. Did you run into any technical problems while completing this activity? What happened, and what steps did you take to you troubleshoot the problems? Were you able to resolve these issues?
7. How might we improve this activity?

Discuss your responses with your group.

Appendix 1. Additional Figures

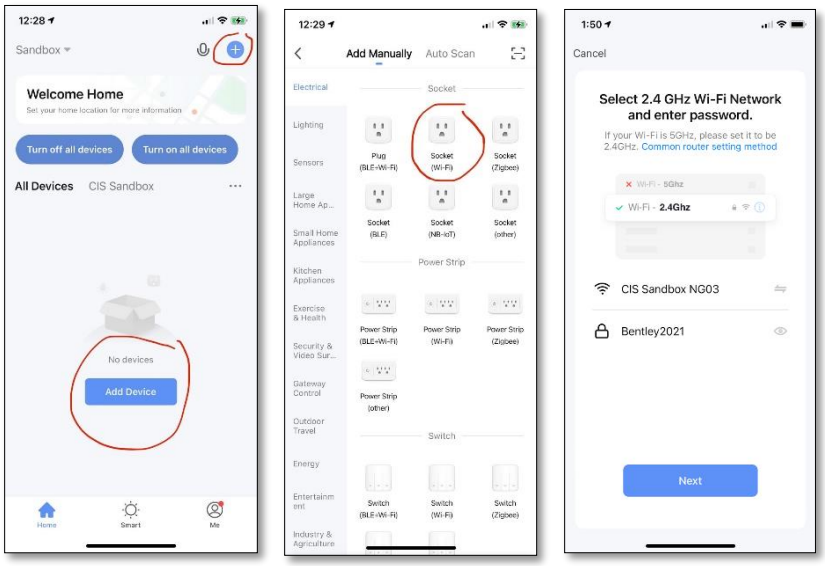

Figure 5. Steps to add a Smart Plug to a Wireless Network

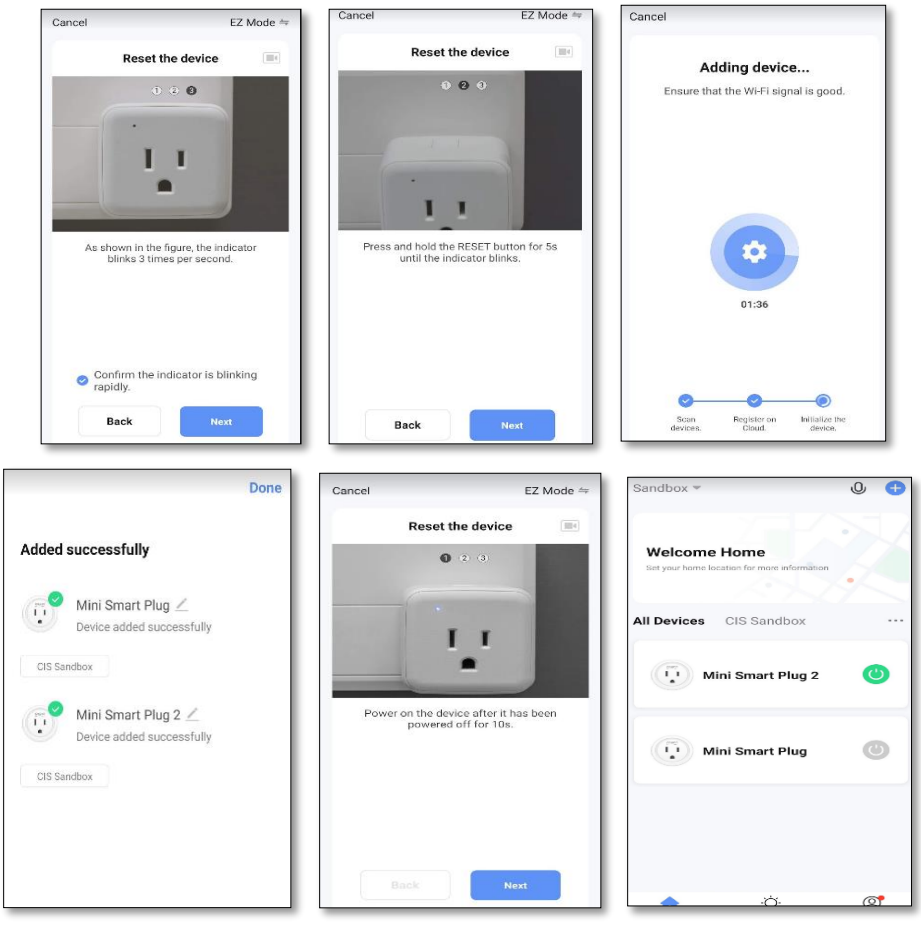

Figure 6. Steps to Configure a Smart Plug using a Mobile App.

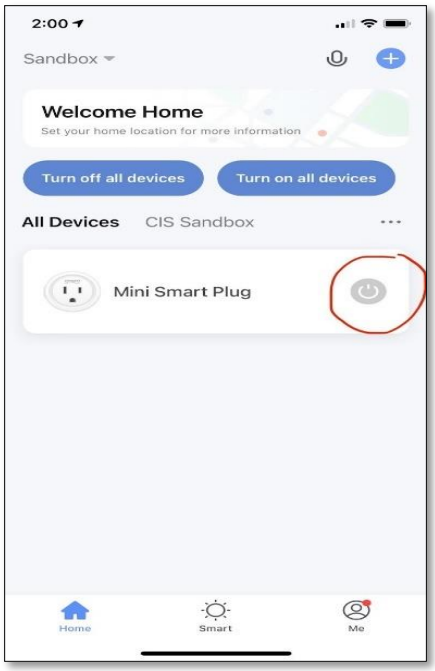

Figure 7. Turning on and off the light using the Smart Plug app.

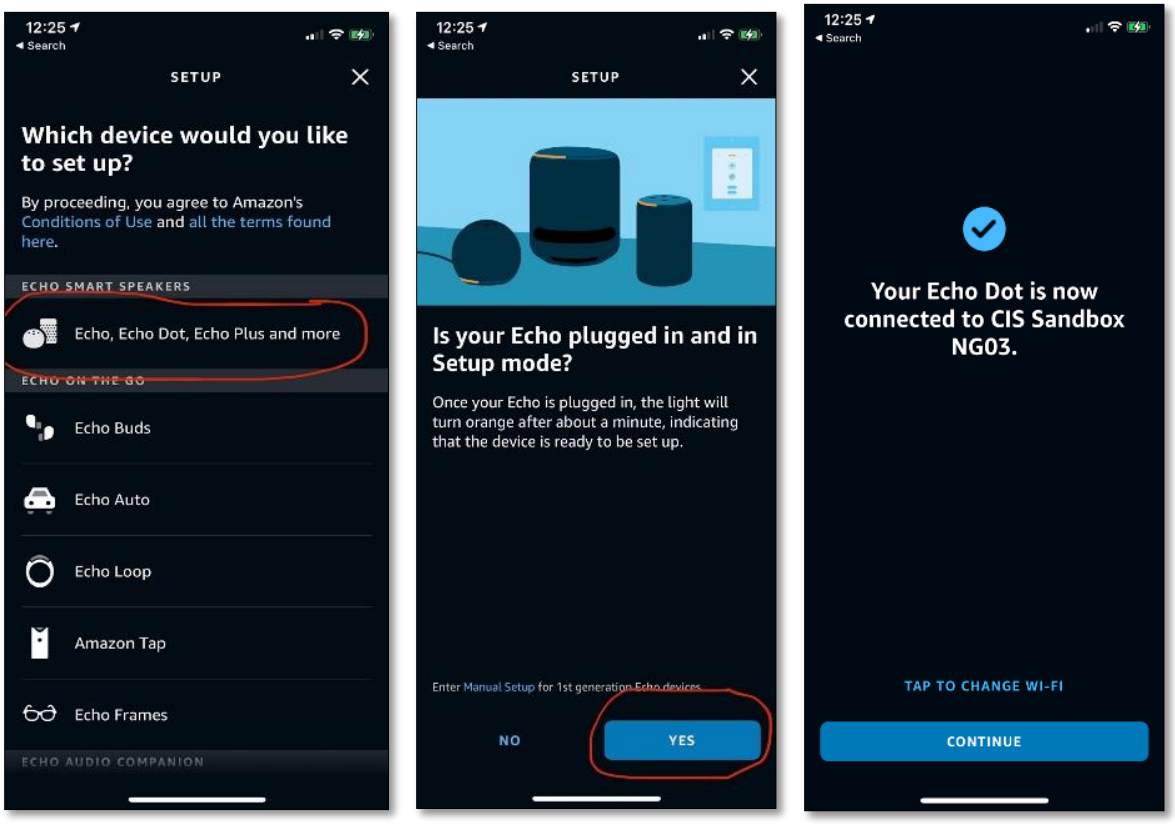

Figure 8. Steps to Connect Amazon Echo to a Wireless Network

Figure 9. Steps to Create an If This Then That Applet

Appendix 2. Creating a Skill with Amazon Blueprints

This Appendix describes steps for creating a skill with Amazon Blueprints. You can run Amazon Echo skills using any Echo-enabled device or the Alexa app on your mobile device.

Visit http:://blueprints.amazon.com. Select the blueprint you wish to customize. In this example, select *Flashcards* in the *Learning & Knowledge* section. Next, click *Make Your Own*. See Figure 10.

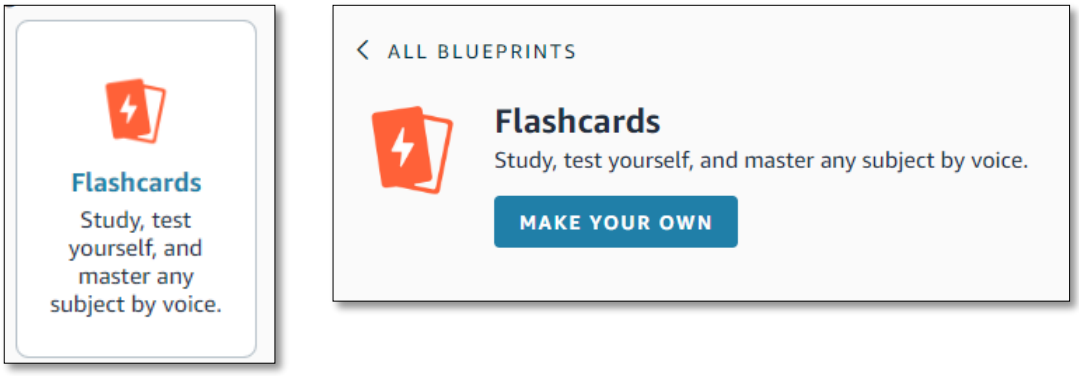

Figure 10. Create the Flashcards Skill

Add the topic and information for the flash cards. See Figure 11.

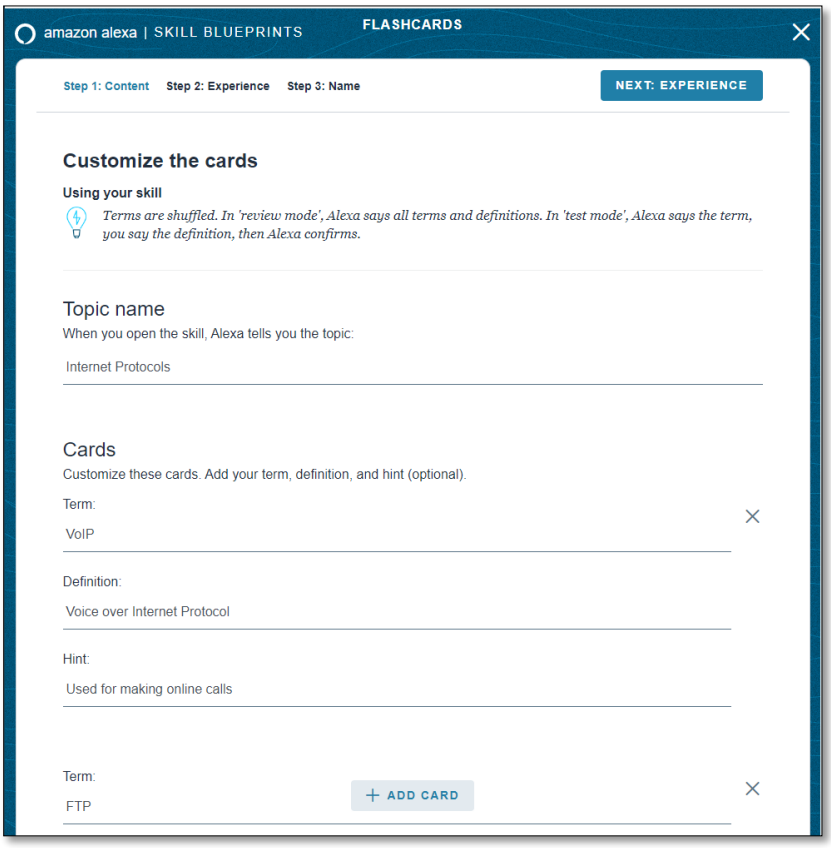

Figure 11. Add Topic and Information

Click *Experience.*

Enter information to customize the greetings, sounds, and feedback for users of this skill. See Figure 12.

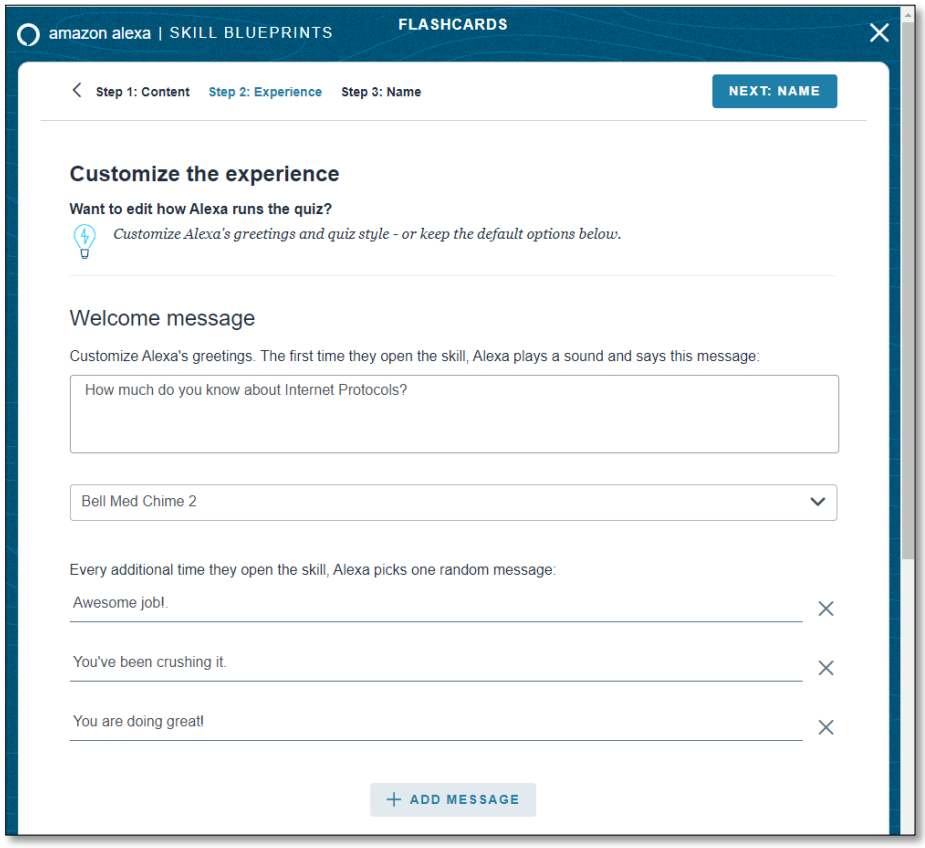

Figure 12. Add Customizations

Name your flashcard set. See Figure 13.

Figure 13. Name Your Flashcard Set

Click *Create Skill* to create the skill. This may take a few moments. See Figure 14.

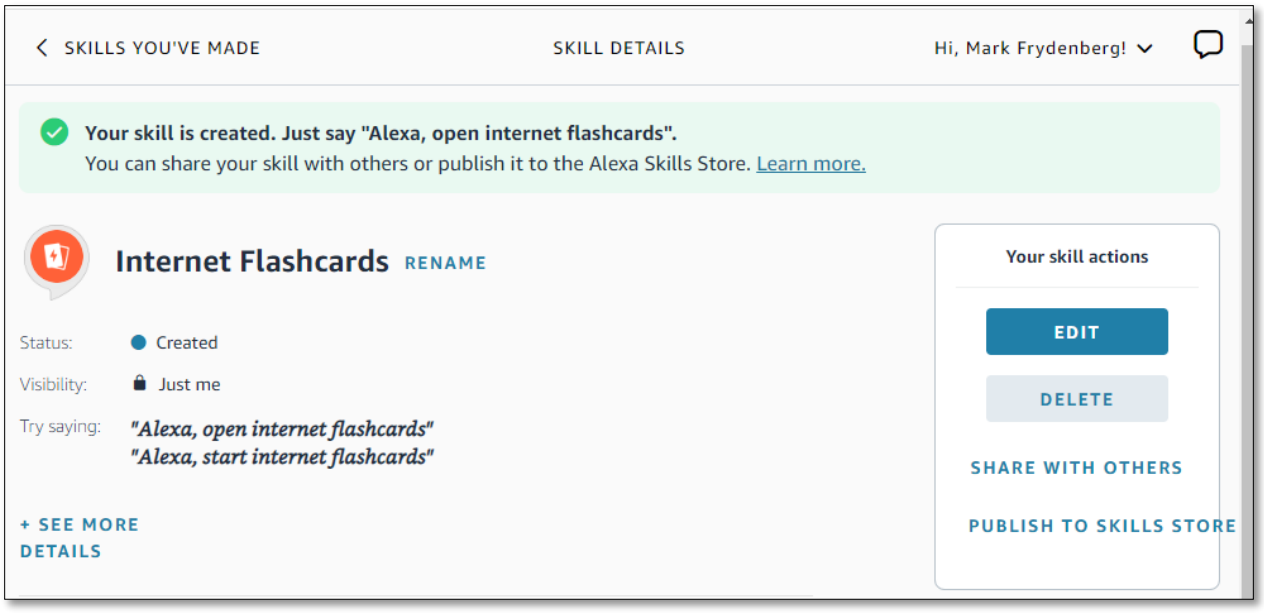

Figure 14. Create Your Skill

Say "Alexa, open internet flashcards" or "Alexa, start internet flashcards." to test your skill using your Echo device or the Alexa app on your smartphone or mobile device.

You can edit the skill at any time using Amazon Blueprints.

You can decide who has access to your skill, as shown in Figure 15.

- Keep your skill private so only the devices on your home network can access it
- Click *Share with* others to get a link to share by email or on social media sites so your friends and followers can access your skill
- Click *Publish to Skills* Store to publish your skill to the Alexa Skills Store for anyone to find, use, and review.

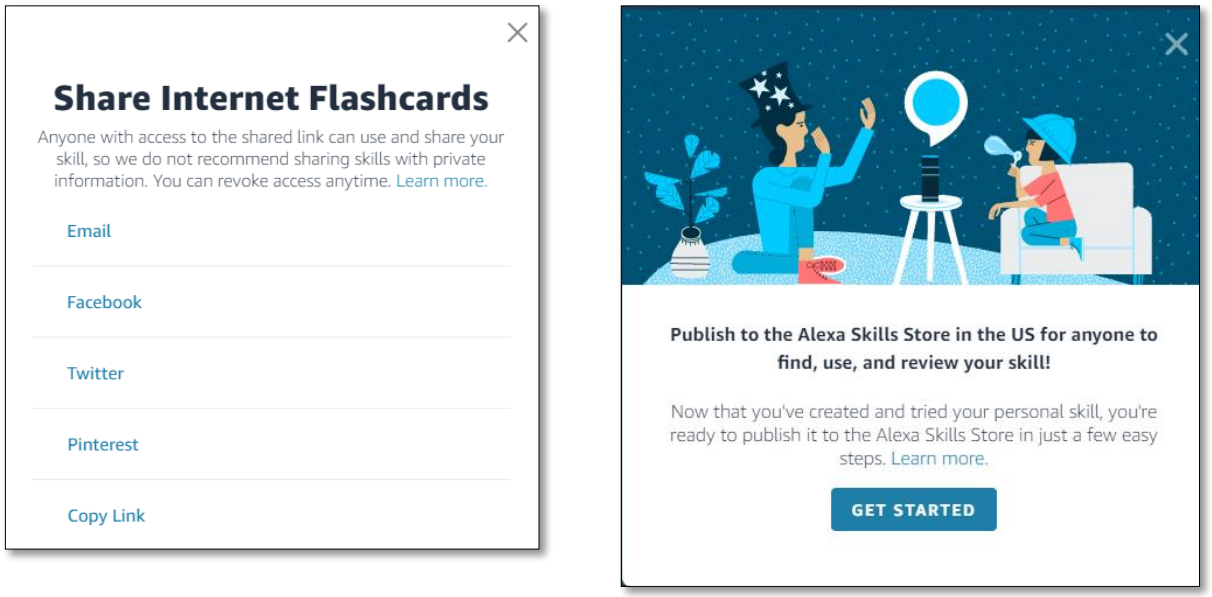

Figure 15. Share and Publish Your Skill

Appendix 3. Resources

This appendix contains information about resources described in this lab activity.

Websites

- Amazon Alexa (web interface to Alexa app with limited functionality): http://alexa.amazon.com
- Amazon Blueprints (for creating skills): https://blueprints.amazon.com
- Flip (collaborative video recording and sharing): http://flip.com
- If This Then That (automate apps and devices): http://ifttt.com

Apps

Install these apps on your mobile device. They are available from Google Play or Apple's App Store.

- Alexa
- Flip (collaborative video recording and sharing)
- If This Then That (automate apps and devices)
- SmartLife (for controlling GoSund brand smart plugs)

Teaching Case

A Registration System for a Citywide Service Project: Design & Development Case

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Hook

Baker Street Church is faced with an unexpected yet wonderful problem. Recent publicity has turned their small service activity into a community-wide event rendering their volunteer management system obsolete. They are seeking help in developing a database that can handle their growing list of projects and volunteers.

Abstract

Many small organizations sponsor events and activities that could benefit from the data management and reporting capabilities provided through a centralized database. However, many of those organizations do not have the budget to afford a commercial solution or an on-going subscription to a cloud-based solution for a small scope event with limited frequency use. The case focuses upon a service project volunteer management system for recording, managing, and reporting on volunteers and the service projects they are doing. The case provides a realistic scenario that can be used in a systems analysis and design, database development, or graduate level management information systems course. Multiple assignment options are provided allowing instructors to select an assignment based upon course material coverage. Suggested assignments include the development of process modeling diagrams such as a data flow or swim lane diagrams and database design and development artifacts.

Keywords: Teaching case, Database design, Process design, Swimlane diagrams

1. CASE SUMMARY

Baker Street Church in Whispering Hills, Missouri, is hosting their second annual "Day of Blessings" event for the community. The outpouring of interest has been more than they had anticipated. They are facing the impossible task of matching a mountain of volunteers to an equally overwhelming pile of service projects. The event has outgrown the capabilities of their spreadsheet and sticky-note matching process that was used the previous year. They seek the assistance of a local MBA student to help them develop a database solution to fill the gap.

2. CASE TEXT: A GOOD PROBLEM TO HAVE

Mike Green, pastor of Baker Street Church in Whispering Hills, MO, stared at the unending list of new email in his Outlook In box. The deadline for submitting service project ideas for their "Day of Blessings" initiative was hours away and the thought of matching the community projects and needs with volunteers was daunting.

The Day of Blessings initiative was relatively new. The event got off to a slow start the previous year, so he was not expecting much of a turnout this year either. However, a local personal interest story, with roots in last year's initiative,

was making current news headlines and the outpouring of interest was overwhelming. The church phone lines had been ringing nonstop with people suggesting projects to do and volunteers wanting to help with this year's event.

His thoughts were interrupted by a knock at the door. Jenny, the church administrative assistant, had a stack of papers and messages. "Mike," she said, "you kind of have that 'deer-in-the-headlights' look about you. I think what I'm about to give you is just going to add to it."

"More projects?" Mike asked as he motioned for Jenny to come in and be seated.

"Yes, more projects AND volunteers," Jenny said emphasizing the 'and' in her reply. "It's a good problem to have."

"I totally agree with you on that," Mike said, "but matching all of the people to the projects without accidentally leaving something or somebody out is going to take more time than we have available. I don't know how we're going to be able to get it done. Last year, we had a small stack of projects and volunteers. We were able to use spreadsheets and different color sticky notes to get projects and people matched. I don't think it will be that simple this year. With that many people involved, we're going to have to do a lot more communicating, generating reports, and handling logistical issues. It would be nice if we had some sort of registration and reporting system to help us with this project. I'm sure there are some out there, but we don't have time to go through the budget approval process to get the money approved to research, purchase, learn, and setup a new system before the big event."

Jenny thought for a moment and offered, "There's a new MBA student in our class for college-aged students who stopped by the church office the other day. He asked if there were any computer-type requests in the list of Day of Blessings projects that he could volunteer to do. I took down his name and number and told him I would get back to him. I'll give him a call to see if he can help us with this. I can check your schedule and arrange a meeting if it sounds like something he can do."

3. THE MEETING

Jenny was able to arrange a meeting with David, the new MBA student, for early the next day. David arrived at Mike's office ready to take notes. "Pastor Mike," David said as he stuck out his hand in greeting, "it's good to see you today. This project came just at the right time! I'm supposed to design and build a database for my management information systems course at school. The deadline to submit a project idea is almost here. What Jenny told me about the system you are needing sounds like it will work for my project. Could you go over the steps of the process and the data needs with me so that I can take notes to figure out what you need and to put something together to turn in for my class?"

"Of course, David," Mike said as he motioned towards a chair in his office. "I hope this works out for both of us. Just to give you a little background, last year was the first time that we ever hosted the Day of Blessings event. With all of the hard things going on in our community, we thought it would be good to do something nice for everyone and to try to bring the community together a bit. Although the event involves people of all ages performing community service projects over an eight-hour period of time on a Saturday, there's a lot of work that takes place behind the scenes in planning, coordinating, and carrying out the event."

Service Project Examples

"In preparation for the upcoming service day," Mike said, "we ask the church congregation if they are aware of, or have any ideas for, service projects that we can do as a church. We also contact various local organizations and agencies to see if there are any projects that they might have for us to do too.

"Organizations are welcome to submit more than one project. Some examples of projects that we did last year include purchasing and installing playground equipment at a local private school, painting a mural in the play area of a local public school, helping an older couple in church paint their house, building a ramp for a person who would soon be coming home from the hospital, making and delivering food baskets in a lower income area of town, taking lunch to our local fire department, and buying gift cards for our local police station.

"The projects range from needing just a couple of people with any skill level to multiple people with specific skills. We also have a certain amount of money allocated in our church budget to pay for the supplies needed for the event activities, so we try to stay within our budget."

Service Project Data

"As you would guess," Mike continued, "in order to carry out all of those service projects, there's a lot of data that we have to collect about the

activity besides the service project name and description. We also need to have a contact name with contact information such as the organization, email, phone, and address; the address at which the activity will take place; the amount of time the project will require; the number of people needed to perform the project; the skills needed to perform the project; the supplies and quantity needing to be purchased for each project; project supplies provided that will not need to be purchased; the actual cost and number of supplies purchased for each project; the date the supplies were purchased; and the estimated amount of time needed for the project with the requested people."

"Bob, the Facilities Director, and I will use the supply list report to purchase all of the supplies before the big day. We will need to record the date when purchases are made, the quantity of each item purchased for each project, and the amount paid. We should also include the name of the vendor from whom the supplies were purchased so that we will have this information to reference if something needs to be returned and for future supplies. Once the purchases are made, I will give the receipts to Jenny, and she will be able to enter the purchase details into the system and store the receipts in the folder she keeps for this event."

Volunteer Data

"In order to carry out all of those projects," Mike said, "we need to have volunteers. Last year, we created a catalog of projects including the project name, description, location, contact, estimated time commitment, as well as the number of people needed. The catalog was posted to the church's website along with a downloadable form that volunteers could fill out and give to the church office with the name of the project they were interested in, special skills they offered, their name and address information, gender, age category, volunteer type (church or community member) as well as their willingness to take the lead on a project. Due to the short timeframe in which our projects were completed, volunteers could only sign up for one project. That restriction applies for this year too.

"We didn't have a lot of projects or volunteers last year, so we just created a spreadsheet for each project and volunteer list and kept them at the lobby welcome desk.

"We didn't know what to expect this year. We anticipated a little growth, but nothing like what we are experiencing. Thanks to the local media, this year is a different kind of animal. Last year, one of our service projects involved repairing the roof of an unemployed single mother and helping her get some bedroom furniture for her kids. After getting to meet her and learn of her plight, one of the volunteers hired her to work at his business. She has just blossomed in her role with the company. During a 'person on the street' interview about the current state of the economy by the local news media, she told them her story and now it seems like the entire community wants to get involved helping others. Thus, our need for a database."

"I see," David paused and then jotted down more notes. "What kind of reports do you think you'll need throughout the process?"

Reports

"Well," Mike replied, "the first type of report we will need is the catalog of service projects so that we can make everyone aware of the projects available and their details. Speaking of projects, we would also need to have a 'shopping list' providing a compilation of all of the supplies that need to be purchased for each of the projects before the day of the event. This would need to be printed in order of supplies needed as well as include the name of the project for which it will be used. On the day before the event, we could use that same report as a check-off sheet to make sure that each project had the supplies.

"We would also need a volunteer list for each of the projects so that we would have the names, phone numbers, and age category of the volunteers. We would also want to include the project leader on that sheet. The report would have to be printed in order of project. Also, on the day of the event, we could use that report as a check-in sheet so that we can make sure that each project has enough people and to get them into the right groups.

"A project summary sheet containing the project names, a description of each project, the location of the activity, the contact for that activity, and the contact's phone number would also be beneficial. The event coordinators would need these sheets so that they could get in contact with specific groups and individuals. I can give you copies of the reports that we had last year" (Appendix A).

Communication

"With the event being so new and small last year," Mike continued, "communicating lists and event details was fairly easy. However, there are going to be a lot more people involved in the event this year, both in and outside the church.

I'm going to have to send more specific emails targeted towards each project. It would be great if the database could send an email 'report' to project leaders with the information about their event and the contact information for the people signed up for their activity. I could send that email out two or three times before the event. You may be able to think of some other emails or reports that would be helpful, but those are the ones that come to mind."

Equipment Needed

David thought for a moment and then asked, "Since obtaining the funds to purchase a new database system is going to be a problem, will you have the resources to actually run the database before and during the event?"

Mike took a sip of his coffee before answering. "I've already been thinking about that. The children's program has grown significantly over the past few years. We anticipated upgrading the computers in the children's check-in process this year and $6000 was allocated in the budget to purchase three new laptops, two tablets, a printer, and any additional hardware required. I think we could go ahead and purchase the new equipment and use it for the Day of Blessings. Once we are done with the equipment, it can be installed in the children's check-in area. Since both processes focus upon checking people in, the memory, storage, and speed requirements should be similar.

"With so many people expected to be involved in the Day of Blessings event this year," Mike continued, "we are going to have to have multiple event day check-in areas set-up. We'll probably have to set up three standalone tables each with a laptop in the north parking lot. Two of the tables will handle event day walkup registrations. The third table will be the 'command center' table to handle registration problems and printing extra reports, so this table will also need a printer. To move people with advanced registrations through the event day check-in process more quickly, we will have two lanes on the parking lot where people can check in while sitting in their cars. A volunteer with a tablet will go from car to car checking people in. Since we will be in the parking lot, we will also need some sort of mobile internet access. Do you have any hardware recommendations that you could make for us?"

Wrapping Up

"Not off of the top of my head," David said as he continued writing notes, "but, I'll see what I can find to recommend. I'll also see if I can find a commercial volunteer management system, similar to what you are wanting, so that you can see what data they collect and reports they run. I know you are unable to buy it at this time, but it may give us some ideas. I would like to create data flow and process models of what I think you are seeing your data collection and reporting processes looking like so I can make sure we are on the same wavelength. I'll try to send you something by the end of the week."

4. ASSIGNMENTS

This project could take multiple paths depending on the role your instructor has for you. Clarify with your instructor the role that you will play.

Request for Proposal (RFP)

Assume the role of David, the MBA student and conduct an Internet search to find a commercial volunteer management system that will fit the church's need for the Day of Blessings event. Mike is ready to acquire and implement the commercial system. His first step is to solicit vendor bids to obtain the technical infrastructure to support the new system.

1. From the church's perspective, develop the functional and technical requirements that would be included in a request for proposal (RFP).
2. From a potential vendor's perspective, develop the vendor's response to the RFP for the technical requirements. Essentially, you are proposing the hardware, software, networking, installation, documentation, and training that will be required to implement the infrastructure.
3. As the documents are developed, record any assumptions you make, regarding the processes, in a separate document.

Process Model Diagrams

Assume the role of David, the MBA student and draw out the functional process steps to verify that you have identified all of the steps and understand how the process works.

1. Create diagrams modeling each of the processes.
2. Write short narratives to accompany your diagrams to verify and support your interpretation of the processes.
3. As the diagrams are developed, record any assumptions you make, regarding the processes, in a separate document.

Data Flow Diagrams
Assume the role of David, the MBA student and create a data flow diagram to illustrate the flow of data through the volunteer management process to verify that you understand how the data is collected, processed, stored, and disseminated.

1. Create a diagram modeling the flow of data through the process.
2. Write a short narrative to accompany your diagram to verify and support your interpretation of the process.
3. As the diagrams are developed, record any assumptions you make, regarding the processes, in a separate document.

Systems Analysis Design and Database Development
Assume the role of David, the MBA student. Mike does not have the budget to purchase a commercial volunteer management system. He wants you to build the database. He wants to:

1. Accumulate the functional and technical requirements for the system.
2. Prioritize the requirements.
3. Create system development diagrams.
4. Create a data dictionary.
5. Create data entry forms.
6. Create queries to generate records needed for service project clients; service project descriptions and resources needed; available volunteers; service project volunteer lists; resource shopping lists; and data needed for various mail-merged letters (e.g., thank you letters).
7. Create reports for the queries including service project client information lists, service project opportunity descriptions and resource needs lists, available service project volunteer lists; resource shopping lists; and informational letters to service project clients and thank you letters to volunteers.
8. As the database is developed, record any assumptions that you make in a short report.

5. CONCLUSION

David worked all week developing and clarifying the diagrams. He watched Pastor Mike's face expectantly as he explained the diagrams and his vision for the database. A slight grin began to stretch across Mike's face as David finished explaining his last diagram. "David," Mike breathed, "That's great! I think you know exactly what we are needing. I can't wait to start using your new database!"

Appendix A

Day of Blessings Project List

Date: 8/02/2022

Project ID	Project Name	Description	Supplies	Street	Number of People Needed	Start Time	Time Estimate	Contact	Contact Phone Number
P22001	Yard cleanup	Remove leaves, sticks, & dead plants, mow yard, trim bushes, and use weed eater for elderly person.	Need to bring equipment.	115 Park St.	5	9:00am	4 hours	Mark Wilson	###-###-####
P22002	Exterior house painting	Paint exterior of house one color.	Paint and brushes provided.	115 Park St.	8	9:00am	8 hours	Mark Wilson	###-###-####
P22003	School mural painting	Fill in mural outline on front parking lot of school.	Paint and supplies will be on site.	Whispering Hills Elementary School	5	9:00am	6 hours	Jane Wynn	###-###-####
P22004	Park arts & crafts	Design arts and crafts to entertain children 6 to 9.	Project lead will purchase art supplies and snacks.	Whispering Hills Park Pavilion #5	6	8:30am	2 hours	Scott Brown	###-###-####
P22005	Drywall repair	Replace drywall on one basement room that had water damage.	Supplies will be on site.	219 Oak St.	3	9:00am	5 hours	Alex Anderson	###-###-####
P22006	Park cleanup	Remove sticks and trash from park.	Rakes, trash bags and gloves will be on site.	Whispering Hills Park	15	9:00am	5 hours	Jason Stevens	###-###-####
P22007	Roof repair	Repair storm room damage.	Supplies will be on site.	877 Sunshine St.	5	9:00am	4 hours	Brian Jackson	###-###-####

Day of Blessings Project Shopping List 2022

Date: 7/28/2022

Project ID	Project Name	Description	Supplies	Price Estimate Each	Quantity	Need to Purchase
P22001	Yard cleanup	Remove leaves, sticks, & dead plants, mow yard, trim bushes, and use weed eater for elderly person.	Recyclable trash bags	$1	10	Y
P22002	Exterior house painting	Paint exterior of house one color.	Paint Brush – 4″	$6	4	Y
P22002	Exterior house painting	Paint exterior of house one color.	Paint Brush – 2″	$4	2	Y
P22003	School mural painting	Fill in mural outline on front parking lot of school.	Paint Brush – 2″	$4	3	Y
P22002	Exterior house painting	Paint exterior of house one color.	Paint Brush – 1″	$2	2	Y
P22003	School mural painting	Fill in mural outline on front parking lot of school.	Paint Brush – 1″	$2	4	Y
P22002	Exterior house painting	Paint exterior of house one color.	Painters' Tape – 1″ width	$6	2 rolls	Y
P22003	School mural painting	Fill in mural outline on front parking lot of school.	Painters' Tape – 1″ width	$6	2 rolls	Y
P22002	Exterior house painting	Paint exterior of house one color.	Paint– White Exterior	$60	4 gal	N

Day of Blessing 2022 7/28/2022

Amber Smith
115 Park St.
City, State ZIP

Thank you very much for serving as Project Lead on the Arts and Crafts activity for 6- to 9-year-olds for the Day of Blessing event. The activity will take place in pavilion #5 at Whispering Hills Park. Please be set up no later than 8:30 a.m. with children expected to arrive by 9:00 a.m. Please purchase the art supplies you need for the activity as well as snacks for 20 children. Listed below are the people who volunteered to help with your event.

	Volunteer Names	Phone	Email	Age
1	Sue Wilson	xxx-xxx-xxx	xxxxx@xxxx.com	Adult
2	Jake Wilson	xxx-xxx-xxx	xxxxx@xxxx.com	Adult
3	Lindsey Adams	xxx-xxx-xxx	xxxxx@xxxx.com	Teenager
4	Lisa Adams	xxx-xxx-xxx	xxxxx@xxxx.com	Teenager
5	Jamie Wilson	xxx-xxx-xxx	xxxxx@xxxx.com	Teenager
6	Matt Wilson	xxx-xxx-xxx	xxxxx@xxxx.com	Teenager

For questions, please contact the church office at (555) 555-1112.

Sincerely,
Mike

Baker Street Church

Tel (XXX) 555-1111 100 Baker Street
Fax Fax (XXX) 555-1112 Whispering Hills, MO 63901

Day of Blessings Project / Volunteer List

Date: 8/02/2022

Project ID	Project	Contact	Volunteer Name	Age Category	Phone
P22001	Yard Cleanup	Mark Wilson	Mark Wilson	Adult	xxx-xxx-xxxx
P22001	Yard Cleanup		Andrew Martin	Adult	xxx-xxx-xxxx
P22001	Yard Cleanup		James Wilson	Teenager	xxx-xxx-xxxx
P22001	Yard Cleanup		Raina Wilson	Teenager	xxx-xxx-xxxx
P22001	Yard Cleanup		Terri Smith	Adult	xxx-xxx-xxxx
P22002	Exterior House Painting	Mark Wilson	Jane Wilson	Adult	xxx-xxx-xxxx
P22002	Exterior House Painting		Jenny Anders	Teenager	xxx-xxx-xxxx