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Framework for Incorporating User Experience Design in the IS Curriculum through Community-Engaged Projects

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Abstract

User Experience Design (UXD) is an often-neglected area of the information systems (IS) curriculum. UXD classes specifically designed for IS students are still uncommon in IS programs and this study aims to add to the body of knowledge to prepare a more well-rounded future generation of IS professionals. With this goal in mind, this study describes the redesign of an introductory UXD course following Kolb's learning cycle and constructivist instructional models. This paper describes the implementation of the supporting pedagogy and the opportunity for students to better master core UXD concepts. UXD, a multi-disciplinary area is built on skills learned in systems analysis and design class while students learn to apply relevant concepts through a hands-on, instructor-led, individual, in-class sample project. The skills are then applied by engaging students in active learning in a team setting to deliver value to a local organization by solving related, real-life challenges. Students work on community-engaged team projects to enhance their appreciation of the impact and relevance of their semester-long project deliverable. Constructivism guides the instructional models of the framework, in which problem-based learning is used to help students build and apply relevant skills. The instructional models and implications for instructional design are discussed along with a proposed pedagogical approach, course setting and structure, tools and techniques engaged, student feedback analyzed, and lessons learned.

Keywords: User experience design, IS Curriculum, Project-based learning, Community-engaged learning, Constructivism

1. INTRODUCTION

The recent technological advancements contribute to the ability of software development organizations (SDOs) to meet the changing user expectations. Users expect more than the sheer ability to complete a task through a software application, they also expect the process to provide a meaningful, engaging, and relevant experience that ultimately results in greater user satisfaction with less cognitive effort (Dadarkar & Tiwari, 2022). These user expectations have been turning the attention of SDOs to user experience design as a dynamically morphing domain as part of their product design. User experience is the experience of technology, products or services that refers to something larger than usability or one of its dimensions such as satisfaction or attitude (McCarthy, 2004), it is the emotions that the user encounters while using a service, a product or an application (Dirin, 2018).

SDOs view XD from two angles. First, from the customer's point of view UXD provides an opportunity for competitive advantage, improved

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return on investment. Customers expect products that fulfill their needs to accomplish a task in an effective and efficient manner. Positive customer experience is found to increase customer loyalty. (Cheng, 2020). Second, from the internal operation's point of view UXD has the promise to provide increased business process efficiency, improved employee productivity, lower training costs, reduced error rates, and more secure systems to support internal operations (Larson & Harrington, 2012).

The demand for UXD professionals is further fueled by global organizations and startups that aim to build the next generation of websites, apps, and IoT devices. Therefore, a well-rounded IS professional should possess the basic understanding of UXD principles to properly address the design-based aspect of information systems. The response to this demand is lacking in most business schools as part of their undergraduate IS programs (MacDonald, Rose, & Putnam, 2022). While it is always challenging to augment the already packed IS curriculum covering technical and business aspects of IS degree requirements, market demands for UXD professionals in the software industry should not be ignored (Getto & Beecher, 2016; Benyon, 2019; Lauer & Brumberger, 2016).

UXD is a multidisciplinary area that magnifies the effort to design a course that best serves IS students. The effort to design, develop, and implement UXD into the IS curriculum is further amplified given the variety of students' skills, backgrounds, and other IS courses across universities. Textbooks are virtually non-existent that cover the UXD for IS students and the related books mainly cover UXD as part of human-computer interaction (HCI) with deeper roots in cognitive psychology and ergonomics geared toward academic fields than practice (Gull, Saeed, & Iqbal et al., 2018). Hence, HCI is more theoretical while UXD is more practical with hands-on project opportunities for IS students. Domain specific UXD books include less relevant and outdated examples with very limited opportunities for the students to practice the concepts covered. In order to be successful in the IS profession, students need to learn relevant and up-to-date skills through engaging projects that allow students "learning by doing" (Smith, 2021).

In response to the steady growth of industry demand and to develop more well-rounded IS graduates, we designed a standalone UXD course that builds on prior IS courses and motivates students to explore the impact UXD has on users of information systems. Students will then use the UXD principles in their IS Capstone course where they develop an app in response to an organization challenge. Learning from the first semester experience, we methodologically re-designed the course with focus on active learning. With this pedagogical approach, students have the opportunity to explore UXD principles by connecting their prior knowledge to the new concepts, apply the concepts in a project setting and contribute in different roles in a self-organized team environment (Spielhofer & Haselberger, 2021). This overarching progression of experimental learning and applying skills was well received by students and our analyses found increased engagement and motivation. In the following sections we review relevant literature, the implementation of our pedagogical approach and the result of our analyses based on data from before and after the pedagogical change followed by lessons learned.

2. LITERATURE REVIEW

This literature review aims to compile UXD specific scholarship of teaching and learning (SoTL) yet occasionally we had to broaden our search and include HCI literature beside IS educational journals (Kreber, 2007; Witman, Ritchlin, & Arboleda, 2007).

UXD in IS

UXD is a complex, multi-disciplinary domain rooted in industrial design with human ergonomics and other cognitive psychological constituents (Churchill, Bowser, & Preece, 2013). Not surprisingly, IS programs scarcely incorporate UXD classes into their curriculums besides basic usability and user interface design principles (Getto, Potts & Salvo, 2013; Haaksma, de Jong & Karreman, 2018). User-centricity is a premise of digitalization and the recent IS literature is more directly pointing out the importance of producing software applications, which not only considers the business goals, but also the client expectations (Kocielnik, Amershi & Bennett). Brenner, Osterle & Petrie et al. (2014) describe the digital user as a new design perspective that shifts the focus to the individual users and their needs throughout the software development life-cycle. Universities and professional bodies such as the Association for Computing Machinery (ACM) are challenged to keep their curricula up-to-date to reflect the changing sociocultural characteristics of users. Getto and Beecher (2016) and Altay (2014) have noted that IS programs are still challenged to understand the specific UXD competencies and they call for educational programs at universities, which include working knowledge of UXD

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principles and processes of digital products and services by solving real organizational challenges. The ACM Curricula Report of 2020 and the IS 2020 A Competency Model for Undergraduate Programs in Information Systems have recognized UXD as part of all four competency subgroups and described five distinct draft competencies (Computing Curricula, 2020; ACM/AIS Task Force, 2020).

UXD in Capstone

The IS Capstone course is designed for IS students during the end of their program of study to showcase their relevant skills (Abrahams, 2010). The class often includes a semester-long project on which students work in a team setting with instructor supervision and provides the students the opportunity to work on a solution in response to business challenges of practice (Payne, Flynn, & Whitfield, 2008). The capstone course with the purpose of empowering students to evaluate, appreciate, and apply multiple skills and perspectives in the form of a collaborative project is a common accreditation requirement among colleges (Knox & Nairn, 2021).

UXD in Team Setting

A common method of delivering UXD courses is the emphasis on teamwork. Dividing students into groups allows them to be more engaged and contribute by applying the techniques, methods, and skills they learned in the course complimented by their diverse backgrounds and experiences. Cliburn (2017) describes the team-based learning principle method of their course, in which students collaborated in the design, development, and evaluation of interactive applications. In Cliburn's class students proposed a project and then they "applied" for different roles on the project based on their skills and strengths. Then they followed a methodology to understand client needs and develop an application in response to the identified needs. This approach suggests that developing a highly-effective, self-organizing team is modeled in UXD courses.

UXD in Community Engaged Learning

Community engaged learning (CEL) is gaining increasing importance in higher education and is a strategic initiative at the author's institution. This approach is also known as service learning, an educational strategy, which combines classroom learning with a relevant community service experience, especially in the IS Capstone course (Wei, Siow, & Burley, 2007; Preiser-Houy & Navarrete, 2012). Mulder (2015) describes their students' collaboration with local community stakeholders to solve societal problems, yet their work was related to HCI curriculum (Gull et al., 2018). The benefit of CEL has been discussed in the literature, e.g.(Rose, 2005) but it lacks UXD specific context. This provides an opportunity to harness CEL's impact on undergraduate IS students' learning experience. Coupled with CEL, UXD is a suitable subject matter that should be incorporate into the IS curriculum body of knowledge.

Learning Models that Support UXD

Constructivist learning theory is built on the premise of building on previously established knowledge (Hein, 1991). This principle allows students to build personal interpretation of the concepts taught in the classroom based on their experiences and interactions with others. The goal of constructivist instruction should support the active process of knowledge construction rather than communicating knowledge (Connolly & Begg, 2006). This can be manifested in engaging students in the actual use of the concepts and techniques in real business scenarios rather than structured learning for the task.

Several instructional models are appropriate to support active or experiential learning. First, a resource-based view of learning allows the instructor to assume a guiding role providing resources, a shift from dispensing expert knowledge (Rakes, 1996). Second, inquiry-based learning allows students to find a solution through research and asking questions driven by a goal initially provided by the instructor. Teaching UXD presents the opportunity for inquiry-based learning as students need to gather needs and identify areas for improvement through interaction with stakeholders, within the team and with the instructor.

To support the project portion of the UXD class, problem-based learning (PBL) engages students with the process that begins with a problem to be solved rather than content to be mastered (Khair, Skudai, & Malysia et al. 2011). PBL engages students through encouraging them to construct their own understanding of the situation, link it to their experience and prior knowledge while interacting with others to refine their understanding and eventually solve the problem (McCarthy, Grabowski, & Koszalka, 1998). PBL helps students develop reasoning skill, self-directed learning strategies, and collaborative learning skills (Khair et al. 2011). Most constructivist teaching strategies place heavy emphasis on collaborative or cooperative learning (CL), which demonstrates the notion that a solution to a problem is not a function of an

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individual but rather of the distributed intelligence of diverse contributors. (Roblyer, Edwards, & Havriluk, 1996). Driscoll (2000) points out that CL helps students to appreciate varying views even those outside of their own.

Teaching UXD is well positioned for the above learning models yet there is a gap in the relevant scholarship of teaching and learning literature to guide IS instructors on the design and implementation of UXD into their programs.

Challenges with Implementing Innovative UXD Teaching Models

The early and more recent relevant literature point out the dynamic nature of the discipline, related tools and technology. These changes require continuous effort to use updated textbooks, create practical assignments and utilize the latest tools (Sousa Santos, 2006; Talone, Basavaraj, & Wisniewski, 2017). To overcome these challenges, it is recommended that the methods, tools, and techniques used in class are harmonized with industry demands and assignments reflect the current needs and expectations of users. Shumba (2006) pointed out the challenge with assigning students to teams with the right composition of complementary skillsets. Students often possess similar skills from prior classes and the narrower breadth of responses to a problem often lacks creativity. Furthermore, collecting requirements and communicating with external stakeholders is often a challenge for CEL projects.

Our literature review of SoTL in the recommended journal by Witman et al (2007) resulted in very limited results that covered UXD and even HCI components of IS programs. Hence our motivation to re-design our UXD course and report our methodology, pedagogical approach and lessons learned.

3. PEDAGOGICAL APPROACH

In response to the gaps in the existing UXD education literature and feedback from students, we identified opportunities to re-design the UXD element of our IS curriculum. The areas covered for the re-design are: UXD in IS, UXD in Capstone, collaboration in teams, UXD in CEL, and learning models. Improvements are discussed in the next sub-sections and summarized in Table 2.

UXD in IS

First we followed the ACM recommended competencies (Computing Curricula, 2020, pg. 119) namely, design tools and techniques, stakeholder needs, benchmarks and standards, integrative design, and application design. Table 1. summarizes the competencies recommended in the ACM Computing Curricula and the areas of class covering them. For a full description, please visit the literature on pg. 119.

Competency	UXD Cycle Phase	Specific Coverage
Design tools and techniques	UCD Cycle established	Four distinct phases with unique techniques and tools.
Stakeholder needs	Requirements gathering (business and user needs)	Observation, interview, focus group, survey, etc. and document findings
Benchmark and Standards	Alternative design	ScOUt model, Task-orientation, UX Honeycomb
Integrative Design	Prototyping	Navigation and Information Architecture
Application Design	Evaluation	Techniques to capture qualitative and quantitative feedback for analysis and improvement

Table 1: ACM Recommended Competencies Embedded in the UXD Course

We employed the UXD Cycle, which includes four distinct phases, namely: requirement gathering, alternative design, prototyping, and evaluation. The requirement gathering established the problem space where the user needs and challenges are identified. The alternative design phase helped students to identify the design space, the specific area of problem(s) that they aim to solve. In the prototyping phase students propose enhanced ways for users to accomplish their task. In the evaluation phase, users have the opportunity to test the redesigned process of accomplishing their task and providing feedback. These phases corresponded with the competency guidelines detailed in the ACM Curricula for UXD in the four disciplines (computer engineering, computer science, information systems, and software engineering). The techniques and

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phases will be discussed in the Implementation of Pedagogy section.

Instructional Model
We followed Kolb's (1984) learning style quadrants and experimental learning cycle as a framework in our pedagogy design. Kolb's learning theory is built on the premise that learning new concepts are provided by new experiences: "Learning is the process whereby knowledge is created through the transformation of experience" (Kolb, 1984, pg. 38). Figure 1. summarizes the phases in Kolb's experiential learning cycle (ELC).

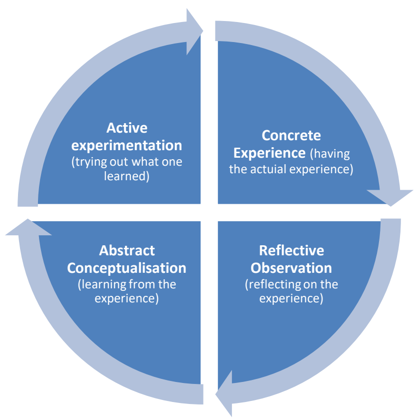

Figure 1. Kolb's (1984) Experiential Learning Cycle

Kolb's four stages are embedded in our UXD course design through the experiential learning model in the form of project work. Students gain concrete experience by interacting with the client who present their organization's goals and challenges along with other stakeholders. Students then reflect on their understanding and linking what they heard to prior knowledge. Emphasis is placed on inconsistencies between experience and understanding. The abstract conceptualization is where students generalize their understanding and prepare to assume the role required by the phase of the UXD cycle. Emphasis is placed on a new idea or modification of an existing abstract concept, which means the student has learned from the experience. The final stage allows students to use the new knowledge and apply it in the UXD phase. These four experiential learning stages are repeated in each of the four UXD phases and students were assessed on their understanding in the form of reflection and debriefing exercises.

UXD in CEL
In response to the author's University's Strategic Imperative of engaging with the community, we partnered with local organizations to provide UXD related services. Students worked on enhancing their users' experience in the form of re-designing their website (UXD course) and building an app to support internal operations (IS Capstone course). Students appreciated the involvement and the impact of their engagement with the community. This approach motivated students to feel ownership of their deliverable as they presented their proposal to the client on-site.

In order to prepare students to solve the real-life business challenges they face, concepts are covered and re-iterated through an individual in-class mock project. The purpose for the individual assignments is to replicate scenarios in which the concepts can be used and students are prepared to apply their newly gained knowledge in team assignments. Therefore, they are presented with the opportunity to apply the knowledge twice and potentially build a deeper understanding of the subject matter.

Collaboration in Teams
Another aspect of our pedagogical approach is the team environment. Students often note in class evaluations that some team members do not contribute or passive participants in the planning sessions wait to be told what to do. We considered this feedback and the challenges identified in the literature review and implemented the following plans to alleviate these challenges. First, during team formation, we ensured diversity in team composition. Students filled out a brief survey in which they rated their skills and interest in a variety of soft and technical skills. We further considered their second degree or minor, gender, and other demographic characteristics. We identified that self-organizing teams are difficult to implement so instructor intervention was necessary. We announced that each assignment will be led by a rotating team lead who is responsible for setting up and leading meetings, submitting the deliverable and providing a transparent summary of each team members' contribution on the top of the assignment in the form of a contribution log. Team leads also had the opportunity to provide private input to the instructor of the challenges that they were not meant to handle such as non-contributing or non-responding team member(s). Students were asked to decide among themselves who takes on what part of the agreed sub-tasks and how it will contribute toward the deliverable. Team members filled out self- and peer assessments during the midterms and after submitting the final deliverable.

Furthermore, we utilized the latest technologies

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v8 n5789

common in today's team environments for technology-supported collaborative learning. These technologies included Atlassian products of Confluence and Jira for work assignment and administration while students utilized Slack for communication. Instructor had access to monitor progress, activities, and student contributions in these applications.

UXD in Capstone
Students in the Capstone course were expected to utilize the knowledge they gained in the UXD class and the emphasis was on the collaboration aspect of the CEL project. Details of the Capstone course is outside of the scope of this paper.

Area (issues prior to redesign)	**Gap in literature**	**Action**
UXD in IS (not guided by competencies)	No evidence of ACM Competencies in IS programs	Included the UXD Cycle to cover the recommended five competencies
UXD in Capstone (no UXD component)	No evidence in the literature of UXD in IS Capstone courses	Students were required to apply knowledge from UXD class to enhance CEL project deliverable.
Teams (no directions from instructor)	Composition, contribution	Diverse teams to promote creativity, contribution log, self- and peer assessments, team lead, self-organization
UXD in CEL (no UXD component)	Only HCI in CEL in the relevant literature	Students worked with local organizations to provide UXD related solutions
Instructional Models (lecture heavy, limited in-class exercises)	Limited directions in literature for UXD course design	Kolb's ELC (inquiry- and problem-based)

Table 2: Response to Gaps in UXD in IS Program Literature

Table 2. summarizes the challenges we identified in the literature review and the actions we took during the UXD class design and development.

4. IMPLEMENTATON OF THE PEDAGOGY

The pedagogical approach was implemented across two sequential courses for undergraduate IS students. The first course titled "User Experience Design" introduced students to UXD principles and is a pre-requisite for the second class, the "IS Capstone", in which students are required to apply the skills in their final project deliverable that draws together all related concepts covered in previous major courses of the IS curriculum. Students take these two subsequent courses during their junior and/or senior year.

As previously mentioned, there was no textbook available to follow for UXD in IS context so the instructor developed and introduced two general models with elements that students were already familiar with from other IS courses:

(1) a base model that covers the core concepts of UXD, and
(2) the UXD Cycle as a process model

Combining these two guiding models and implementing across two IS courses is an innovative pedagogical approach to teach UXD for IS students. It allows the instructor to combine concepts learned in systems analysis and design with a front-end focus rather than system level-holistic approach. Even though students were familiar with the elements of the models the particular methodology developed for UXD allowed the instructor to highlight the key differences between systems design and UXD. Students showed more interest in applying previously established knowledge as a premise of constructivism (Hein, 1991). The instructor encouraged students to build personal interpretations of the concepts in the UXD methodology that enables the active process of knowledge construction. The project setting further supported the constructivist learning model as students linked their knowledge and experiences with fellow students to construct their own understanding of the methodology to support UXD.
The next section describes the two models in detail and how they enable students' knowledge construction.

Core Concepts
A model was drawn to familiarize students with the core concepts of UXD. We collectively named it the ScOUt model as shown in Figure 2.:

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v8 n5789

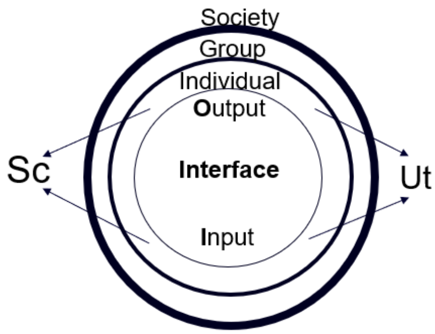

Figure 2. UXD Core Concepts (The ScOUt Model)

This model helps students conceptualize the notion that individuals that use some technology to accomplish a task need to interact with the technology and that experience needs to be enhanced. Users have a goal to accomplish a task (Ut) and they interact with the system's core functionality (Sc) through an Interface. Users must provide some input (I) that is easy to understand and leads to some output by the system (O) that completes the task based on Dix, Finlay, Abowd, & Beale (2004) and rooted in human-computer interaction but designed to cover IS concepts and examples. Group and societal expectations are considered in addition to individual needs. This basic model is revisited many times to ensure students do not lose sight of the process-based approach of UXD. Several examples from the industrial design are discussed with students, such as garage doors, chairs, and even Norman's Door and linked to software application design. For homework, students are asked to identify digital interfaces that fail to consider the above model, for example, difficulty to understand what input is required or possible (affordances and signifiers) or output is not providing the desired outcome or does not complete the task.

Students are then introduced to the UXD Cycle, which is a four phased process-based framework comprising of (1) requirement gathering or discovery; (2) Alternative Design; (3) Prototyping; and (4) Evaluation. Students spend several weeks on each phase of the UXD Cycle to learn specific tools, techniques, and methods for each phase and then apply in a mock in-class, individual project. A high-level overview of concepts and techniques covered for each phase in the UXD Cycle:

Requirements gathering to establish the *problem space*: Discuss how needs are identified from both the business and users along with tasks that users want to accomplish in different scenarios (observations, focus groups, interviews, surveys). Then students learn to compile the information gathered for analysis. They need to be able to capture the way users currently accomplish the task (flowchart, scenarios, essential use case analysis, hierarchical task analysis, current UI critique, etc.). Describing who the users are through user characteristic tables, personas, etc. Mixing requirements gathering techniques are discussed.

The mock in-class project is based on data collected from students interviewing each other about their perceived college experience followed by instructor lead discussion to identify common themes across the interviews. Focus on good grades in order to get a good job is a theme that most students identified in their data and further focused brainstorming discussion identified potential solutions to help students get good grades in the form of an application that helps students better prepare for classes and tests by pairing them up with study groups. This example shows students that they may not know their needs until after several rounds of questions and answers, often performed by business or system analysts. The established goal is to build a "Study Buddy" app and further discussion establishes tasks students want to accomplish with this app. Related tools and techniques are covered that students use to present their findings about users and tasks that will serve the basis of identifying system features that help users accomplish those tasks in an efficient and effective manner. In this phase, students develop contextual understanding of the tasks and identify with related opportunities and constraints.

Clients from the community present their organization and challenges at this point of the course and students are equipped with the skills to ask relevant questions that help them identify who the users are, what their goals are and what tasks users want to accomplish. Again, they present their findings but now in teams and applying the techniques and tools covered through the in-class exercise.

Designing alternatives – the *design space*: after establishing the requirements, students are able to identify the area they plan to improve through helping users to accomplish their intended task. The goal is to improve the way users currently achieve that task guided by sound requirements identified in the prior UXD cycle element. This is the step where improved user experience is established. Brainstorming and other relevant techniques and tools are used to capture ideas in a team setting after the basics are covered in-class.

Prototyping: In this phase students model various system features that meet core aspects of the tasks users want to accomplish. We differentiate low and high fidelity and horizontal and vertical prototypes. Low fidelity techniques include sketching, wireframing, storyboards, and card-based activities. Students enjoy this step as they can quickly pivot to different ideas without investing much effort or being bound to an idea. Hand-drawing is encouraged yet several applications are available that help to create low fidelity prototypes. The high-fidelity prototypes include close-to-final layout with interaction modeled. Users can "touch and feel" this prototype and provide more useful feedback.

Evaluation: We discuss formative and summative evaluation and assess learnability and memorability as quantitative measures while assessing cognitive and emotional measures as qualitative measures.

Students apply the skills in the real-life project and reach out to the client for early feedback to ensure they understand the needs as they progress in the design cycle. The iterative nature of the UXD cycle is emphasized in class as students often receive feedback that requires further improvement. This is an important lesson in the class that we have been emphasizing from the beginning as the first prototype will likely not be perfect.

Assessments
Individual assignments include the steps to develop the "Study Buddy" app. The team assignments similarly include deliverables for each UXD Cycle phase with write up on methods, tools, techniques and concepts used, lessons learned, improvements made. Furthermore, the quizzes tested students understanding of the concepts and essay questions provided the opportunity for students to elaborate on scenario based questions.

The class included several related videos in which SDO executives explained the importance of UXD and videos in which frustrated users pointed out the poor UXD on everyday thigs. We also had two expert guest-speakers one from the industrial design field while the other is from a SDO.

5. ANALYSIS

An attitudinal survey was administered at the end of each semester in which the UXD and IS Capstone courses were taught. Data from these surveys were used to compare students' perceived knowledge of a variety of IS elements in UXD context prior and after the class re-design. The redesigned Capstone course had an enrollment of 40 student while 64 students took the redesigned UXD course across two sections.

We present the findings from the UXD class as the redesign had a greater impact on this class. Following Baham (2019) we invited all students to complete an anonymous survey that measured their perceived UXD skills prior the class, current knowledge (after the class) of specific areas of the UXD cycle, and their comfort level with UXD moving forward. The measures were answered using a 5-point Likert scale ranging from 1-Strongly Disagree to 5-Strongly Agree and 3-Neutral. 32 out of 35 students completed the survey for the class prior to re-design while 55 out of 64 students completed in the re-designed course. Data was collected at the end of the semester upon completion of the project. The full questions are in Appendix A. The results are summarized in Appendix B and t-scores for two independent samples is included in Appendix C.

We measured students' perceived current knowledge of core concepts and methods of UXD taught in the class both with regards to themselves as individuals and to their teams. More significant increase is noticeable in the alternative design and evaluation phases of the UXD cycle. These pre-treatment scores prompted the instructor to re-visit those phases in the course design to enhance student learning. Also, evaluation was difficult without proper feedback from clients in the pre-treatment class.

Implementing the discussed active learning models with the related pedagogical approach showed significant improvement in students' perception of the extent to which the class structure, exercises, assessments, and projects meet their learning style. This emphasizes the demand for experiential learning and involving projects from the community.

6. RECOMMENDATIONS AND LESSONS LEARNED

The class is subject to future enhancements but the instructor compiled a list of lessons learned from the re-designed class:

- Do not lose sight of industry demand and current practices. UXD is a dynamic area especially in the IS field and new techniques and tools emerge quickly.

- The project-based learning is a must in this class and makes a huge difference. Students were engaged and excited using a tool that helped them envision the enhanced design. Even a mock project makes a difference but having them see the impact their work made in their community is something they are proud of and motivated to do their best at.

- Provide enough time to do in-class work so students can ask questions or get help if they feel stuck. They provide higher quality work even if they have to finish later.

- The interviews and final presentations are essential in improving students' communication skills and confidence. Same goes with teamwork skills, which are mandatory in the current business climate.

- Seek end user input, even if not all stakeholders can provide feedback. Students seem to lose motivation without it.

- Do not let students assume they know what the users want. Even asking fellow students provides rich information from a different perspective.

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APPENDIX A: Student Feedback Survey Questions

Instructions: Please think through your learning journey in the class regarding user experience design. Please rate each questions. Your answers are anonymous, they cannot be linked to you and the results will be reported in an aggregate level.

Question 1: Prior to this course, I was ___________ of UXD principles and practices.

A	B	C	D	E
Not knowledgeable at all	Not very knowledgeable	Neutral	Somewhat knowledgeable	Very knowledgeable

Questions 2-7: Currently I have an adequate knowledge of _________.

2. Goal of user experience design (UXD).

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

3. Requirements gathering for UXD.

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

4. Presenting findings from requirements gathering.

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

5. Alternative designs

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

6. Prototyping

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

7. Evaluation

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

Questions 8-13: My team has an adequate knowledge of _________.

8. Goal of user experience design.

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

9. Requirements gathering for UXD.

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

10. Presenting findings from requirements gathering.

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

11. Alternative designs

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

12. Prototyping

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

13. Evaluation

A	B	C	D	E

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

14. Overall, I am (now) knowledgeable of UXD principles and practices

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

Questions 15-18: The ________ fit my learning style.

15. course structure

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

16. assignments

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

17. teamwork

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

18. project

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

19. I feel that the exercises and project enhanced my knowledge of UXD principles.

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

20. I feel comfortable doing UXD related tasks at a future job.

A	B	C	D	E
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

APPENDIX B: Summary of Student Survey Results

Both prior and after the re-design values are included for the mean values by measurement items. The standard deviations are in parentheses. *P>0.05

Measures	**Prior** Mean (St. dev)	**After** Mean (St. dev)
Prior UXD knowledge Q1*	1.82 (0.62)	1.97 (0.71)
Current UXD knowledge Q2* Goal of UXD	4.52	4.71

ISSN: 2473-4901
v8 n5789

	(1.08)	(1.13)
Q3* Requirements gathering	4.44 (1.01)	4.68 (0.95)
Q4 Presenting findings	4.11 (0.84)	4.69 (0.94)
Q5 Alternative designs	3.91 (1.21)	4.41 (1.08)
Q6 Prototyping	4.09 (0.89)	4.52 (0.93)
Q7 Evaluation	3.88 (1.34)	4.49 (1.21)
Perceived team UXD knowledge Q8* Goal of UXD	4.55 (0.79)	4.78 (0.94)
Q9* Req. gathering	4.38 (1.12)	4.70 (1.03)
Q10* Pres. Findings	4.23 (1.10)	4.58 (1.03)
Q11 Alt. designs	3.81 (1.44)	4.52 (1.38)
Q12 Prototyping	4.21 (1.03)	4.89 (0.98)
Q13 Evaluation	3.79 (1.42)	4.54 (1.12)
Q14 Overall knowledge	4.11 (1.12)	4.68 (0.87)
Learning Style Fit Q15* course structure	4.02 (1.48)	4.38 (1.21)
Q16 assignments	3.73 (1.89)	4.31 (1.13)
Q17* teamwork	3.14 (1.72)	4.12 (1.18)
Q18 project	3.34 (1.62)	4.48 (1.41)
Future outlook – *I feel____* Q19 … *that the exercises and project enhanced my knowledge of UXD principles.*	4.12 (1.12)	4.73 (0.88)
Q20* … *comfortable doing UXD related tasks at a future job.*	3.12 (1.92)	3.82 (1.68)
N	32	55
Average grade-class	3.45 (0.52)	3.62 (0.48)

 ISSN: 2473-4901
v8 n5789

APPENDIX C: t-scores for two independent samples

The standard deviations are roughly equal, mean sores of answers to questions 1, 2, 3, 8, 9, 10, 15, 16, and 17 did not show statistically significant differences between prior and after redesign scores on the p<0.05 significance level. These questions were related to concept that students seemed to be the most comfortable with from other classes, for example, questions related to teamwork and requirements gathering. It suggests that new concepts specific to UXD benefited the most from the class redesign following the ACM recommended competencies embedded in the UXD course coupled with constructivist pedagogical model.

	prior redesign			after redesign															
Q#	**mean**	**sd**	**n**	**mean**	**sd**	**n**	**s_p^2**	**$SE(x_1-x_2)$**	**t statistic**	**DoF**	**> 0.2**	**0.2**	**0.1**	**0.05**	**0.02**	**0.01**	**0.005**	**0.002**	**0.001**
Q1	1.82	0.62	32	1.97	0.71	55	0.46	0.15	**0.99**	85	**x**	1.29	1.66	1.99	2.37	2.64	2.89	3.20	3.42
Q2	4.52	1.08	32	4.71	1.13	55	1.24	0.25	**0.77**	85	**x**	1.29	1.66	1.99	2.37	2.64	2.89	3.20	3.42
Q3	4.44	1.01	32	4.68	0.95	55	0.95	0.22	**1.11**	85	**x**	1.29	1.66	1.99	2.37	2.64	2.89	3.20	3.42
Q4	4.11	0.84	32	4.69	0.94	55	0.82	0.20	**2.88**	85		1.29	1.66	1.99	2.37	2.64	**2.89**	**3.20**	3.42
Q5	3.91	1.21	32	4.41	1.08	55	1.27	0.25	**1.99**	85		1.29	1.66	**1.99**	**2.37**	2.64	2.89	3.20	3.42
Q6	4.09	0.89	32	4.52	0.93	55	0.84	0.20	**2.11**	85		1.29	1.66	**1.99**	**2.37**	2.64	2.89	3.20	3.42
Q7	3.88	1.34	32	4.49	1.21	55	1.59	0.28	**2.18**	85		1.29	1.66	**1.99**	**2.37**	2.64	2.89	3.20	3.42
Q8	4.55	0.79	32	4.78	0.94	55	0.79	0.20	**1.16**	85	**x**	1.29	1.66	1.99	2.37	2.64	2.89	3.20	3.42
Q9	4.38	1.12	32	4.7	1.03	55	1.13	0.24	**1.35**	85		**1.29**	**1.66**	1.99	2.37	2.64	2.89	3.20	3.42
Q10	4.23	1.1	32	4.58	1.03	55	1.12	0.23	**1.49**	85		**1.29**	**1.66**	1.99	2.37	2.64	2.89	3.20	3.42
Q11	3.81	1.44	32	4.52	1.38	55	1.97	0.31	**2.28**	85		1.29	1.66	**1.99**	**2.37**	2.64	2.89	3.20	3.42
Q12	4.21	1.03	32	4.89	0.98	55	1.00	0.22	**3.06**	85		1.29	1.66	1.99	2.37	2.64	**2.89**	**3.20**	3.42
Q13	3.79	1.42	32	4.54	1.12	55	1.53	0.28	**2.73**	85		1.29	1.66	1.99	**2.37**	**2.64**	2.89	3.20	3.42
Q14	4.11	1.12	32	4.68	0.87	55	0.94	0.22	**2.65**	85		1.29	1.66	1.99	**2.37**	**2.64**	2.89	3.20	3.42
Q15	4.02	1.48	32	4.38	1.21	55	1.73	0.29	**1.23**	85	**x**	1.29	1.66	1.99	2.37	2.64	2.89	3.20	3.42
Q16	3.73	1.89	32	4.31	1.13	55	2.11	0.32	**1.79**	85		1.29	**1.66**	**1.99**	2.37	2.64	2.89	3.20	3.42
Q17	3.14	1.72	32	4.12	1.18	55	1.96	0.31	**3.15**	85		1.29	1.66	1.99	2.37	2.64	**2.89**	**3.20**	3.42
Q18	3.34	1.62	32	4.48	1.41	55	2.22	0.33	**3.44**	85		1.29	1.66	1.99	2.37	2.64	2.89	3.20	**3.42**
Q19	4.12	1.12	32	4.73	0.88	55	0.95	0.22	**2.82**	85		1.29	1.66	1.99	2.37	**2.64**	**2.89**	3.20	3.42
Q20	3.12	1.92	32	3.82	1.68	55	3.14	0.39	**1.78**	85		1.29	**1.66**	**1.99**	2.37	2.64	2.89	3.20	3.42

The distribution table followed DF=80 from https://www.medcalc.org/manual/t-distribution-table.php

The above analysis was provided by an anonymous reviewer.

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v8 n5789

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