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Sara Moussawi
Department of Information SystemsCarnegie Mellon University, USA, smoussaw@andrew.cmu.edu

Savanid Nui Vatanasakdakul
Department of Information SystemsCarnegie Mellon University, Qatar, savanid@cmu.edu

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FOR THE MANY NOT THE FEW: MOVING TOWARDS A WIDER STUDENT ENGAGEMENT IN UNDERGRADUATE RESEARCH IN INFORMATION SYSTEMS

Sara Moussawi
Department of Information Systems
Carnegie Mellon University, USA
smoussaw@andrew.cmu.edu

Savanid (Nui) Vatanasakdakul
Department of Information Systems
Carnegie Mellon University, Qatar
savanid@cmu.edu

Abstract:

It is evident that developing undergraduate research experiences is crucial for improving students' learning. In information systems (IS), opportunities available to undergraduate students are mostly limited to honor theses and independent projects. Integrating research components in the IS curriculum can ensure a consistent and sustainable research engagement model for undergraduate IS students. This study aims to explore the different components of two undergraduate research courses in IS, how these components align to various research and teaching approaches, and how they can be easily integrated into other IS courses. We use a multiple-case study design and analyze the case studies drawing on Healey and Jenkins' model (2009) of teaching and research alignment. We map the course components to four categories: research-led, research-oriented, research-based or research-tutored. We then discuss recommended integrations of the extracted components into several IS courses and provide examples.

Keywords: Curriculum design, Information Systems, Research skills, Undergraduate education, Undergraduate research

I. INTRODUCTION

Academics agree that undergraduate students must experience learning through research and inquiry [Carnell and Fung 2017; Healey and Jenkins 2009] and that building students research skills is essential for students in all disciplines [Dwyer 2001; Healey and Jenkins 2009]. Involving undergraduate students in research improves their learning [Garde-Hansen and Calvert 2007; Kenny et al. 2001]. A comprehensive review of the literature on undergraduate research shows overwhelming support for engaging students in research. The most prominent benefits reported in prior research include: increased student interest in the discipline, enhanced career preparation and readiness, increased clarity and confirmation of career path, increased self-confidence, better understanding of the research process, benefits in critical thinking, problem solving and science literacy, and improved skills including research techniques, collaborative work, communication and leadership [Seymour et al. 2004].

Examples of undergraduate research in various disciplines (e.g. chemistry, engineering) include summer research experiences, undergraduate research programs (e.g. grants, faculty mentorship), first-year research seminars, senior theses. The main concern with these options is that they provide access only to select students and exist outside of the formal curriculum. Researchers have advocated for the need to enhance the relationship between teaching and discipline-based research in the effort to mainstream undergraduate research through its

integration into the curriculum [Healey and Jenkins 2009]. A more recent model for undergraduate research that has been integrated in the classroom is the course-based undergraduate research experiences (CURE). This model emerged as a response to the call for many sciences, technology, engineering and math (STEM) programs to involve more undergraduates in research and has gained attraction in various fields. CURE courses involve students in learning experiences where the whole class is engaged in solving one research question that has not been explored before [Dolan 2016].

In IS, the efforts to engage undergraduate students in research have been limited for several reasons. First, in most universities, there is no clear path for integrating research into the curriculum except through independent or honors research projects that are usually aimed for a select number of students. Second, the low number of information systems students pursuing graduate degrees could be related to the high average salary upon graduation. Prior research suggested that the large salaries for graduates in the business and engineering fields are a defining factor in students' pursuit of advanced degrees [Hathaway et al. 2002; Hauptman 1986]. However, IS scholars would agree that the benefits from engagement in research will arm students with the necessary problem solving and critical thinking skills that they need to address the increasingly undefined and complex problems in the information systems field.

In this paper, we present two case studies that incorporate various research components into two elective IS courses that are offered to all students, i.e. are not part of honors research projects. The case studies are implemented at a large research university in two campuses, one located in the United States and the other one in the Gulf region, Qatar. We draw on Healey and Jenkins' [2009] work relating to the alignment between research and teaching to investigate the case studies. Ensuring alignment between teaching and research through curriculum design is an approach that ensures consistency and sustainability [Cleaver et al. 2017]. Our analysis maps the courses' components based on two dimensions: emphasis on research content or processes and problems, and engaging students as participants or audience. Our discussion presents recommendations for easily integrating research components into IS courses.

The next section presents our literature review followed by the theoretical background that we draw on to analyze each of the case studies. Following that, we present the two case studies followed by a discussion then a conclusion.

II. LITERATURE REVIEW

Benefits from Students' Engagement in Research

A three-year study investigated summer-intensive research experiences at four liberal arts colleges, and encompassed retention programs, career promotion programs, research apprenticeships as well as research-based learning which involved any research-like experiences in the classroom [Seymour et al. 2004]. This study reported student gains from undergraduate research as personal and professional gains, gains in various skills, learning to work like a scientist, enhanced graduate school preparation, clarity on career plans and shifts in attitudes towards learning as a researcher [Seymour et al. 2004].

Prior work also found that participation in undergraduate research at the Undergraduate Research Opportunity Program of the University of Michigan increased the likelihood for students to pursue graduate education [Hathaway et al. 2002], and significantly improved their intention to enroll in graduate programs in different contexts (e.g. for minorities and in STEM fields) [Eagan et

al. 2013; Barlow and Villarejo 2004]. Furthermore, prior research findings showed that alumni reported benefits from their research experience even if they were engaged for only one semester. The benefits were higher for students who devoted more time or worked on a senior thesis. Furthermore, committing to research did not interfere with other campus activities or the ability to maintain high grades [Bauer and Bennett 2003]. Alumni who participated in undergraduate research (worked with an advisor and produced a senior thesis - through an Undergraduate Research Program- or self-reported to have engaged in research activities in some form) reported greater perceived enhancement of skills. When compared with the student group who did not engage in undergraduate research, the results showed statistically significant skill enhancement especially for cognitive and personal skills. More specifically, students with undergraduate research experience reported better communication and leadership skills, ability to understand scientific findings and analyze the literature, clear career goals, and development of intellectual curiosity [Bauer and Bennett 2003].

The Emergence of Classroom Research Experiences

The development of undergraduate research opportunities is viewed as an important step to improve undergraduate education [Kenny et al. 2001]. The National Survey of Student Engagement reported that it is more likely for senior students who major in biological and physical sciences and who attend private institutions and baccalaureate-liberal arts colleges to participate in research activities [Buckley and Kuh 2009; Hu et al. 2008]. More recently, the National Institute of Health (NIH) and the National Science Foundation (NSF) have invested in undergraduate research programs with the aim of increasing student retainment and enrollment in graduate programs especially in STEM fields [Eagan et al. 2013].

CURE emerged as a response to the call for many STEM programs to offer research experiences at scale [Dolan 2016]. In this model, students engage in addressing a research question over the course of one semester. Faculty who engage in CURE instruction could benefit from publishable research results. Other benefits relate to improved graduation and retention rates in STEM fields. CURE presents a different model of undergraduate research since students register for a CURE course as part of their curriculum and during a regular academic semester [Dolan 2016]. This model has been implemented in various fields such as chemistry, engineering, and most recently in music [Kerr and Yan 2016; Shaban, Abdulwahed and Younes 2015; Dvorak 2021].

Alternative Classroom Research Experiences

While CURE offers a successful model for integrating undergraduate research at scale in the curriculum, it is not the only way and may not necessarily be a good fit for all courses. At the heart of research and creative activities are two fundamental learning concepts: “learning as a process of constructing understanding, and … mentoring learners by scaffolding the mastery of new skills and experiences” [Buckley and Kuh 2009, p.419; Hu et al. 2008]. A genuinely student-centered undergraduate education is strongly connected to re-thinking the teaching-research relationship. This relationship needs to be led not necessarily by academics’ research interests, but rather by students’ research interests when feasible [Garde-Hansen and Calvert 2007]. In the next few sections, we illustrate how the examples, tools and outcomes from two elective IS courses present course components that **help promote research skills and** that are easily integrated into existing information systems courses.

III. THEORETICAL BACKGROUND

In this study, we aim to present yet a different model of incorporating research at the undergraduate level. We make the claim that more students will benefit from research components taught in various IS courses. Based on two case studies, we reflect and present course components that can be integrated in various courses at different levels and that would build students' research skills. To do so, we build on a model that maps research foci to teaching methodologies.

Healey and Jenkins [2009] proposed a model that describes the nature of undergraduate research and inquiry (Figure 1). The model presents a mapping of the ways students can be involved in research depending on whether students are engaged as active participants or audience; and whether the research approach highlights the research content or research processes and problems. This model is inclusive of the different pedagogies relating to undergraduate research and consists of four different quadrants: research-led, research-oriented, research-tutored and research-based programs.

Research-led programs center on students learning about current research in the field (i.e. current research findings and themes). Research-oriented programs focus on students developing their research skills through an emphasis on the process by which knowledge is produced as well as the content. Both research-led and research-oriented categories rely on information transmission as the main mode of teaching and hence students are frequently an audience. In research-based programs, students are researchers. They work alongside the instructor and undertake research and inquiry-based activities [Carnell and Fung 2017; Healey and Jenkins 2009; Giffiths 2004]. The research-tutored category emphasizes student discussion of research content. Both research-based and research-tutored categories focus on engaging students in research tasks and discussions. Additionally, both research-based and research-oriented programs emphasize the process through which research is created, while research-tutored and research-led categories stress the research content.

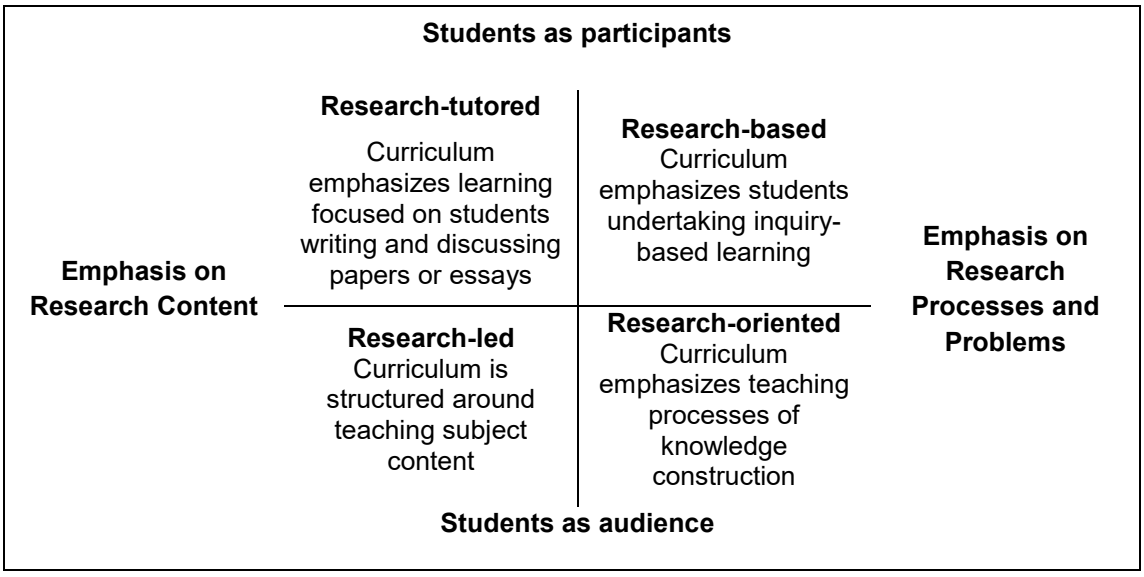

Figure 1: Categories of Teaching and Research Alignment
(Adapted from Healey and Jenkins 2009)

IV. RESEARCH METHOD

The purpose of this study is multifold. First, we aim to explore the course components of two undergraduate research courses in IS. Second, we investigate how these components align to different research and teaching approaches by drawing on Healey and Jenkins' (2009) framework. Third, we examine the possibility of integrating these components into other IS courses. To accomplish these goals, we adopt a multiple-case study design as our research method. Case studies are suited for research with exploratory nature that aims to understand the nature and complexity of the process under investigation [Creswell 1994; Yin 2014]. Multiple case designs allow for exploring the phenomenon of interest in diverse settings [Drake et al. 1998]. The two cases for our study are two IS elective courses offered to undergraduate IS students at a large research university in two different campuses. One course (Case Study 1) is offered at the US campus, while the other course (Case Study 2) is offered at the Gulf campus, Qatar. Two different instructors independently offer the two courses as full semester courses. The unit of analysis for the case studies is the course as it provides sufficient breadth and depth to address our research aims. Case evidence was obtained from syllabi and course schedules, course assignments and rubrics, other teaching documents, the observations of the courses, papers and projects as they unfolded through the semester, one end-of-semester focus group report for Case Study 1, reflection surveys and teaching evaluation comments.

V. CASE STUDY 1: UNDERGRADUATE RESEARCH SEMINAR ON INTELLIGIENT AGENTS (USA CAMPUS)

Context

This course is a full semester research seminar for undergraduate IS students titled "Research seminar on Intelligent Agents". It is an elective course offered to junior and senior students at a large research university in the United States. This course engages students in research at the intersection of information systems, artificial intelligence, and psychology. The course immerses students in readings and discussions on topics relating to intelligent agents. Themes range from exploring intelligent agents' classifications to dimensions of trust, the role of anthropomorphism, the factors impacting users' perceptions of intelligence and experiences when interacting with intelligent agents and similar systems. A wide range of agents and systems is explored, e.g. personal intelligent agents, online recommendation systems, embodied robots, smart cars, etc. Assigned readings are academic journal and conference publications from various academic journals and conferences, mostly in IS. The list of readings highlights different approaches to research and study design. The readings also employ various theoretical frameworks such as the technology acceptance model(s), media richness theory, schema theory, uncanny valley, and computers as social actors framework among others.

Analysis

The course activities include student- and instructor-led class discussions, lectures, weekly reports, and a research paper proposal. Every week students are assigned readings for in-class discussions. Students are also appointed as paper leads, i.e. to manage the in-class discussion for the assigned paper. Students leading the discussion of a paper, share a one-page report 24 hours in advance with the entire class. In this report, students present a brief summary, one interesting aspect of the paper, one novel research study that draws on this research, and any questions they might have.

During the first half of the semester, the instructor integrates lecture content to introduce students to academic research types, research design and a number of relevant theories. Halfway through the semester, students are encouraged to think about their specific interests. After learning

how to search academic databases, cite their work and look for sources of evidence, students are tasked to share a list of readings for in-class discussion. This process helps set the stage for students to think through potential research questions that intrigue them. During the last five weeks of class, students work on creating a research proposal. The process starts by coming up with a research question to exploring the literature, then working on developing the study motivation, theoretical model, arguments, and eventually proposing an appropriate research design.

Table 1: Mapping of course activities to Healey and Jenkins' [2009] categories for case study 1

Research-tutored • Students prepare weekly reports that encourage them to build their critical thinking skills and creativity • Students lead in-class discussions for assigned papers • Students engage in paper discussions • Students write paper proposal	**Research-based** • Students craft the different parts for the research paper proposal (e.g. research question, motivation, literature review, hypotheses, research design and potential contributions)
Research-led • Instructor teaches on theoretical frameworks, research types and study design • Instructor assigns academic papers for in-class discussion	**Research-oriented** • Students prepare weekly reports • Students engage in discussions in class • Students lead in-class discussions for assigned papers • Students learn and search academic databases

In Table 1, we present a mapping of the course activities to the four categories in Healey and Jenkins (2009). The course emphasizes each of the four categories through its different activities. Research-oriented activities emphasize the teaching of processes of knowledge construction. The weekly reports, all in-class discussions, including the portions led by students engage students in learning about the process of research creation as well as the content. The proposal is the only research-based activity and takes place over five weeks. It immerses the students in the process of creating a research proposal from idea generation to writing and presenting the proposal. Research-tutored activities include the weekly reports, students leading in-class discussions, students' contributions to in-class discussions as well as the process of writing the paper proposal. All these activities focus on students writing and discussing papers. Research-led activities include instructor lectures as well as assigned papers. These activities focus on teaching the subject content.

Indicators of successful outcomes

Students who enrolled in this course (in two offerings) overwhelmingly reported high engagement and positive learning experiences evident through teaching evaluations, students' comments and, the outcomes of a focus group analysis conducted by a consultant in the university's teaching and learning center. Additionally, three paper proposals from the first offering were accepted and published under the emergent research forum and poster categories at top IS conferences, specifically at Americas Conference on Information Systems (AMCIS) and the Association of Computing Machinery's Special Interest Group on Management Information Systems on Computers and People Research (ACM SIGMIS CPR) [Hass and Moussawi 2020; Volodin and Moussawi 2020; Marques and Moussawi 2020].

VI. CASE STUDY 2: DIGITAL TRANFORMATION, STRATEGY AND MANAGEMENT COURSE (QATAR CAMPUS)

Context

This course title is “Digital Transformation, Strategy and Management”. It is an elective in the undergraduate information systems program at a large university campus in the Gulf region. The research course is intended for junior and senior students in Information Systems (IS) who aim to engage in research in the domain of IS adoption in various technology platforms and cultures. The course was first offered in Spring 2018, and then Spring 2019 and Spring 2020. Due to the relative selective and small enrollment of bachelor’s degree in Qatar campus with approximately 20 to 30 students per year to the program. The enrollment to this course is about 10 to 12 students per semester.

The course design encourages students to think critically and develop understanding of IS adoption, utilization, and strategies in the lens of IS adoption. Given the global aspects of the digital revolution, the course adopts a global perspective, where students explore multi-dimensional aspects of IS management, incorporating strategic leadership, cross cultural management and technology adoption and diffusion in different contexts. This course provides an understanding of IS enabled change in the business environment, the alignment between IS strategies and business objectives, and ways in which business could leverage IS to transform and create digital strategies for a sustained competitive advantage. Students are also exposed to digital eco-systems in various industries and across cultural platforms.

Analysis

The course is designed around lecturing on theoretical aspects on IS strategic frameworks, IS adoption theories, cultural theories. Students have activities and assignments to apply those theoretical concepts in assignments, which are research-based activities. The course also incorporates students led presentation and discussion around assignments.

The course is structured around weekly discussions and reports on papers that students are assigned to read, which mainly revolve around theoretical frameworks on IS adoption and cultures. Halfway through the semester, students start thinking about their specific research interests and learn how to apply theoretical frameworks to investigate a technology adoption of their choice. They learn how to search academic databases and look for sources of evidence. This process helps set the stage for students to think through potential research questions that intrigue them. By the end of the semester, students develop and present a research proposal.

Research-led activities presented in Table 2 aim to teach students the subject content. Specifically, students learn about current research in the discipline of IS adoption through assigned readings. They also learn about various theoretical backgrounds used to investigate technology adoption in many contexts. Research-oriented activities emphasize the process of knowledge construction. Course activities under this category give students the opportunity to critique academic papers. They discuss different research methods and techniques used to understand behavioral aspect of people and organizations when adopting certain technology. Research-based activities are student-focused and engage students in learning by doing.

Table 2: Mapping of course activities to Healey and Jenkins' (2009) categories for case study 2

Research-tutored • Students present their project in class • Students lead in class discussions for assignments	**Research-based** • Students work on assignments aimed to apply theoretical concepts • Students work on crafting a research proposal
Research-led • Instructor lectures on theoretical aspects on IS strategic frameworks, IS adoption theories, cultural theories • Instructor assigns readings on IS adoption and culture	**Research-oriented** • Students engage in in-class discussions focusing on theoretical framework integration. • Students learn how to search academic databases • Students discuss reports and readings

Students undertake the journey of their research and inquiry through the term project. Students fully engage in research. They start their journey by identifying their research interests and choice of technology, industry, and cultural contexts. For example, one could be interested in studying the adoption of social media in the airline industry in Australia. They undertake a literature-based investigation of the research problem by identifying and reading scholarly articles related to the topic. Then, a specific research question is created. They then propose suitable theoretical frameworks and research methods to investigate the research question in the format of a research proposal.

Research-tutored activities aim to engage students in paper discussions. After taking the journey of research inquiry, students will present their proposal outlining literature review, research question, research method and expected contributions. Peer-learning and critique technique is adopted to utilize the research-tutored environment. Classmates conduct further search on the topic presented by their peers. Discussion revolves around comments provided by peers relating to existing studies, used methods and findings.

Indicators of successful outcomes

Students enrolling in this course reported high engagement and positive learning experience. Outcomes related to academic conferences publications and presentations are reflected in 2 peer-reviewed publications under the research-in-progress category at the Americas Conference of Information Systems [Defiandry, Vatanasakdakul and Aoun 2020a] and the Bled conference [Defiandry, Vatanasakdakul and Aoun 2020b]. Other outcomes relate to one student pursuing the research journey by enrolling in the honor research program.

VII. DISCUSSION

Research opportunities for undergraduate students are crucial for the development of undergraduate education. Existing studies in various domains outlined many benefits for involving undergraduate students in research [Boyer 1998; Garde-Hansen and Calvert 2007; Kenny et al. 2001] including better understanding of the research process, increased student interest in the field, better career preparation, and improved research and communication skills [Seymour et al. 2004]. These benefits are incurred even with limited periods of engagement in research, e.g. one semester only [Bauer and Bennett 2003] and with models of undergraduate research engagement that tend to be very selective in nature.

In IS, efforts to integrate research in the undergraduate curriculum have been limited. The opportunities available to students to engage in research are most often restricted to honor theses, and independent projects and grants. Hence, a small number of students get the opportunity to benefit from research engagement. In this paper, we examine two case studies, i.e. two courses, with the aim of investigating undergraduate research courses' components. Both courses are offered as elective IS courses in two different campuses of the same university (hence two cultural contexts: US and Gulf region). It is important to note that these two courses aim to promote research experiences for a large number of students compared to selective research programs. Successful outcomes from both courses emphasize a promising approach to build students' research skills.

Alignment between research and teaching through curriculum design can ensure a sustainable approach to student engagement in research. The analysis of the two cases reveals several components that map onto one of four quadrants that emphasize the research content vs the research process and problems or the students as active or passive participants. The identified components seem easy to integrate into various courses depending on the course's teaching method and research goals. An IS program can set research goals that students meet as they go through the curriculum with different courses integrating a variety of intentionally chosen research components. This approach will help equip students with necessary research skills that they will need post-graduation. Take for example a user experience (UX) specialist, he/she needs the skills to formulate a research question and be able to analyze input from users in its various forms, i.e. interviews, surveys, experiments.

Rethinking the teaching-research alignment in undergraduate IS education can play an important role in improving student learning and refining student skills. Table 3 offers examples of course components under each of the four categories of Healey and Jenkins model [2009] and explains the nature of the teaching-research alignment as well as the recommended integrations into IS courses.

Integrating research-led components can involve including academic journal and conference papers on class relevant topics and discussing theoretical frameworks and research designs where relevant. For instance, a course discussing the adoption of technology can discuss frameworks like the technology acceptance model (TAM) as well as other adoption models that build on it (e.g. UTAUT models). An introductory IS course might choose to include a paper discussing the history of the field (e.g. Hirschheim and Klein's paper [2012]) so IS students gain a better understanding of what IS is and how it evolved as a field. If class sessions allow, instructors can include research-oriented components by engaging students in discussions of those papers. For instance, an IS course on IT outsourcing can assign relevant papers for in-class discussions or review a relevant theoretical framework. Another component under this category that can be integrated into IS courses that require research on a specific topic relates to training students on using and searching academic databases available to them through the university libraries. Such components (and resulting skills) can be easily integrated into certain courses where they are a good fit.

The last two categories, i.e. research-tutored and research-based are perhaps better suited for seminar or project focused courses. Under the research-tutored category, students are asked to create weekly reports to summarize their viewpoints and be prepared to make their arguments in class. Students can even be asked to lead the class discussions. These components are a better fit for more advanced discussion-based seminars, e.g. in a systems integration across organizations course. Research-based components emphasize the research process of proposing a research question, applying theoretical concepts or possibly drafting a paper proposal. A geographical information systems (GIS) or a managing digital transformation course can ask students to propose a research question and try to recommend a model to answer it. Such proposed models can use GIS tools or build on existing theoretical frameworks.

Strategically designing these integrations for various courses across the IS curriculum could help undergraduate IS students build and refine their research skills and increase their interest in pursuing various research opportunities. The recommendations we make in this paper are generalizable to all universities across all tiers. The proposed components (Table 3) require a minimal level of adjustment to existing courses. Additionally, many materials and rubrics are available (e.g. in relevant domains, or from research programs, or research focused courses) to guide instructors in designing and grading students' work in relation to the proposed course components.

Another way to integrate research components into the undergraduate IS curriculum is to offer more seminar courses highlighting faculty research areas. Involving different faculty by discussing papers in their areas would be helpful to increase students' knowledge in these topics. Additionally, increasing students' awareness of faculty research can create additional opportunities for them to undertake independent research studies in later semesters or be interested in pursuing graduate studies. This path leverages faculty expertise and engages students and faculty alike.

Table 3: Components and Recommended Integrations

	Components	**Recommended Integrations**
Research-led	Instructor teaches on theoretical frameworks, research types and study design. Instructor assigns academic papers for in-class discussion.	These components emphasize the content and findings of research papers; the teaching approach engages students as audience. Lectures on relevant theoretical frameworks can be integrated into various IS courses (e.g. courses on IT systems, IT crowdsourcing, IT security and privacy). Academic papers can be assigned for discussion in several IS courses.
Research-oriented	Students engage in discussions in class. Students lead in-class discussions for assigned readings Students learn and search academic databases	These components emphasize research processes and problems; the teaching approach engages students as audience. Learning how to conduct searches in academic databases can be integrated into existing IS courses. Students can leverage these skills for their papers and projects in various IS and non-IS courses. These skills will also broaden students' knowledge by identifying and reading more scholarly articles from their quests.
Research-tutored	Students prepare weekly reports that encourage them to build their critical and creative thinking Students lead in-class discussions for assigned papers	These components emphasize research content and engage students as participants These components can be integrated into several IS courses. Encouraging students to make arguments and positions supported by evidence from assigned readings can help deepen the conversation. Students can be encouraged to recognize implications and provide analysis of complex ideas. Active participation and peer discussions are crucial steps for students to think

	Components	Recommended Integrations
		deeper and learn to demonstrate their ability in scholarly arguments, which turns to new knowledge for leaners. Through such discussions, students will start to develop their understanding into the subject matter and think about research as content.
Research-based	Students craft the different parts for the research paper proposal (e.g. research question, motivation, literature review, hypotheses, research design and potential contributions) Students work on assignments aimed to apply theoretical concepts	These components emphasize research processes and problems and engage students as participants. While crafting a formal academic paper is not the focus of many IS courses, some of its components can be. For example, projects can require students to propose a research question that they aim to address in their projects. Students can also be asked to frame the motivation for their projects or build arguments to support their ideas (maybe based on theoretical frameworks).

VIII. CONCLUSION

We draw on Healey and Jenkins' [2009] teaching-research alignment model and adopt a multi-case design to investigate the different components of an undergraduate research course. The components can be easily and strategically integrated into existing IS courses at the undergraduate level to help build students' research skills. We present examples of these components and label them as either research-process or -content focused and as having students as active or passive learners. Undergraduate research in IS has historically been limited to honor students and independent projects. Promoting a research culture through consistent and sustainable alignment between teaching and research can have tremendous benefits for undergraduate IS education. Particularly, educators should aim to promote research active strategies with a focus on either research content or processes.

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