Online Social Networking Software as Ad-Hoc Project Management Software in Capstone Project Courses

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***Abstract*— In this paper, we explore the use of online social networking (OSN) software as ad-hoc project management (PM) software. Through the adaptation of specialized OSN software, project teams can facilitate group collaboration as they work towards completing project milestones. This study aims to showcase the importance of sustained engagement throughout the lifecycle of the project, across both meta-level engagement with the external community and micro-level engagement within and among the project team members. More specifically, this work identifies how OSN technologies cultivate online community which can be shown to augment project motivation and participation resulting in project success. Under the lens of an existing theoretical model, one which highlights individual collaboration within online community spaces, we measure perceptions of the customized OSN software before and after its implementation. A content analysis highlights how successful project teams maximized features of the system, which is supported by a social network analysis (SNA), which highlights levels of individual engagement across the project lifecycle as they relate to online interaction and project results. Survey data identifies individual perceptions across various aspects of the system as it fosters social interaction and build online community, represented in terms of social capital.**

Keywords- Social Networking Analysis; Computer Supported Collaborative Work; Collaborative Writing; Project Management; Capstone Project.

I. INTRODUCTION

This research builds atop preliminary research highlighting how online social networking (OSN) software can facilitate success in project teams [1]. More specifically, this study measures the adoption of OSN software across information technology (IT) capstone courses.

When the New Year rang in on January 1, 2016 the estimated human population on earth was around 7.45 billion [2]. Of this population, 324 million currently live in the U.S., where it is estimated that 87% of the population have access to the Internet and 73% are using social technologies to collaborate and communicate online [3]. For digital natives, or individuals having grown up with internet technologies, it is estimated that 86% of digital natives participate in some form of OSN, with some estimates as high as 98% [4] [5] [6] [7].

Within academic environments, OSN software has found tremendous success, as grade schools, high-schools and colleges incorporate various types of social media into the classroom. In [8], Thoms et al. introduced a shift in modality away from traditional learning management systems, or LMS, towards more student-centric OSN software to support classroom activities. In this paradigm, OSN software provides users with a common set of tools that focus on course engagement through higher levels of peer-to-peer interactions. This research was extended in [9] to show how OSN software can yield greater levels of interaction and overall course satisfaction when compared against LMS software.

This research suggests that OSN software is uniquely suited to facilitate capstone courses, by providing an environment that supports intra-group, or project team communication via wiki and messaging and inter-group, or course communication including blogs and discussion boards. Grounded in theories of constructivism, engagement and social presence, the software design was measured using a content analysis, social network analysis (SNA) and survey data. Results showcase the beneficial nature of OSN software as a means for fostering project-level activities as individuals work towards the completion of their final IT artifact. In the process, OSN software also fosters engagement and interaction.

The rest of this paper is structured as follows. In Section II we introduce background for project-based communities of practice and identify the role capstone courses play in higher education. Section III establishes a theoretical framework that considers constructivism, engagement theory and social presence theory as integral components of OSN software used within the academic space. Section IV focuses on the OSN system design. Section V highlights the research methodology. Section VI details the results across two interventions. Section VII provides a comprehensive discussion and analysis of the results section. Section VIII identifies the limitations of this study. Section IX presents the conclusion followed by references in Section X.

II. BACKGROUND

A. Project-based Communities of Practice

As identified in [10], college courses can be classified as niche communities of practice, which facilitate, among other things, shared understanding and identify among participants. In more successful communities of practice, sustained engagement and collaboration exist whereby

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knowledge-building becomes an intrinsic function of the community itself [11]. Although not all college courses mirror these ideals, capstone project courses strive to.

B. Capstone Courses

This paper focuses primarily on capstone project courses, which are typically milestone courses for college students and required for graduation. A popular mechanism adopted by many colleges and universities is requiring students to complete a year-long or semester-long capstone project in their junior or senior year of study in hopes of better preparing these students for similar activities they would encounter in the workforce. More so, as identified in [12], capstone courses aim to provide students with little, to no industry exposure, with a valuable experience prior to completing their degree.

Capstone project-based courses are also highly regarded and recommended as a core component of effective undergraduate education [13] [14]. Consequently, the inclusion of these projects into the undergraduate experience has been largely influenced by expectations from industry that graduates exhibit high-levels of problem solving, oral and written communication, teamwork and project management skills [15] [16]. These projects become especially important for students who are unable to attain industry experience prior to graduating, thus making project-based courses a bare minimum qualification for graduating students.

Often times, IT capstone courses are team-based, where groups of students work towards some end-goal. Where capstone projects are collaborative in nature, students are afforded greater opportunities to develop team-based skills and learn pivotal techniques in cooperation as individuals coordinate around a central IT artifact. Essentially, team-based projects help to prepare students to work effectively in teams [17]. The underlying mechanisms of team-based capstone projects in IT education and team-based projects in professional settings are similar because both methods involve expressing and discussing ideas in order to construct mutually acceptable explanations. Lainez et al. [18] suggest that capstone projects deliver skills that consider various business processes, product development, artifact design, implementation and also involve teamwork and problem solving. Problem solving, as identified further in Ayas and Zeniuk [19] can be instrumental in building healthy communities of practitioners.

Students value these experiences as well and capstone projects offer students a chance to begin developing a working portfolio prior to graduation. Dunlap [20] discovered that engaging students in learning and problem-solving activities reflects the true nature and requirements of workplace communities and help students feel better prepared to work effectively in their profession; a viewpoint supported by students as well [15]. Furthermore, Clarke [21] identified that industry-aligned projects increased student confidence and allowed students to explore areas of the IT field not covered in the academic curriculum.

Ultimately, within IT capstone courses, students are presented with opportunities to consolidate their understandings of "systems analysis, software development lifecycles, specific software design support tools, entity relationship modelling, entity life histories, database design, web site design, or web server programming" [22]. Furthermore, when students engage in experiential learning, they become active participants in the learning process, constructing their own internal knowledge through both personal and environmental experiences [22, 23]. Lynch et al. [24] found that IT capstone projects provide students the opportunity to build, not only technical skills of the discipline, but the social aspects of systems development as well.

III. THEORY

Human computer interaction (HCI) is an interdisciplinary field that encompasses concepts from numerous fields including computer and behavioral science. The theoretical model adopted in this research is one first proposed [25] and extended in [7] [8] and considers three primary constructs for fostering interaction within collaborative environments. The first construct focuses attention on the individual and their perceptions of their role within the project space. The second construct is engagement theory, which represents how individuals work collaboratively within the project space. A third construct, social presence theory, represents the project space as a thriving community.

A. Constructivism

Constructivism grounds a community to the individual and considers the interactions and experiences of the individual as crucial components of cooperation and goal achievement [26] [27]. Such interactions and experiences also consider a participant's engagement with certain technologies. Largely linked to the work of Piaget [28], who first theorized that learning can be based on the interaction and experiences of the learner within a specific context, constructivism provides a holistic view of individual learning and how individuals interact within larger groups. Additionally, Squires [29] states that constructivism focuses on individual control, with individuals making decisions that match their own needs. Thus, within a project space, individuals should be able to control how they interact with other team members and in a manner they feel most comfortable. Using the simplistic functionality of social software, instead of more complex PM software, individuals are provided with more flexibility and control.

B. Engagement Theory

In many capstone projects, teamwork is required, which requires communication and cooperation. Engagement theory states that individuals must be meaningfully engaged in project activities through interaction with others, which can be facilitated and enabled through specialized software [30]. Project software is not known for their exciting and group-oriented features, but OSN software is. OSN software provides environments that embrace interaction. Therefore by leveraging the popularity of OSN software, we hope to create an environment that promotes dialogue among team members.

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Dalsgaard [31], whose research is supported in Waycott et al. [32] argues that social software can be used to support the constructivist approach set forth in the previous section. Social software engenders a cooperative approach to learning, where individuals work towards establishing a cohesive unit. In this respect, social software can refer to any loosely connected application where individuals are able to communicate with one another, and track discussions across the internet [33]. Consequently, the development of OSN software must consider the individual's point of view in such a manner that they are presented with a certain level of control and autonomy within the larger community. Once again, social software supports these philosophies and makes participants the locus of control within a larger self-governing environment.

C. Social Presence Theory

We introduce Social Presence Theory to understand the manifestation of our OSN as a dynamic and vibrant collaborative project space. Social Presence Theory considers the degree to which an individual's perception of the online community, affects his or her participation in the community [34] [35]. When individuals believe that others are interacting and exchanging information, individuals may be more inclined to engage themselves or not. As discussed in Garrison et al. [36], alternative methods for enhancing social presence must be explored to help substitute for the lack of visual cues individuals receive in face-to-face settings. Research by Richardson and Swan [37] identified that a student's perceived level of social presence directly relates to their perceived learning. From the lens of social presence theory, we consider students' ideas as knowledge objects that are improved continually through collaboration by discussing inconsistencies and resolving doubts [38]. In fact, the essence of social presence is that collaboration can promote conscious development of cohesive ideas that no single individual could have developed alone. Thus, pedagogically, we can view students as active constructors of knowledge who capitalize on each other's reasoning to gradually refine ambiguous, figurative, and partial understandings of important concepts. This suggests that increasing levels of community can yield higher levels of learning. OSN technologies work well in this regard and have successfully helped enhance social presence through peer feedback [39] and individual profiles and avatars [40], both of which are implemented within the OSN designs we investigated. Additionally, Thoms et al. [41] discovered that OSN technologies can foster higher levels of course learning through openness and collaboration and can align very well with course learning objectives.

Together, these three theories provide a holistic model that considers course community, individual learning styles and how each can be influenced and enhanced with technology.

IV. System Design

A. Project Management Software

The field of project management (PM) is quite mature and with this maturity comes a seasoned array of PM software to support project-based activities. Intrinsically, PM software looks to provide project teams with the ability to manage project activities including scheduling and planning. Scheduling typically refers to resource management and accounting and planning typically centers on organizing different phases of the project. Wikipedia alone compares over 300 PM platforms, from desktop platforms such as Microsoft Project to web-based platforms such as Basecamp.

While PM software may be a necessity for large-scale projects, for small-scale and short-term projects, sophisticated and complex PM software can be time-consuming. Additionally, adopting and learning to use PM software can be a daunting feat for nascent users, especially when the duration of a project is less than a year. Therefore, this study introduces OSN software as ad-hoc PM software; one supported by underlying theories that mirror students' underlying learning experiences.

B. OSN Software as PM Software

Prior to Web 2.0 and the explosion of social software, Preece [42] highlighted the difficulty that social software designers have in controlling interaction. To date, OSN designers still struggle to develop software that is both easy to use and useful. In this research, we extend existing OSN software, Elgg v1.8.2, which has already shown success in supporting our theoretical constructs [7] [8] [25] [51]. Elgg was founded in 2004 and is an open source OSN engine offering individuals and organizations with many of the components required to implement an online social environment.

Elgg provides an extensible platform for constructing a project-based OSN due to its large number of developer plugins. Identifying planning and scheduling as important criteria for project management Elgg provides support for the following features:

- Individual profiles to allow users to customize their online profile.
- Communities and community profiles for unique and isolated project spaces.
- Instant Messenger for real-time communication when team members are working synchronously but in remote locations.
- Group and individual blogs for sharing information and providing project updates.
- Wikis for collaborative writing and documentation.
- Calendars and notifications to create events and reminders for project milestones.
- File uploads with version control to support project documentation.
- Discussion boards for asynchronous conversational threads on project topics and activities.

Figure 1 highlights the community home page, or what a project team sees upon logging in. Although the homepage

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can be customized with specific modules, by default, users are presented with active content from across the site, which can be filtered by user or date.

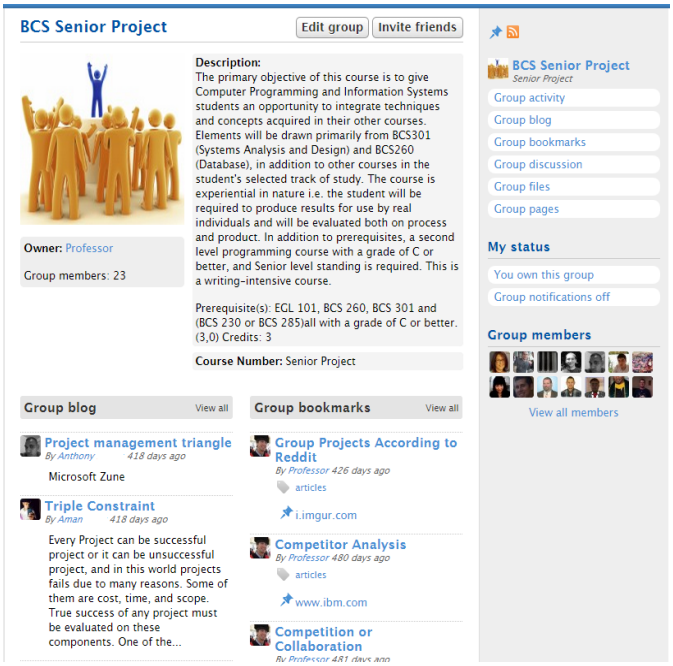

Figure I. OLC Landing Page

C. *Collaborative Writing Software*

A significant artifact within a project-based OSN centers on the analysis and design of project objectives. As a shared artifact, collaborative writing software functions as a mechanism to support information sharing and group knowledge construction. A specific subset of collaborative writing, wiki software utilizes Internet-based technologies to facilitate the collaborative writing process by keeping track of page creation and page edits. Wikis provide unique opportunities for obtaining and managing user-driven content and are also effective for facilitating virtual collaboration and tracking the evolution of user-driven content, which aids in coordination and synchronization of group information. Wikis also provide for a shared dialogue and centralize information among project collaborators. Additionally, wikis allow members to engage in group learning and share in knowledge construction within a virtual community [43]. These notions are important for project teams working towards shared goals and shared meaning.

When wiki technology was first introduced, prior to the Web 2.0 explosion, collaborative writing was limited to early HTML-style markup [44]. Current wiki-technologies provide collaborators with a wide range of tools and share commonalities with other OSN software [45]. Illustrated in Figure 3, today's wikis are no longer syntax-based, with difficult HTML-style markup notation. Today's wikis incorporate rich-text editors, allowing even novice web users to contribute, a notion that is particularly important for student users, many of whom have limited experience constructing wikis. Recent research by Xu [46] implemented wiki-technology in project-based computer science courses, highlighting how wiki technology helped to centralize and capture all project activities through wiki pages created by both the instructor and students. Additionally, Popescu [47] discovered that wikis also helped students to find interesting information; by reading other teams' wiki pages, students could check their progress, see how they compare with others teams, look for inspiration and models and discover different ideas and approaches. A limitation identified in He and Yang [48] is that a wiki should not be a tool that aims to supplant communication channels and works best when additional modes exist. This limitation is accounted for in our OSN since the wiki comprises only one component.

D. *Project-based Wiki*

Figure 2 illustrates a read-only version of the wiki. In this view, users can present their project charter to the larger community.

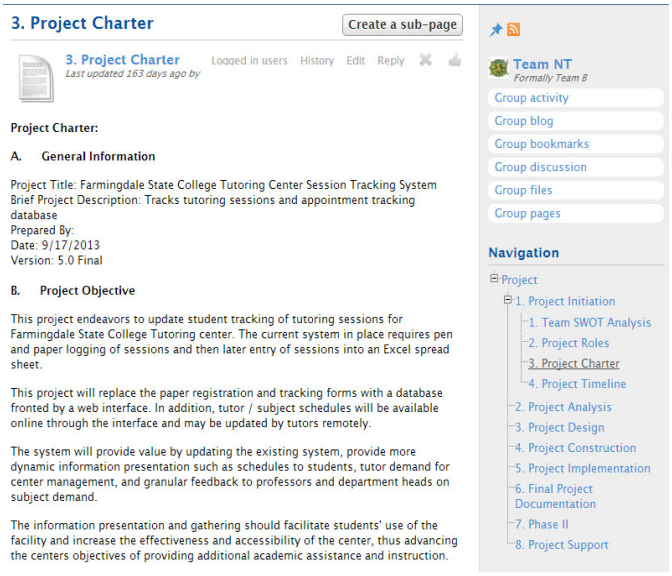

Figure II. OLC Wiki Page

Figure 3 illustrates wiki in edit-mode, which allows users access to edit the wiki page in a what-you-see-is-what-you-get (WYSIWYG) editor and also control who has access to the edit or view the wiki. In this view, editors can create content, link to existing content and control who has access to edit or view a document.

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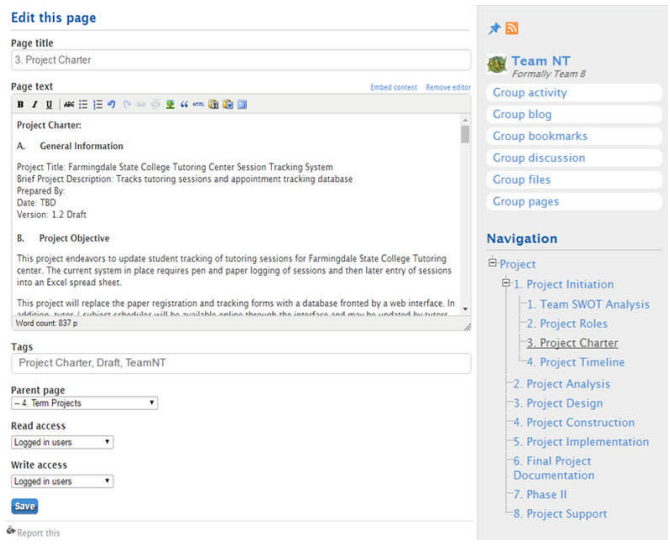

Figure III. OLC Wiki Page

V. RESEARCH METHODOLOGY

This research aims to measure the proposed design and is best categorized as a proof-of-concept case study. Our population of users consisted of 11 teams across two IT capstone courses. To measure how OSN software can be used as ad-hoc PM software, we measure how well the software facilitated team collaboration, peer-to-peer interaction, learning and course community. Each team worked together over a seventeen-week period and each team's goal was to construct a fully-functional IT artifact by the seventeenth week. The IT artifact comprised 40% of the project grade. Project documentation and weekly collaborative assignments constituted 30% and a course-wide discussion board also constituted 30%.

Project teams were comprised of three to four students and were formulated by the instructor prior to the start of the course. Due to a late-semester change, one project team consisted of two members.

In addition to the course-wide community, each team was assigned a designated OSN community, which consisted of file repository, blog and wiki space, with pre-defined templates for each of the project development phases. At the end of the semester, all teams were expected to present their final artifact to the class.

It was highly suggested that project teams utilize the wiki templates, as outlined by the instructor, but it was not required. As illustrated in Figure 3, predefined templates were constructed for each community space and included pages for: 1) Project Initiation, 2) Project Analysis, 3) Project 4) Design, 5) Project Construction, 6) Project Implementation, 7) Final Project Documentation, 8) Phase II and 9) Project Support. Students participating in the capstone course would already have taken a course on formal software methods and be familiar with the systems development lifecycle. The wiki aimed to realize knowledge acquired in this course.

Data was captured from each capstone course, over a period of six months.

VI. RESULTS

To explore how specialized OSN software can support project-based courses and enhance classroom learning, we collected data from multiple sources. Our first point of data collection is through survey research, which measures perceived levels of learning, community and interaction. To support survey findings, we perform a social network analysis and look at in-bound and out-bound interactions among OSN participants.

A. *Population & Demographics*

Demographic information was captured through pretest surveys conducted across two classes. Including the instructor, the total user population was 45. 15% of participants were female and 85% were male. 52% of participants were aged 18 to 25, 34% were aged 26 to 35, 12% were aged 36-50 and 2% were aged 50 and above. All participants were members of the IT capstone course, an upper-division course required for graduation.

B. *Content Generation*

Detailed in Table 1 is a breakdown of wiki contributions between Group 1 and Group 2. Group 1 consisted of 22 students, of which 16 played an active role in editing the project wiki resulting in 401 page edits across 114 unique pages. Group 2 consisted of 18 students, of which 16 played an active role in editing the project wiki resulting in 222 page edits across 108 unique pages.

TABLE I. WIKI CONTENT GENERATION

Metric / Results	Grp. 1	Grp. 2	Diff (%)
No. of Students	22	18	20%
Total Editors	16	16	-
Total Pages Created	114	108	5%
Total Pages Edited	401	222	58%
Average Page Edit	3.5	2.1	50%

C. *Survey Data Analysis*

Closed-ended pretest and posttest surveys were distributed to all participants resulting in 42 completed pretests and 35 completed posttest surveys. To ensure confidentiality, no personally identifiable information was collected.

1) *Perceptions on Interaction*

Cronbach Alpha scores for our survey constructs related to items associated with the OSN scored .83 indicating that survey items maintain an adequate level of internal consistency.

Detailed in Table 2 are factors relating to overall perceptions on interaction and collaboration. In pretest results 88% of individuals agreed or strongly agreed that high levels of interaction would be important. These numbers increased to 94% in posttest results. Additionally, 88% of individuals agreed or strongly agreed that learning

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through group collaboration would be important with 95% agreeing or strongly agreeing that exchanging feedback with others would be important. In posttest results, these numbers were 92% and 91% respectively. Regarding sense of community, 86% agreed or strongly agreed in pretest responses, while 85% agreed or strongly agreed in posttest responses.

2) OSN Perceptions on OSN

Detailed in Table 3 are factors relating to overall perceptions on interaction and collaboration. In pretest results 86% of individuals agreed or strongly agreed that interaction through an OSN would be important. These numbers decreased to 83% in posttest results. Additionally, 81% of individuals agreed or strongly agreed that an OSN would increase interaction. In posttest results, these numbers decreased to 77% for this item. Regarding learning, 71% agreed or strongly agreed that an OSN could support learning, while 68% agreed or strongly agreed in posttest responses. Regarding the OSNs ability to support community, 86% agreed or strongly agreed in pretest results, while 77% agreed or strongly agreed during posttest results.

3) Wiki Perceptions on Interaction

Detailed in Table 4 are constructs relating to the wiki and interaction. In pretest results 83% of individuals agreed or strongly agreed that they were interested in using the wiki, while posttest results found 77% of individuals agreeing with this statement. 81% of individuals agreed or strongly agreed that the wiki facilitated group cohesion with 81% also agreeing that it supported collaboration. These numbers were 83% and 83% in posttest responses. Regarding interaction, 77% agreed or strongly agreed that the wiki supported interaction, while 74% agreed or strongly agreed in posttest responses.

TABLE II. SURVEY RESPONSES (INTERACTION)

Survey Item	SA	A	N	D	SD	AVG	STDEV
(pre) High levels of interaction seem important.	50%	38%	7%	2%	2%	4.31	0.90
(post) High levels of interaction were important.	63%	31%	3%	3%	-	4.54	0.70
(pre) Learning through collaboration seems important.	38%	50%	7%	2%	2%	4.19	0.86
(post) Learning through collaboration was important.	63%	29%	3%	3%	35	4.46	0.92
(pre) Exchanging feedback seems important.	50%	45%	-	2%	2%	4.38	0.82
(post) Exchanging feedback was important.	57%	34%	6%	-	3%	4.43	0.85
(pre) A sense of community seems important.	43%	43%	10	2%	2%	4.21	0.90
(post) A sense of community was important.	54%	31%	11	-	3%	4.34	0.91

TABLE III. SURVEY RESPONSES (OSN DESIGN)

Survey Item	SA	A	N	D	SD	AVG	STDEV
(pre) Interaction through an OSN seems important.	36%	50%	7%	2%	5%	4.10	0.98
(post) Interaction through an OSN was important.	49%	34%	11%	6%	-	4.26	0.89
(pre) OSN will increase interaction.	43%	38%	12%	2%	5%	4.12	1.04
(post) OSN increased interaction.	37%	40%	14%	6%	3%	4.03	1.01
(pre) OSN will increase learning.	31%	40%	19%	5%	5%	3.88	1.06
(post) OSN increased learning.	37%	31%	23%	6%	3%	3.94	1.06

TABLE IV. SURVEY RESPONSES (WIKI AS A TECHNOLOGY)

Survey Item	SA	A	N	D	SD	AVG	STDEV
(pre) I am interested in using a wiki in this course.	34%	49%	12%	2%	2%	4.10	0.89
(post) I was interested in using a wiki in this course.	31%	46%	20%	3%	-	4.06	0.80
(pre) A Wiki will facilitate group cohesion.	33%	48%	12%	2%	5%	4.02	1.00
(post) A Wiki facilitated group cohesion.	29%	54%	14%	3%	-		0.74
(pre) A wiki will facilitate group collaboration.	32%	49%	12%	2%	5%	4.00	1.00
(post) A wiki facilitated group collaboration.	34%	49%	14%	-	3%	4.11	0.87
(pre) A wiki will facilitate group interaction.	33%	43%	17%	5%	2%	4.00	0.96
(post) A wiki facilitated group interaction.	31%	43%	20%	3%	3%	3.97	0.95

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TABLE V. SURVEY RESPONSES (WIKI AS AD-HOC PROJECT MANAGEMENT SOFTWARE)

Survey Item	SA	A	N	D	SD	AVG	STDEV
(pre) A wiki will help facilitate project management.	33%	50%	12%	2%	2%	4.10	0.88
(post) A wiki facilitated project management.	37%	49%	11%	3%	-	4.20	0.76
(pre) A wiki will help organize project information.	40%	43%	13%	3%	3%	4.15	0.92
(post) A wiki organized project information.	37%	54%	9%	-	-	4.29	0.62
(pre) A wiki will facilitate content creation.	29%	50%	14%	2%	5%	3.95	0.99
(post) A wiki facilitated content creation.	34%	51%	14%	-	-	4.20	0.68
(pre) A wiki for project portfolios is an excellent idea.	39%	41%	15%	2%	2%	4.12	0.93
(post) A wiki for project portfolios was an excellent idea.	37%	49%	14%	-	-	4.23	0.69

4) Wiki Perceptions on Project Management

Detailed in Table 5 are factors relating to the wikis ability to facilitate project management. In pretest results 83% of individuals agreed or strongly agreed that a wiki could help facilitate project management. Levels of agreement rose to 86% in posttest responses. Similarly, pretest results show that 83% of individuals agreed or strongly agreed that a wiki could help organize project information, which rose to 91% in posttest responses. Additionally, 79% of individuals agreed or strongly agreed that the wiki would foster content creation and posttest results showed that 85% of individuals agreed or strongly agreed. Finally, 80% of individuals agreed or strongly agreed that the wiki would be an excellent way to showcase the capstone project. Levels of agreement rose to 86% in posttest results.

D. Social Network Analysis (SNA)

1) SNA Background

Social network analysis (SNA) is used to identify and measure interactions within an associated social structure. More specifically, an SNA utilizes numerous statistical measures for analyzing activity within a social structure and often times results in a visualized graph of the network as shown in Figure 4 and Figure 5. The ability to view social graph structure and community evolution can be a crucial measure of a learning design and can serve as an early indicator of its success [49].

2) SNA Design

In this study, SNA graphs were constructed in Microsoft Excel, with the 2014 NodeXL Template extension. NodeXL is a free and open source extension, which provides a range of basic network analysis and visualization features [50]. Using NodeXL, Figure 4 and Figure 5 were constructed using the Fruchterman-Reingold algorithm, which positions team members, or nodes, in a manner so that all edges are of more or less equal length and there are as few crossing edges as possible. Arrows, represent weighted interactions and larger arrows indicate a greater number of interactions between members. Bi-directional arrows occur when there is interactivity between students, measured in-degree and out-degree values. A higher average value for in-degree and out-degree indicates that those students more frequently interacted with one another.

3) OSN Sociograms

Illustrated in Figure 4 and Figure 5 are sociograms for two capstone courses utilizing the OSN software for PM-activities. Discussed in more detail in the Discussion, team members are identified by their group letter and group project grade. For example, B3(95) represents the third member of Group B and their final project grade was 95 out of 100.

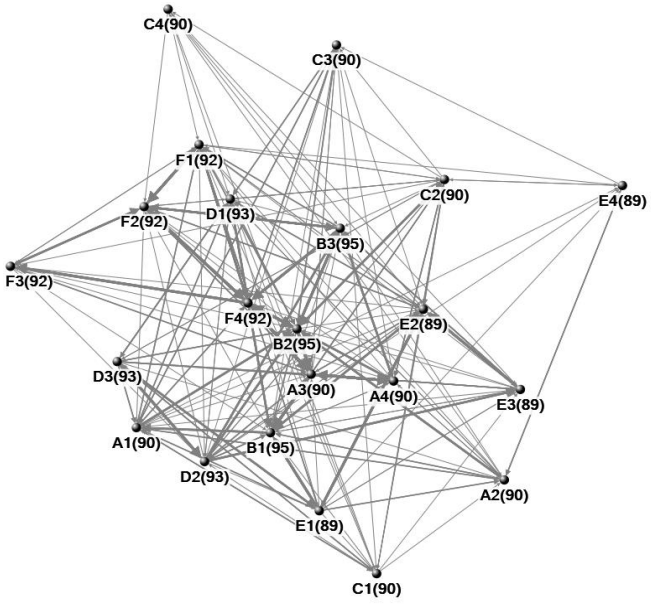

Figure IV. Group 1 Sociogram

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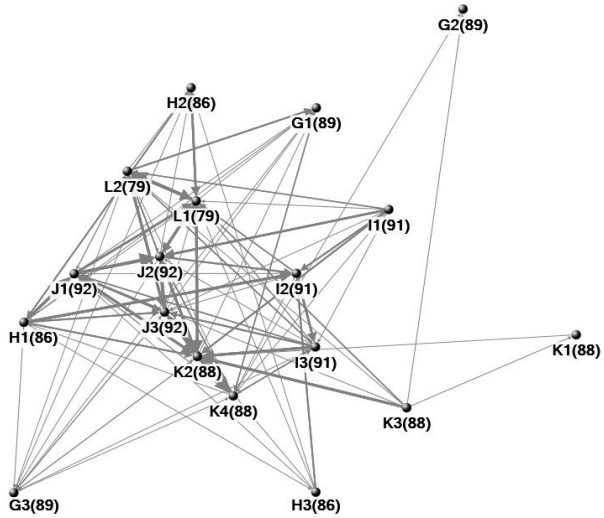

Figure V. Group 2 Sociogram

1) SNA Metrics

Identified in Table 6 are the SNA metrics calculated for Group 1 and Group 2. Overall, Group 1 experienced higher levels of overall interaction with 416 interactions compared to Group 2, which experienced modest levels of interaction with 189 interactions. The number of unique edges, which represents unique interactions between any two students was 115 for Group 1 and 60 for Group 2.

TABLE VI. SNA METRICS

Metric / Results	**Group 1**	**Group 2**	**Class Diff (%)**
Vertices	22	18	20%
Edges	416	189	75%
Unique Edges	115	60	63%
Min Degree	2	0	200%
Max Degree	15	12	22%
Avg. In-Degree	9.1	5.9	43%
Avg. Out-Degree	9.1	5.9	43%
Avg. Betweenness Centrality	7.81	9.2	16%
Density	.43	.35	21%
Avg. Grade	92	88	4.4%

Average in-degree and out-degree refers to the average number of interactions pointing in and out of a single node. For Group 1, average in-degree / out-degree was 9.1 with a standard deviation of 3.29 for in-degree and 1.93 for out-degree. For Group 2, average in-degree / out-degree was 5.9 with a standard deviation of 3.91 for in-degree and 2.68 for out-degree.

Betweenness centrality is an indicator of a node's centrality in a network and is calculated using the number of shortest paths from all vertices to all others that pass through a node. For Group 1, average betweenness centrality was 7.81 with a standard deviation of 5.16. For Group 2, betweenness centrality was 9.2 with a standard deviation of 8.77. Density, which is the count of the number of connections divided by the total number of possible connections, was .43 for Group 1 and .35 for Group 2. Finally, the average final group grade was 92 for Group 1 and 88 for Group 2.

VII. DISCUSSION

The overarching goals of this study is to present OSN software as a viable option for capstone courses, one that allows users to participate in course-level and team-level activities. To explore these claims, OSN software was introduced to two IT capstone courses, where we measured its ability to foster peer-to-peer interactions and support project success.

A. OSN Promotes Teamwork

An important role of the OSN was to facilitate the workflow of project teams. To measure this, we consider a couple of factors. First, we focus attention on survey responses relating to the wiki's ability to enhance group cohesion, collaboration and interaction. Pretest results showed a majority of individuals believed that the wiki could facilitate cohesion (82%), collaboration (82%) and interaction (75%). More so, however, it was very encouraging to discover high levels of agreement in the posttest that the wiki actually contributed to higher levels of cohesion (78%), collaboration (83%) and interaction (74%). Engagement theory is concerned with meaningful engagement. This amounts to finding the right tools for the right projects. Wiki software is geared towards collaboration and interaction where individuals bear witness to the evolution of a project's analysis and design. Wiki software also reinforces the notion that projects can be both user-centric and group-oriented, thus facilitating individual ownership and motivation.

Referring back to the sociograms in Figure 4 and Figure 5, the proximity of nodes reflects that these nodes interacted with one another more frequently. In other words, the closer a set of nodes are to one another, the more cohesive that group of nodes are as a single unit. In dynamic environments, bonds tend to strengthen as a network becomes denser. As one would expect within capstone projects, where students are working collaboratively towards project milestones, the network graph will likely organize in a manner where project members are relatively close to one another. In Figures 4 and Figure 5, this is the case, with the exception of a couple peripheral nodes (i.e. C1 and G2). This outcome would be expected in any organizational network where individuals, while functioning as part of the larger community, are still responsible for working within their own respective project teams in order to accomplish project milestones. Taken together, the quantitative results at hand indicate that students utilized the OSN to set achievable project goals, resolve misunderstandings about design decisions, and negotiate deliverables, similar to the way team-based IT projects function in the real world. In this way, collaborating students used one another as a resource

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for learning, while also working to complete their project milestones.

B. OSN and Wiki as Support for Project Success

An objective of this study was to investigate the role of OSN software in promoting project success. An important measure of project success stems from a group's ability to establish the parameters of success through analysis of business requirements and the design and construction of the IT artifact. Through an analysis of survey responses and grading of each team's final IT artifact, it was evident that the OSN helped contribute, in part, to each team's project success. In pretest survey responses, it was encouraging to discover that the majority of individuals believed that the OSN wiki would facilitate project management (83%), project information organization (85%) and content generation (83%). More so, it was encouraging to discover higher levels of agreement in posttest responses, where individuals perceived that the OSN wiki did, in fact, contribute to higher levels of project management (86%), project information organization (91%) and content creation (85%). Each of these factors is an important dimension of project management that promotes a shared understanding of technical requirements, which helps to mitigate expensive and time consuming rework. This concept can apply to both short-term and long-term real-world IT projects.

We acknowledge that survey results paint a limited picture, which is why we also dive into the interactions that took place across the OSN. Average project grades indicate a stronger performance by teams within Group 1 (92%) compared to teams within Group 2 (88%). We attribute this, in part, to the patterns of interaction that took place within the OSN and the levels of social capital that existed across both networks. More dense and active networks, such as with Group 1, tend to result in more communication and collaboration, which, in turn, can contribute to higher quality output. This is discussed in more detail in the next section.

C. OSN Software Builds Social Capital

Within IT capstone courses, and academic courses in general, OSN software provides opportunities for greater levels of social capital. Simply defined, social capital is the common social resource that facilitates information exchange, knowledge sharing, and knowledge construction through continuous interaction [51]. Social Presence Theory, which focuses on the degree to which an individual's perception of the online community, in its entirety, affects his or her participation in that community.

Analyzing the levels of community in Group 1 and Group 2, our first point of measurement refocuses attention back to the survey responses and, specifically, those constructs relating to the OSN software's ability to enhance interaction and community. Pretest results were encouraging and showed that individuals were positive from the start that community would be important (86%) and that an OSN could be an important resource for facilitating this community (86%). These perceptions continued throughout the lifecycle of the intervention and posttest results showed high levels of agreement that a sense of community did play an important role (85%) and that the OSN was an important factor for facilitating interaction (86%). Similarly, pretest results indicated that high levels of interaction would be important (88%) and that exchanging feedback with their peers would be important (95%). Again, posttest results supported these perceptions, revealing high levels of agreement across these constructs (94% and 91% respectively). The fact that the OSN is an open environment allowed team members to review the progress of their classmates and pose questions and receive responses in an open dialogue was likely a large contributor to these results. In environments where identity and affiliation play a role in shared outcomes, tools that support sharing and encourage interaction can enhance overall levels of trust and contribute positively to these shared goals [52].

A secondary factor for analyzing community support brings attention back to Figure 4 and Figure 5, which represent the peer-to-peer interactions within the OSN. The sociograms clearly identify Group 1 as a more tight-knit group that Group 2. While Group 1 consisted of 20% more students, an important indicator for social capital can be determined by network density. Group 1 maintained a density factor of .43, which means that around 43% of all individuals communicated with one another on a regular basis. Group 2, on the other hand, had a density of .35, or roughly 21% lower than Group 1. Within a smaller group, one might expect a greater level of activity among all nodes, but this was not the case. To make sense of this, it is important to reflect back on the notion that social capital considers individual's perception that the community is an active and vibrant space. Fewer interactions result in lower levels of perception across constructs related to these factors. Consequently, in the end, a lack of connectivity among participants resulted in a lower quality product as discussed in the previous section.

D. OSN as Support in Technical Learning

One final consideration should be discussed and centers on the introduction of OSN software within an academic setting and specifically for the purposes of learning and collaboration. While the merits of an OSN as a mechanism for project success and/or enhancing levels of academic community are debatable, the introduction of specialized social software, such as those integrated within an OSN, into team capstone courses provides a number of tangible and intangible benefits not measured completely in this research.

Social software is pervasive across today's dynamic business environments. Therefore students should be exposed to their applications outside of peer-networks such as Facebook and Snapchat and prior to their entering the workforce. Capstone courses are often a final course prior to graduating making them an optimal platform for their introduction. As a matter of consequence, establishing an online community of practice where students can engage in information sharing and knowledge construction through online social networking technologies introduced in this study, students may be better prepared for similar types of communication and interaction when they enter the IT workforce. Additionally, although we focus on academic

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communities in this study, research has found numerous similarities between computer supported learning and working teams that make knowledge gained in one setting applicable to another setting, making this research applicable to other domains [54].

VIII. Limitations and Next Steps

It is important to acknowledge the limitations in this research. One limitation considers grouping pretest and posttest results from Group 1 and Group 2. Rather than present the results per class, it was decided that a high-level view of student perceptions would provide better insight to the capabilities of an OSN as a tool to foster project management. A more in-depth analysis of Group 1 and Group 2, which focuses specifically on the differences between each course, may also prove interesting. Additionally, a primary goal of this research has been to showcase OSN software as a proof-of-concept for enhancing collaboration among project-based teams, which we believe was successful across a number of dimensions. As such, we currently do not compare our results against capstone students utilizing more formal PM software, nor do we compare LMS software as a viable option for PM software. Both limitations present opportunities for future research in this space.

IX. Conclusion

In this paper, we investigate the adoption of OSN software as a system for managing IT capstone projects. OSN software provides unique affordances across ad-hoc, short-term project teams and provides individuals with a user-centric environment capable of managing the project lifecycle, while also facilitating high-level discourse with the larger course community. Through the analysis of survey data and supported through a social network analysis, our findings show the powerful and positive impact OSN software has on supporting project success by facilitating peer-to-peer interaction and enhancing levels of collaboration.

X. References

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