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How are Social Media, Engineering and Leadership Related to One Another from a Student Perspective?

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Abstract

This paper investigates student perceptions of the relationships between social media, engineering, and leadership. Participants in this study consisted of freshmen engineering students enrolled in a first-semester introduction to engineering course at the University of South Carolina. A grounded theory approach was used, in which instructional activities and data collection processes occurred concurrently, were guided by one another, and developed over the course of the study. The phrase "social media engineering leadership" is developed within this paper to include social media mediated communication within an engineering leadership context. The results of this study suggest that social media engineering leadership skills include the ability to collaboratively define problems, create and evaluate solutions, and communicate the results.

Introduction

The broad objective of this study is to explore how social media literacy skills and engineering leadership skills can be co-developed in a freshmen introduction to engineering course. Social media has been suggested as an effective leadership tool because it provides an ability to connect humans to each other[1]. However, the relevance of social media to engineering leadership has not been methodically investigated. Of particular interest are the students' perceptions of the connections between engineering, leadership, and social media. Typical engineering freshmen in the US have grown up with and in social media. For many, it is integral to the way they communicate with one another and document their activities. As such, their perceptions of these connections are possibly different than those of the authors, who might see social media as either a distraction, or a potential "add-on," to the learning and practice of engineering.

Increasing our understanding of the students' attitudes and dispositions towards social media, engineering and leadership can inform the development of engineering education and practice. Therefore, this study explores two related research questions:

1. How are social media, engineering and leadership related to one another from a student perspective?
2. How do student self-perceptions of their leadership skills change while taking a course with social media literacy and engineering leadership development components?

To facilitate discussion of these questions, this paper coins the phrase Social Media Engineering Leadership (SMEL) to describe what might exist at the intersection of social media literacy and engineering leadership development and practice.

Background

This study was inspired by a recent article by Goulart[2], which described the General Electric Colab. GE Colab is an internal social network with Facebook- and Twitter- like functions coupled with file sharing and other features for employee collaboration. GE Colab enables information sharing, instant communication, advanced search, blogging, videoblogs, and more [3]. Subsequently, Desier interviewed GE officers of various organizations with different levels of social-media literacy [4]. That study sought to describe capabilities leaders must build to capitalize on the transformational power of social media. The results included six dimensions of social media-literate leadership:

- The leader as producer: Creating compelling content
- The leader as distributor: Leveraging dissemination dynamics
- The leader as recipient: Managing communication overflow
- The leader as adviser and orchestrator: Driving strategic social-media utilization
- The leader as architect: Creating an enabling organizational infrastructure
- The leader as analyst: Staying ahead of the curve

Desier purported that leaders who master the six dimensions of social media literacy will be more creative, more effective in collaborating across organizational boundaries, and rewarded with a competitive advantage. These six dimensions provide a lens through which information generated by this study can be viewed.

For engineering education to remain relevant to the needs of industry, it seems logical to look towards state-of-the-art leadership tools being deployed by General Electric, one of the world's largest engineering companies. In addition, developing instructional activities for future engineers should also be guided by fundamental understandings of leadership and engineering-leadership development.

The theoretical framework for the instructional activities described in this study is the social change model of leadership development (SCM)[5] . SCM is a widely used leadership model in engineering education[6-11] and involves the growth of critical values in three domains: individual, group, and societal. This type of leadership differs from "management," which requires hierarchical relationships for decision making. Instead, this type of leadership involves a kind of intentional movement in an organization to accomplish something that is desired or valued[12]. It is value-based. The authors suggest SCM concepts are synergistic with findings and concepts related to SMEL that are developed in this paper. Both involve collaboration and communications which are sited in culture.

Participants

Participants in this study consisted of 17 first-time, first-semester freshman mechanical engineering students that were enrolled in a single section of the course ENCP 101 Introduction to Engineering. These included 5 female and 12 male students. All of the students were members of the university's Honors College, indicating a high level of academic achievement prior to enrolling at the university. Limitations of this study include that it represents a case study with a single group of freshman engineering students, enrolled in the course taught by one of the authors. The consent documents and research methods that were employed in this study were designed to avoid coercion, and were approved by the local Institutional Review Board for Human Research.

Five teams of 3 or 4 students each were formed at the beginning of the course, which worked together on the assignments and on in-class group work throughout the semester. The teams were formed by the instructor using the criteria that each member of a team was enrolled in another course with one or more of the other team members. In some cases, all team members shared a course together outside of ENCP 101. The primary intent was to help students develop study groups outside of class and promote student success in general, as opposed to some consideration specific to this study.

Course Description

ENCP 101 is a 3-credit course and is the first required engineering course in the undergraduate mechanical engineering curriculum at the University of South Carolina, a large public university that has earned the Carnegie Foundation's top-tier designations in both research activity and community engagement. This study is based upon a single section of ENCP 101 that was taught during the Fall 2015 semester in a hybrid format.

The class met for two hours on Friday afternoons. These face-to-face class meeting times were used for a variety of purposes. These included lectures on specific topics, class discussion, hands-on laboratory activities, field trips to various engineering-related locations on the university campus, and opportunities for student teams to work on assignments related to social media engineering leadership concepts. Approximately one-third of the instructional activities for this course were delivered by distributed learning methods, meaning that instruction occurred outside of the scheduled Friday classroom sessions. These activities included recorded lectures and instructional videos that could be viewed at a time of the student's choosing. They also included participation in specific campus events that were integral to success in the course. Students were generally expected to complete the distributed learning activities before the next Friday class session.

A syllabus for the course that details learning outcomes, and lists all learning activities and assignments, is provided in the Appendix to this paper. A style of problem-based learning pedagogy was utilized consistently throughout the course, in that content and pacing were driven by the twenty-one (21) assignments listed on the syllabus. These consisted primarily of individual and team assignments completed outside of scheduled class time, but included six 1-point in-class activities as well. The learning activities and assignments that were directly related to the research questions of this study are described below.

It should be noted that the Social Change Model of Leadership Development (SCM) was introduced to the students during a class session. Students were given class time to read a handout on this model, followed by class discussion. The instructor guided this discussion towards the concepts that leadership is a process (to make positive change), rather than a position (of authority). The importance of personal awareness values in leading change was highlighted. This discussion on personal awareness was used as segue into a personal communication styles inventory activity.

Social Media Assignments

Four assignments involved a deliverable produced by social media. The first two social media assignments in the course, Online Presence and Interview a Junior, were individual assignments. The latter two of these, the Alpine Tower Statics Laboratory Wiki and NAE Grand Challenges Video Project, involved teamwork and are discussed later in this section of the paper.

The goal of the <u>Online Presence Assignment</u> was to help establish expectations for the class structure and included five simple steps. Students were simply required to upload a picture of self to the "Class Photos Wiki" in Blackboard, create a LinkedIn profile, create a YouTube channel, log in to a college network computer and identify the name of one program that the student did not have on a personal computer, and send an email from the student's college email account to the instructor with the results of the first four steps.

The <u>Interview a Junior Activity</u> was intended to promote student success while honing video production skills. Each student created and published a 2-5 minute video on YouTube that was to be designed to introduce new and prospective students to the mechanical engineering student experience at the university. Students were given the opportunity to interview junior mechanical engineers and ask the following questions. What is your favorite university class, and why? What is your favorite university person, and why? What is your favorite university place, and why? What advice do you have for freshmen? The students recorded the interviews with their smartphones or handheld FLIP video cameras available for loan from the instructor. Video editing software was installed in the college computer labs for production purposes. Students were instructed to select a theme and content for their videos by reviewing the recordings and selecting a series of video clips that best address the objective of this assignment. Variety in selected clips was expected. Students submitted their videos by posting a YouTube link and description in the class Blackboard site.

Team Assignments

The course included five team assignments with an intentional leadership development component. These were the Engineering Disciplines Team Concept Map, Hand Pump Laboratory Team Report, Simply Supported Beam Laboratory Report, Alpine Tower Statics Laboratory Wiki and Grand Challenges Video Project.

A team leader was designated for each of these five assignments, which provided every student with an opportunity for an intentional leadership experience. As the first assignment was given, the instructor led a class discussion on the roles of team members and team leaders. After the deliverables for team assignments were submitted and in order to reflect individually on the experience, students were required to submit a Self-Reflection using a journaling tool in Blackboard. The intent of these structured reflections was to reinforce and foster competencies in teamwork skills, self-understanding, leadership and problem solving.

The first team assignment was the <u>Engineering Disciplines Team Concept Map</u>. The team goal was to develop a concept map that encompasses 3-4 of the engineering disciplines described in the textbook. Requirements were for each student to individually develop a concept map based on one discipline, and then the group to meet and combine these into a single map. The final map was to include connections between disciplines wherever they could be added meaningfully.

While the task itself had a "divide and conquer" component, teamwork was required and was evaluated and included in the assignment grade.

Teamwork was also associated with the Hand Pump Laboratory Assignment. Here, each team performed a series of experiments on a hand operated water pump during a Friday class session. The experiments involved determining how the rate of the pumping affected the pump's volumetric capacity and the amount of work to pump a slug of water. Recommended procedures and potential challenges for the capacity and work studies were provided, which included written instructions and pre-lab videos. During class, student teams worked together to make the measurements and perform the data analyses. However, each student submitted an independently written report using a memo format provided by the instructor.

The Simply Supported Beam Laboratory Assignment was the third team project. Here, teams collected the experimental data and prepared a single team laboratory report. An individual component was included in that each member analyzed the data and prepared a graph of the results independently. All individual graphs were submitted as part of the team report; however the team had to agree on using one of these as the official report graph. The technical objective of this laboratory was to use basic mathematical and graphical techniques to determine how well experimental data fits a theory. The applicable theory associated with static equilibrium for a simply supported beam was provided through prelab videos and a laboratory handout. Experimental data was obtained from an 8-foot long wood 2x4 beam that was simply supported on two bathroom scales. The applied load was generated by a team member standing at various positions along the length of the beam. A memo format for the laboratory report was again assigned.

Teamwork Assignments with Social Media Deliverables

As mentioned, two course projects required both teamwork and the use of social media tools in the development of the project deliverable: the Alpine Tower Statics Laboratory Wiki and the NAE Grand Challenges Video Project.

The Alpine Tower Statics Laboratory Wiki was the deliverable for an in-class laboratory activity. The deliverable for this activity was a team-created web page, made using Blackboard's wiki tool. Wikis are considered social media in that they are computer-mediated tools that enable groups to collaborate and co-create content. For this activity, the wiki audience was defined as prospective mechanical engineering students, and the goals were to both educate others on engineering problem solving, and to inspire them to study mechanical engineering at our university.

For the hands-on laboratory activity, each team was to determine the forces in the members at one joint of the university's Alpine climbing tower. To collect the data, the class met at the Alpine tower, equipped with tape measures and protractors. Team members took turns climbing the tower and measuring the dimensions of the massive pressure treated pine members and connections. With these and an assumption on the density of pine, each team calculated the weight of the tower (approximately 26,000 lbs). Then, using static equilibrium concepts described in a series of prelab videos, students estimated the force in each member at a 3-member joint near the base of the tower.

The NAE Grand Challenges Video Project was the culminating course activity. It provided an opportunity to develop social media engineering leadership skills through exploration and communication of the National Academy of Engineering's Grand Challenges for Engineering in the 21st Century[13]. The Challenges range from managing the nitrogen cycle to advancing personalized learning. Through the Challenges, this project included aspects of community service, global learning, professional engagement, and research. The objective of this assignment was for each team to create a video between 2-5 minutes in length in response to the question: Which of the 14 Grand Challenges identified by the National Academy of Engineering would you choose to address, and how would you do it? Each team selected a different challenge, and was instructed to produce a video that described:

- The challenge
- The social impact
- The national technological readiness to address the challenge
- Possible avenues to solve the challenge

Teams were instructed to create all-original video content using class/reading materials provided by the instructor and posted in the class Blackboard site. This included the NAE website and the university library's engineering database. Videos were posted to YouTube as either "Public" or "Unlisted," and the URL emailed to the instructor. The videos were screened during the last class session of the semester.

Communication Styles Inventory

Students were asked to complete Hartman's communication styles inventory[14]. The purpose was to increase student self-awareness and self-regulation, in accord with SCM. This inventory consists of 67 statements, with the instructions to "circle each statement that you feel describes you." A self-scoring sheet results in categorization of a dominant communication style, either Analytical, Driver, Amiable or Expressive. After each student had completed the inventory and read descriptions of these categories, they were grouped by style and asked to discuss a series of questions:

- When you are a team member, what things are most important to you and how do you like to be treated as a member of that team?
- When your team is first created, how do you get the team to begin its work?
- How do you manage the team member that does not pull his or her weight?
- How do you handle a dominant/take control team member?
- How would you build a team that has a well-rounded/ balanced membership?

After the first question was discussed, group members shared with the rest of the class the key points of their discussion and gave an illustrating example. After all the questions had been discussed and shared in this manner, the instructor led a discussion, asking what differences the students observed, and what are the implications for leadership. There were striking differences which were consistent with the inventory author's work. However, the most important result of this activity was that it enabled the formation of in-class discussion groups for the subsequent minute paper and application card activities, where they were grouped either by common or by different communication styles, as discussed in the research methods section, below.

Research Methods

The last four weeks of the ENCP 101 course were designed to both provide instruction on and to assess how social media, engineering and leadership are related to one another. A grounded theory approach[15] was considered appropriate to explore this research question, in that no pre-conceived notion of the connections between social media, engineering, and leadership was present to be tested. Therefore, data collection, analysis and learning were interwoven during that phase of the study.

Instructional activities prior to this phase of the course included lectures and discussion on the engineering mindset, engineering design process, memory and learning, problem solving strategies, and leadership, and were reinforced by the teamwork and social media assignments. During the last phase of the course, instructional activities were guided by the social change model of leadership development. Activities touched on all three aspects of this model, personal values, group values, and community values.

Data sources included student concept maps, minute papers and application cards[16]. They also included pre/post surveys, and team reflections conducted as semi-structured focus groups. This section of this paper describes how each research instrument was applied. This is followed by a section which discusses the results and their implications.

SMEL Concept Maps

Concept maps are diagrams that provide an observable and assessable record of students' conceptual schemata[16]. In this study, Social Media Engineering Leadership (SMEL) Concept Maps were created by each team in order to characterize student perceptions of the components of and relationships between the three concept domains of social media, engineering, and leadership. To start the activity, each student was given three 3x5 note cards. On the first card, individuals were instructed to list concepts that relate to engineering for about 2 minutes. They then shared and discussed their ideas with other members of their team. This process of privately brainstorming and then publicly discussing was repeated for the concepts of leadership and then social media. After these activities, each team was given a large poster board and markers and asked to create a concept map. Instructions included to start with a central concept of social media engineering leadership connected to the concept domains of social media, engineering, and leadership, as shown in Figure 1.

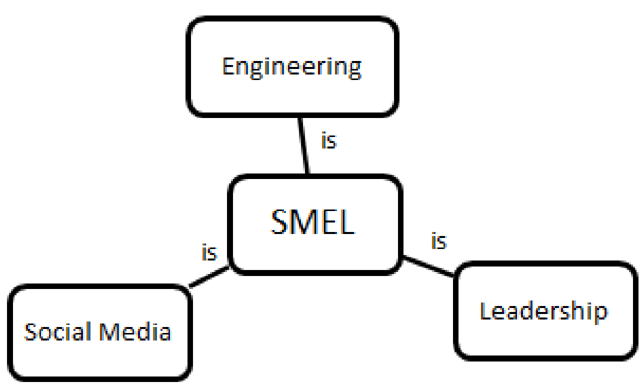

Figure 1. Starter Concept Map for Social Media Engineering Leadership (SMEL).

Students were instructed to list and arrange their concepts for each domain, and to link and cross-link these using relationship words such as on, is, has, used in, produced by, and other verbs and phrases. Each team then orally presented their map to the rest of the class. The instructor then collected all of the 3x5 cards and concept maps, and used these to further develop the course's remaining content.

Six Dimensions Minute Papers

Minute papers are useful for collecting written feedback when students are presented with new information. In this study, students were assigned to read the article *Six Social-Media Skills Every Leader Needs*[4] prior to class. In class, they were given a handout summarizing the six dimensions of social media literate leadership presented in the article. After a brief instructor-led discussion of this article, students were given 3x5 note cards and asked to answer the question "Which dimension is most important to an engineering leader, and why?" After two minutes of reflective writing, students were grouped by common communication styles (see above) and asked to discuss their papers and to come to a consensus on the dimension that each group felt most important. These were shared with the class, discussed, and captured on the chalkboard.

Design Applications Cards

Application cards prompt students to think about possible applications, connect newly learned concepts with prior knowledge, and see more clearly the possible relevance of what they are learning[16]. In this study, application cards were used on the last day of class as part of the review for the final exam. As part of the review, the instructor provided notes on the chalkboard that included a flowchart of the engineering design process, and a concept map for social media (derived from earlier student concept maps). Each student was given a 3x5 card and asked to describe three applications of social media to the engineering design process. After two minutes, students were asked to pair with someone else not in their communication style category, and to discuss their cards. An open discussion followed where students reported their applications to the class; these were captured on the chalkboard to facilitate the reporting of different applications by the class.

Peer Video Evaluations

Evaluating the work of peers can help students internalize the characteristics of quality work[17]. In this study, SMEL peer evaluations were incorporated in the screening session of the student team NAE Grand Challenges videos. After the class watched each video, students were asked to complete a peer evaluation. The form for the evaluation included six statements, each with a Likert scale of strongly agree, agree, disagree, strongly disagree. Students were asked to circle a response for these statements:

This video demonstrated ability to…

- Apply technical principles of engineering
- Apply the engineering design process
- Communicate a compelling story
- Apply skills of digital-multimedia production
- Promote positive change
- Work together as a team

A free-form response box was included after each statement with the instructions to explain the rating. The items on this peer evaluation form were intended to address the three aspects of engineering, social media, and leadership, as they related to the culminating class project.

Course Learning Concept Maps and Team Reflections

The final exam for the course included the assignment to create a concept map indicating what a student learned in ENCP 101. Again, each student individually developed a concept map based on his or her own learning, and then the group combined these into a single map. Instructions included that the final map should include connections between multiple concepts wherever they could be added meaningfully. As each team finished their group concept maps, they were taken to a different room for a team reflection activity. A semi-structured focus group format was employed to conduct the team reflections. In reference to their concept maps, groups were asked about the most important, least important, and most challenging concepts learned.

Leadership Skills Pre/Post Survey

This study included a pre/post survey to assess student values towards leadership skills. This leadership values survey was adapted from previous work by Ahn et al, in which an instrument was created to measure leadership, change, and synthesis in engineering undergraduate[18]. Ahn's survey Included 45 questions which were characterized through exploratory factor analysis by four factors: (1) being an engineering leader, (2) engineering leadership, (3) engineer's impact on society and economy, and (4) development of an adapter to change. The first three factors were considered to relate closely to the three aspects of the social change model of leadership development, and statements related to these factors were included in our survey. For example, survey questions related to factor 1 (being an engineering leader) address individual qualities, self-awareness and personal values. Factor 2 (engineering leadership) survey questions emphasize group-related values including collaboration and interaction between the group and the individual. Finally, factor 3 (impact on society) questions include societal values such as community, environmental, and economic impact. Therefore, the use of Ahn's survey in the context of the social change model is considered to have face validity.

Results

Question 1: How are social media, engineering and leadership related to one another from a student perspective?

Social Media and Engineering

The student's SMEL Concept Maps directly asked students to connect the concepts of social media and engineering, resulting in directed representative connections. An example concept map is shown in Figure 2. Shared concepts gathered from the concept maps indicating a relationship between social media and engineering include the ideas of communication, teamwork, technology, efficiency, sharing and understanding. All 5 groups represented <u>communication</u> as critical to either social media or engineering or both. Four of the 5 groups made the connection of <u>technology</u> to both areas. <u>Efficiency</u> was also attributed to both social media and engineering in 2 of the 5 maps and to both social media and leadership in 1 map. Considered together, these shared concepts suggest that students view social media and engineering together as working cooperatively and effectively to understand, produce and share information.

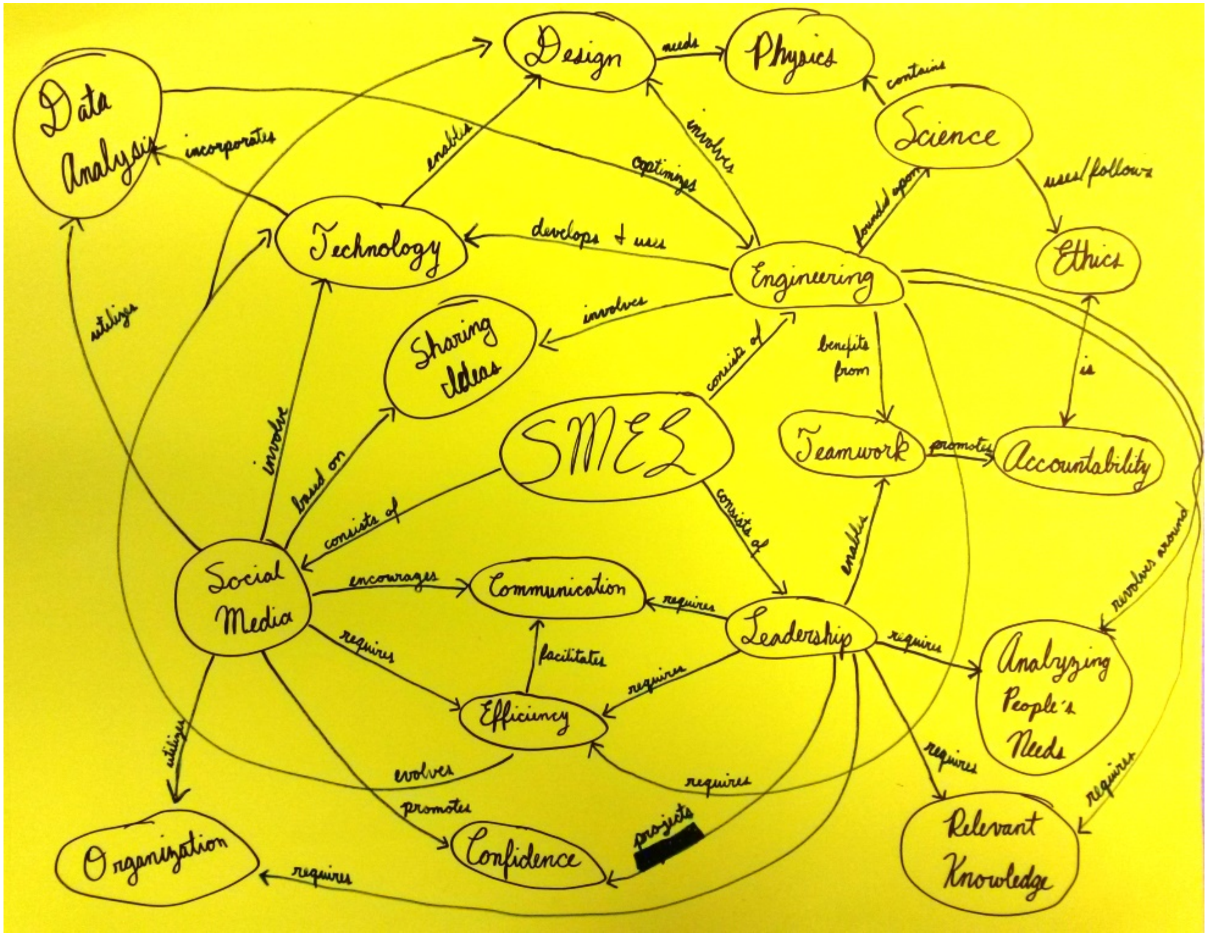

Figure 2. Student-generated Social Media Engineering Leadership Concept Map.

Social Media and Leadership

Connections between social media and leadership also emerge in the data from the SMEL Concept Maps. Shared concepts gathered from the concept maps between social media and leadership include the ideas of communication, understanding, efficiency, organization, teamwork and people – a list not surprisingly similar to the list connecting social media to engineering. The social media-leadership connection list, however, omits the idea of technology. Instead, <u>people</u> and <u>organization</u> appeared frequently at the connection between the leadership and social media concepts.

As the capstone project of this course, the Grand Challenges videos culminated in the application of the social media and engineering leadership connections explored throughout the course. The project required team leadership to choose and represent the challenge, some technology skill to produce the video, and teamwork to complete the task as assigned. Written peer evaluations of the videos were conducted after each video was shown during a class period. Students were asked to assess each video in terms of engineering design, communication, production, teamwork and promoting positive change. The Grand Challenges videos themselves are interesting, but more relevant to this study are the student video surveys and reflections on the project – their thinking about what they learned and attempting to apply it to other students' work. Specifically, the "disagree" columns from the survey indicate where students felt the videos fell short. Out of 17 responses, students viewing the videos indicated lack of success as follows: multimedia production – 10, communicating a compelling story – 9, design process – 6, principles of engineering – 4, promoting positive change – 1.

Interestingly, the overarching shared concept from the SMEL Concept Maps for all 3 concepts – social media, engineering and leadership – was communication. Yet in the Grand Challenges video project, the culminating project of the course meant to employ the 3 shared concepts, the shared criticisms involved an inability to communicate – both using multimedia and telling a compelling story. Most likely, the criticisms of engineering and design content also relate to communicating ideas. The students see communication as important, can recognize when communication isn't effective but, in the eyes of their peers, apparently didn't recognize how to communicate a specific concept. It appears they learned strategies to communicate among themselves while working on the project, but still lacked the skills to identify what and how to communicate about a topic. Applying this observation to the concept of leadership, then, the assumption is that team leadership was not wholly successful either.

Social Media and Engineering

The Design Application Card activity required students to take a step further toward application of these shared concepts with the question, "How can social media be applied to the engineering design process?" Although students answered this question individually, the same shared concepts emerged: communication, collaboration and understanding ideas. Given the following overview of the design process, students provided multiple examples of social media applied to the engineering design process. These are summarized in Table 1.

Table 1. Student-generated applications of social media to the engineering design process, generated by the Design Application Card activity.

Design Process Steps	Number of Responses	Student Application Response Examples
Define the problem	9	news, monitor complaints, opinion surveys, research, bright light to problems need solved
Background research	7	talking to experts, articles, blogs, forums, databases, think tanks, direct survey
Specify requirements	0	
Evaluate and choose a solution	14	collaborate within the group, vote, share ideas, brainstorming, organize information
Develop prototype	13	collaboratively create model, connect engineers to sponsors
Test and evaluate	2	share with groups/communities to gain feedback
Communicate results	16	Twitter, news, mass send, groups/communities, email, text, YouTube

The responses on the Design Application cards reveal how comfortable the students are in identifying social media methods to gather information, to collaborate and to communicate. Taken from the abstract to application, students easily connect social media constructs to a design task, underscoring the concepts of communication, teamwork, technology, efficiency, sharing and understanding that were generated through the SMEL concept maps.

Social Media and Engineering Leadership

As with the other connections, engineering and leadership shared concepts appear in the SMEL Concept Maps. Again, students established connections between engineering and leadership through the concepts of efficiency, understanding, communication and teamwork. Additional concepts shared by engineering and leadership that emerged include problems, design, research, goals, and projects. These additional shared concepts indicate that the students, at least in a conceptual way, recognize that engineering leadership goes beyond teamwork and collaboration, in that it also requires knowledge, skills and application.

The Six Dimensions Minute Papers required the students to think about social media skills in the context of being an engineering leader. The report-out phase of the minute paper activity was captured on the board in the classroom. These results are shown in Figure 3 (note that there were 2 groups of Expressives and Drivers to balance discussion group size). Student groups replied most frequently (3 out of 6 groups) that “architect” – establishing organizational and technical infrastructure – is the most important social media literacy dimension for an engineering leader. It is interesting to note how the communication style of the group members manifest itself in the explanations of why “architect” is important. The low-assertiveness Amiable group described facilitation and communication of everyone’s ideas, whereas high-assertiveness Expressive and Driver groups described collaboration associated with accountability. Other social media skills believed important to engineering leadership represented by the student included “producer” – creating content, “analyst” – staying abreast of innovations, and “recipient” – managing communication overflow.

In using data collected from the course, natural connections between social media, engineering and leadership appear to have emerged for these students. Looking at the course as a whole rather than at the individual connections, information presents itself as to what course mechanisms were or were not important in promoting or supporting the shared concepts. Course Learning Concept Maps and Team Reflections reveal the students’ perspective on what may have supported making the connections and which approaches were less effective. In looking at these course concept maps, for example, similar shared concepts are represented as on the SMEL Concept Maps at the beginning of the course – communication (5 occurrences), teamwork (3), and leadership (3). One important, new concept also emerges, however – career connections. All 5 groups represent ties to careers on the final course concept map. These connections suggest that considering social media, engineering and leadership in the context of future goals and of defined careers adds a specific element of relatability to these other concepts.

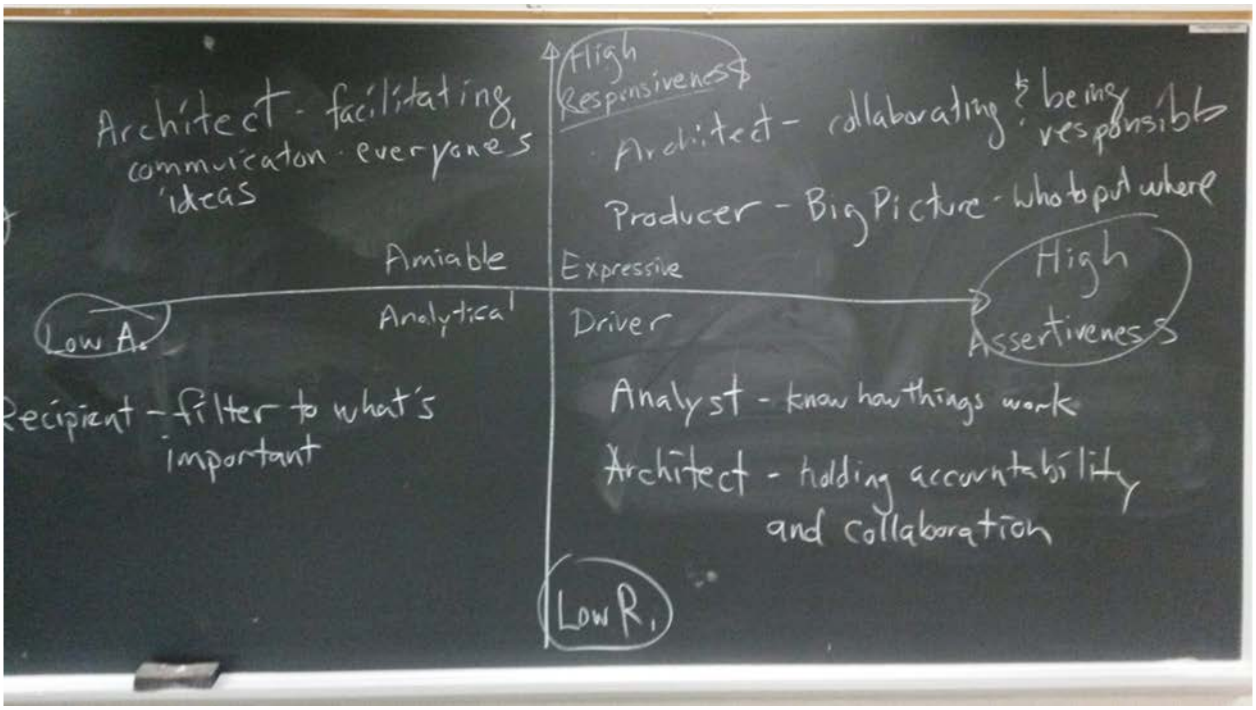

Figure 3. Student perceptions of the most important dimensions of social media literacy to engineering leadership within Hartman's communication styles coordinate frame.

Question 2: How do student self-perceptions of their leadership skills change while taking a course with a social media engineering leadership development component?

In this study, a leadership skills survey was administered at the beginning of the first class period and again after the final exam. To analyze the results, numerical values were assigned to the survey response statements: Rarely=1, Sometimes=2, Frequently=3, and Almost Always=4. Changes in pre/post responses on individual items where assessed for statistical validity with a two-tailed paired t-test. Here, a p-value less than 0.10 (90% confidence) is considered significant. These and mean values for each survey statement are shown in Tables 2a-2c. Also included are composite values for all statements within each factor of the survey.

A comparison of the composite means for the three factors indicates that students initially rated themselves lower on individual factors (mean 2.9) than on interpersonal factors (mean 3.44) or societal factors (mean 3.28). These differences were determined to be statistically significant using a two-tailed, sample equal variance t-test, with p-values less than 0.04. This implies that the students in this group tend to be more social- and civic-minded than narcissistic. Strauss made a similar observation about this age group[19].

Table 2a. Survey Results – Being an Engineering Leader (Individual Values)

Question	Pre Mean	Post Mean	p-Value
Change is a smooth and easy process for me	3.07	2.40	0.012*
I establish goals for a project and explain the best way to accomplish these goals to my team members	3.00	3.33	0.055*
I facilitate developmental opportunities for my team members during a project	2.14	2.71	0.055*
I manage and organize my time efficiently	2.60	2.27	0.096*
I actively seek leadership opportunities in and out of the classroom	2.67	2.93	0.164
I independently initiate new individual or team projects	2.20	2.53	0.173
I look for opportunities to share my knowledge with my peers	2.93	3.20	0.217
If I see the need, I take on responsibilities that are not assigned to me	3.13	2.87	0.217
I am a confident person	3.33	3.20	0.334
I motivate my team members to accomplish predefined goals	3.00	3.13	0.433
I take ownership of a project in which I am involved	3.53	3.40	0.499
I clearly explain technical matters to people who are not familiar with my area of study	3.13	3.00	0.499
I effectively delegate projects and authority to other people	3.07	3.13	0.670
I perceive myself to be technically competent	3.13	3.20	0.719
I can organize and structure a group to accomplish a common goal	3.33	3.40	0.751
I easily explain and discuss the fundamental elements of a project with other team members	3.20	3.13	0.751
I am able to solve problems in nontraditional ways	3.00	3.07	0.774
I am not afraid to take risks when making project-related decisions	3.13	3.07	0.774
I actively encourage my peers to solve problems	2.80	2.87	0.792
I identify conflicts in a team project and solve them before they harm the project and the people involved	3.00	2.93	0.792
I clearly visualize a project even when I am given limited information	3.07	3.13	0.843
Composite Value	**2.98**	**3.00**	**0.723**

Table 2b. Survey Results – Engineering Leadership (Interpersonal Values)

Question	Pre Mean	Post Mean	p-Value
I can acknowledge when I am wrong and learn from my mistakes	3.53	2.73	0.001*
I listen to my peers' concerns and opinions even if they are different from my own	3.53	3.13	0.054*
I treat my peers with respect and dignity	3.80	3.47	0.055*
I create an environment of trust among my team members	3.47	3.20	0.164
I do my best to make my team members feel important and get involved in a project	3.47	3.13	0.173
I work well with people who have backgrounds that are different than my own	3.40	3.27	0.582
When making decisions, I take into account opinions of all the people involved in the project	3.27	3.20	0.670
I gather as much input as I can before making decisions	3.07	3.00	0.751
Composite Value	**3.44**	**3.14**	**0.009***

Table 2c. Survey Results – Engineer's Impact on Society & Economy (Social Values)

Question	Pre Mean	Post Mean	p-Value
I feel responsibility for the success and failure of a project	3.79	3.36	0.054*
I anticipate having to learn new skills over the course of my career	3.93	3.80	0.164
I understand the business implications of product development	2.93	3.20	0.217
I am passionate about achieving my goals	3.53	3.33	0.271
I am aware of competition among companies in my field	3.07	3.20	0.499
I pay attention to environmental issues while designing new products	2.47	2.60	0.546
I believe that changes in the economy will impact my job	3.33	3.47	0.582
I consider my work as helping people to live a better lives	3.20	3.07	0.582
I am aware of the impact that engineers have on society	3.33	3.40	0.751
I believe societal issues affect how engineers do their jobs	3.53	3.60	0.806
I am primarily aware of cost and revenue when designing a product	2.67	2.73	0.806
I believe that engineering design is affected by issues related to social and business environments	3.60	3.60	1.000
Composite Value	**3.28**	**3.28**	**0.966**

When the survey was given at the end of the semester, mean responses to a number of survey statements changed; statistically significant changes are marked with an asterisk (*). Within both the individual and the societal factor groups, mean responses to some statements increased and some decreased, resulting in little to no change in the composite mean value for the group. However, the mean response decreased for every statement in the interpersonal factor group. As a result, the composite mean decreased from 3.44 to 3.14, and this decrease was statistically significant with a p-value of 0.009. This implies something about leadership and teamwork, either (a) that maybe the students thought they were better at these skills than they turned out to be when forced to take on specific leadership and team member roles, or (b) that the students actually got worse in these roles as a result of one semester of college and this particular class. The authors would like to believe that the former is most likely.

Looking at specific questions in Table 2, the individual values question with the most significant change was "Change is a smooth and easy process for me." At the end of the semester, students rated themselves lower on this question than at the beginning. Student self-ratings also significantly decreased for the interpersonal values questions "I can acknowledge when I am wrong and learn from my mistakes," and "I listen to my peers' concerns and opinions even if they are different from my own," and on the societal values question "I feel responsibility for the success and failure of a project." These trends can be interpreted as an increase in student awareness of the difficulty in managing change. The changes in these individual questions, along with the overall decrease in self-ratings of interpersonal skills, suggest that the students realized through this course, or other first-semester experiences, that leading teams of other engineering students requires more work than they initially thought.

Discussion of Results

Taken as a whole, the findings suggest that Social Media Engineering Leadership can be described as social media mediated communication within an engineering leadership context.

But there is perhaps more to it than that. The data collected from the described activities suggests that shared concepts link social media, engineering and leadership. Identifying and reviewing these connections may inform future practice intended to develop student skills in these areas.

Based on these data, it is suggested that leading teams of engineers to complete a project can in some aspects be facilitated by using social media communication and collaboration tools. Leaders with social media skills of analyst and producer can help in defining problems and gathering information, collaboratively creating and evaluating solutions, and communicating the results. However, recall that in the Six Dimensions Minute Papers, students identified architect (defined as promoting collaboration and accountability) as the most important role for an engineering leader. The Grand Challenges teams may have functioned well as a group following this model, but missed the mark on defining the message and delivering it. Their video productions did not demonstrate leadership that also filled the roles of producer and analyst as described above. Without such holistic leadership, it is possible that the social media element of the Grand Challenges Video assignment distracted from the message itself, with neither the message nor its delivery culminating in satisfying results.

The end-of-course team reflections suggest that through the course, students believed they made progress in developing leadership skills as they led and were led. The teams consistently reported that taking turns as assigned leader was beneficial to understanding of leadership and teamwork. Several teams supplemented that comment with the idea that letting someone else lead was also an important skill to learn and that the teams got better with each task.

However, it appears that the most difficult connection for the students is the one between engineering and leadership. They believe that they can perform engineering tasks and they can learn skills to mediate a group. The challenge is to get the conceptual connections -- efficiency, understanding, communication, teamwork, problems, research, goals, skills, business, analyzing, knowledge, projects -- reflected in application activities that result in not just working together, but bringing together the knowledge, skills, ideas and teamwork in order to communicate or deliver a concept or product effectively.

Conclusion

An overall challenge remains as a result of reviewing this data. Connections between social media mediated communication and engineering leadership need to be further defined, cultivated, practiced and put in context. Students appear comfortable with social media as a tool. To them, it is not a centerpiece or foundational skill, but an efficient and effective tool for all types of communication, research, and even as articulated for use in the engineering design process. Putting such conceptual values into practice remains an important goal to achieve.

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Appendix: Syllabus for ENCP 101 Introduction to Engineering

Course Description
Engineering problem solving using computers and other engineering tools.

Learning Outcomes
During this course, students will demonstrate the ability to:
1. Answer the questions “what is engineering?” and “what does an engineer do?”
2. Use a suite of computer applications that will be used throughout the engineering college experience.
3. Articulate a framework for solving engineering problems.
4. Analyze the relationships between theory, practice and design of mechanical engineering components and systems.
5. Use basic mathematical and graphical techniques to determine how well experimental data fits a theory.
6. Use social media to articulate a strategic vision for change that helps people and the planet thrive.
7. Function as both member and leader on an engineering team.
8. Develop a delightful degree completion plan.

Schedule of Distributed Learning and Face-to-Face Class Topics and Activities

Week	Distributed Learning Activities	Face-to-Face Class Topics
1	Semester Begins	Engineering Mindset & Engineering Design Process
2	Engineering Disciplines Videos	Memory & Learning Strategies Interview a Junior Activity
3	Campus Resources Field Study	Bloom’s Taxonomy, Constructivism & Problem Solving Methodology
4	Energy Systems Content & Videos	Energy Plant Field Study
5	Hand Operated Water Pump Videos	Hand Pump Laboratory
6	Engineering Career Fair Field Study	Advisement & Graduation with Leadership Distinction
7	Simply Supported Beam Prelab Videos	Simply Supported Beam Laboratory
8	Excel Data Analysis & Graphing Videos	Class Cancelled Due to Weather
9	Alpine Tower Statics Prelab Videos	Alpine Tower Statics Laboratory Activity
10	To Engineer Is Human Video	Fall Break
11	Composite Materials Videos	Aerospace Research Center Field Study
12	NAE Grand Challenges Videos & Content	Social Media Engineering Leadership NAE Grand Challenges Topic Selection
13	Creative and Everyday Leadership Videos	Social Change Model of Leadership Communication Styles
14	Social Media Engineering Leadership Videos & Content	Social Media Literate Leadership and Engineering Design Process
15	Team Work	Thanksgiving Break
16	Team Work	NAE Grand Challenges Video Screening
17	Finals Week	Final Exam Concept Maps Focus Groups

List of Assignments and Their Relationships to Learning Outcomes

	Learning Outcomes								
Individual and Team Assignments	Engineering Practice	Computer Tools	Problem Solving	Engineering Analysis	Experimental Data	Social Media	Leadership/Teamwork	Student Success	Grade Points
Online Presence Assignment		Y				Y		Y	5
Interview a Junior Video		Y				Y		Y	10
Engineering Disciplines Team Concept Map	Y						Y		8
Engr Disciplines Concept Map Self-reflection									2
Engineering Job Review	Y							Y	5
Hand Pump Laboratory Report			Y	Y	Y				8
Hand Pump Laboratory Self-reflection							Y	Y	2
Program of Study Eight-Semester Plan								Y	5
Simply Supported Beam Laboratory Report		Y	Y	Y	Y		Y		8
Self-reflection on Simply Supported Beam Lab								Y	2
Alpine Tower Statics Laboratory Wiki		Y	Y	Y	Y	Y	Y		8
Alpine Tower Statics Lab Self-reflection									2
Graduation with Leadership Distinction Plan							Y	Y	5
NAE Grand Challenges Video Project	Y	Y	Y	Y		Y	Y		14
Final Exam Concept Map							Y		10
In-Class SMEL Development Activities									
Concept Maps on Social Media Engineering Leadership	Y					Y	Y		1
Communication Styles Inventory & Activity							Y	Y	1
Application Cards on Social Media & Engineering Design	Y					Y			1
Minute Papers on Engineering Leadership & Social Media Literacy Dimensions						Y	Y		1
Peer Evaluations of NAE Grand Challenges Videos							Y	Y	1
Leadership Pre/Post Survey							Y	Y	1