Engineering Social Media to Teach Engineering

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Abstract:

Engineering educators can use social media tools to supplement classroom learning with standard and well-understood passive and active educational models. Lesson planning, including social media time lining and assessment strategies, must be developed in advance to ensure success. This paper provides two example plans to help engineering professors think about effective ways of incorporating social media into the classroom.

1 Introduction

The heavy use of social media and mobile platforms has led to changes in how students learn, the expectations students have for individual and group learning, and also changes in educational ethics [1], [2]. In general it can be said that the speed of information retrieval and networking has changed learning for a significant majority of the world's population. Unlike many of their professors that were born in earlier generations, the current college students have been surrounded by embedded computer systems and unprecedented access to communication technology from the moment they were born.

As a group, Millennial generation students were born between 1980 and 1994, and thus the first half of this student demographic has already matriculated at universities, completed four-year degrees, and moved into the workplace [2]. This half grew up using the Internet primarily as an on-line encyclopaedia of knowledge served by low-bandwidth static HTML websites. It also watched email become a standard method of communication. The second half of the generation, though, has seen perhaps the most profound change in society's use of communication technology. This second half is currently somewhere in the educational pipeline – either in secondary school or at universities. These students are immersed in a broadband media-rich Internet with advertising-driven content enabled by data mining of the locations they visit. These students have also been instrumental in establishing the modern culture of communicating with text messages sent from smart phones.

Sweeny identified a number of characteristics in the research he completed on the Millennial generation [3]. Some of these characteristics can be mapped into four categories that are quite relevant when professors consider using social media to teach engineering. The first category is feedback. In general, Millennial students like merit systems that tell them how well they are doing in the eyes of others and expect instantaneous feedback when possible. The second category is learning style. As a group, these students prefer to learn with others and they also do not read as much or as deeply as previous generations. The third category is an "always online" expectation with extensive access to information and each other through text messaging, web browsers, social networks, and on-line gaming environments. Finally, the fourth category is a roaming behaviour enabled by the now ubiquitous mobile telephone.

Figure 1 shows these characteristic categories further organized into needs, challenges, and learning skill sets.

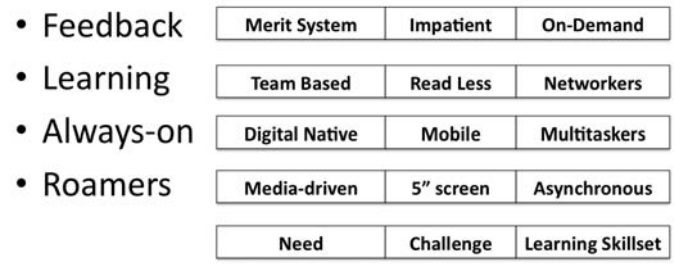

Figure 1: Categorizing Millennial Student Characteristics

Needs represent student classroom expectations. Challenges represent student characteristics that may impede learning if not manipulated properly. Finally, the learning skill sets represent target areas for social media learning exercises. For example, the roaming behaviour enabled by mobile telephones results in asynchronous learners that may prefer spontaneous texting rather than face-to-face meetings or voice. Instructors can exploit this characteristic in the students by asynchronously supplementing classroom instruction with micro-blogs distributed using the Twitter social media tool.

The computing history and documented characteristics of Millennial students suggest that they learn and interact in different ways. It is natural, then, to consider adopting some of the social media tools of the current generation as content delivery mechanisms.

2 Social Media

The development and use of social media is a large and complex area of research. In this paper, it is assumed that readers have a general knowledge of well-known social media sites such as Twitter, FaceBook, and YouTube. Readers interested in acquiring a more detailed understanding are encouraged to read a detailed paper on the business potential of social media recently published by Kaplan and Haenlein. They define social media as a "group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content [4]." They also describe the historical development of the major types of social media and present a classification scheme based on social presence and self-presentation. Finally, they generate a categorization of social media tools into six types: blogs, collaborative projects, content sharing, social networking, virtual gaming, and virtual social worlds. Some of these categories can be easily adapted as classroom supplements while others present a larger challenge. For example, while virtual gaming may be a useful supplement in some courses, for most educators the learning curve and start up costs would be extensive. Yet, adding asynchronous blogging activities is straightforward and low cost.

In Figure 2, each category of social media is presented with examples and a difficulty index. The difficulty index is clearly arguable: many users may consider FaceBook and LinkedIn as low difficulty examples of social networks. Yet, these environments could require more complex monitoring and assessment of students when compared to basic blogging activities. Consider, as an example, that not all forms of social media are secure. Thus, when an instructor produces an assignment on certain social media sites, the assignment can rapidly take on a life of its own with people that are not enrolled in the class participating in the

discussion. The absence of instructional authority in these asynchronous learning environments may make some of the data and criticism directed at students by outsiders questionable unless monitored effectively by the instructor.

Category	Example	Difficulty Index
Blogs	Twitter	Low
Blogs	Edublog	Low
Blogs	Podcasts	Low
Collaboration	GoogleDocs	Low
Collaboration	Wikis	Medium
Content Sharing	YouTube	Medium
Social Networks	LinkedIn	Medium
Social Networks	FaceBook	Medium
Virtual Gaming	UniGame	High
Virtual Worlds	Second Life	High

Figure 2: Example Social Media Tools

Thus, in producing the difficulty index, the authors of this paper considered ease of content creation, utility as a classroom supplement, ease of monitoring, and ease of assessment. The index is meant only as a starting point by suggesting to instructors the level of commitment each example tool requires.

The index was created after reviewing the experiences of others as published in the educational literature. A substantial number of published papers document the creation and use of electronic learning environments or social media tools. Recent examples include [5][6][7][8][9]. Similarly, there are many papers that provide good summaries of Web 2.0 technologies, social media, and how social media support the constructivist view of education [10][11][12][13]. The education literature also includes many papers that specifically target one type of social media as a classroom supplement. The most popular appears to be education blogs, where students are asked to blog about their learning [14][15][16]. Similarly, as mobile phone usage continues to increase, other recent articles have looked at using location services, such as GPS or zip-code identification, to provide just-in-time educational products [17][18]. Finally, the use of micro-blogs, like Twitter, generates significant discussion [19][20][21].

Many papers, however, do not present detailed lesson plans or time lining. Thus, the rest of this paper will focus on providing engineering professors with suggestions for planning social media activities and show concrete example lesson plans with timelines.

3 Planning Social Media Activities

The biggest challenge educators face with all activities is planning and assessment. Social media activities are different from classroom activities because they lack the authority of instructor presence. But, in general, they can be designed using similar techniques. Figure 3 provides checklists to help educators produce a detailed lesson plan and assessment plan for each social media activity.

Planning Steps	Assessment Steps
Set Goal	Assign
Set Difficulty	Monitor
Set Model	Evaluate
Set Limits	Classify
Write Exercise	Refine

Figure 3: Planning Social Media Exercises

Begin the planning steps by setting a goal that has a definite educational result. Determine the knowledge the students will gain and the reasoning process they will use. For example, will students derive a circuit equation, build the circuit, and document success using a YouTube video or will they use Twitter posts to critique oral presentations given by their classmates? As step two, choose a difficulty level by using a well-known learning taxonomy such as Bloom's Taxonomy [22]. In this step, determine how detailed the student responses to the exercise must be in order to be considered minimally successful. Remember that social media encourages constructivism, however, and students could move through higher levels of learning once the exercise is assigned. As step three, determine the educational model that will be used to direct the exercise. Some simple examples to try include spaced repetition [23][24], concept mapping [25], and reflective practice [26]. Modify the model to fit the social media tool only if necessary. Next, as step four, set limits by determining if it will be a passive exercise with information transferred only from instructor to student, an active exercise with feedback between participants, and the role that outsiders can provide to students through comment fields, "like" or "dislike" adjective tags, or other on-line voting mechanisms. Finally, as the final step, write the activity.

The assessment plan is equally important. The first step is assigning the social media exercise. Choose a time near when the subject matter is taught during lecture in order to assist short-term memory recall and enable longer-term deeper memory retention. Also, be sure that the instructor has appropriate time to monitor and assess student performance once the exercise is assigned. Cleary communicate the expectations for participation to the students before the exercise is assigned. Include the merit structure used to grade the exercise. The second step to proper assessment is monitoring student participation. For some exercises, this may require nothing more than responding to student comments. For others, the instructor may need to police the dialogue and criticisms occurring in discussion threads. The next two steps are classic grading exercises where instructors evaluate the student contributions and classify them into grade categories. Finally, as the instructor, reflect on the exercise and refine it, if needed, before using it again in the future.

Two example activities are documented next in this paper. Both use the Twitter micro-blogging service in order to illustrate how different educational models can be applied using a common and easy-to-use tool. As a micro-blog, Twitter is an on-line journaling tool with very short text entries, called "tweets", that are limited to 140 characters because Twitter was developed around the SMS concept for text messaging [27]. Tweet authors can make tweets publically visible or visible only to follower-groups. This allows a teacher to set a basic security level because creating a private class account, rather than using a public account, can eliminate outsider noise. The use of Twitter differs from assignments given through email or class websites because tweets are pushed to subscribers through mobile phones or a Twitter feed integrated into a student FaceBook or MySpace account.

4 Example: Spaced Repetition with Taxonomy Climb

This example was designed to supplement and review topics taught in a first course in digital logic circuit design at the Milwaukee School of Engineering. It uses the spaced repetition educational model to asynchronously feed students key points and tasks about digital logic design at regularly scheduled intervals. It differs from many applications of spaced repetition because it does not measure student confidence in their learning through any feedback mechanism. Instead, it is designed to be a passive learning exercise where the social media tool is used only for content delivery and assignment suggestion. The complete planning checklist is shown in Figure 4.

Plan	
Set Goal	Students can judge the quality of their own Moore finite state machine design.
Set Difficulty	Students must design a Moore FSM using a minimal component set.
Set Model	This exercise uses Spaced Repetition with Taxonomy Climb. It moves upward through the taxonomy levels: knowledge (K), comprehension (C), application (A), analysis (N), synthesis (S), and evaluation (E). Repetition on days: D1, D2, D3, D5, D7, D10, D13, D17, D21 Taxonomy verbs: list, describe, explain, diagram, examine, categorize, synthesize, judge
Set Limits	Private tweets to class follower group. Student collaboration tweets allowed.

Figure 4: Completed Planning Checklist for Spaced Repetition with Taxonomy Climb

The exercise is designed to last three weeks with repetition sequencing increasing from one to four days along the timeline. The instructor controls delivery and the evaluation of success is delayed until the end of the exercise when students must submit a final product for grading. The goal of the exercise is to move beyond the classroom instruction of basic machine design to an evaluative judgement about the quality of the design. This material is not presented in depth during lecture due to time constraints. The exercise progresses along its timeline of spaced repetition and simultaneously moves students upward through the different levels of Bloom's Taxonomy of Learning. The levels are listed in Figure 4 for quick reference, along with a single letter key for use in Figure 5.

Figure 5 shows the social media timeline, the taxonomy level of each tweet, and the actual tweet text-message. Some of the tweets reflect material learned in lecture. But, by the end of the exercise, the tweets have moved passed lecture content and encourage independent discovery of optimal design techniques. In many ways, this social media exercise is similar to the assignment of homework problems. A key difference enabled by the social media, however, is the asynchronous nature of tweet arrival, which hopefully encourages spontaneous thought and refreshes the cognitive learning loop of the student. Also, even though the student may be at work on something else, may choose to ignore the tweet, or may delay processing the activity until later, the instructor has caused a momentary return to the course content and perhaps encouraged the student to keep working on extending the knowledge through higher level thinking.

Timeline		
Day	**Level**	**Tweet**
D1	K	Single-bit memory elements, called flip-flops, remember one single value. List the 4 classic flip-flops.
D2	C	Describe the 4 classic single-bit memory elements. Explain why DFFs are the most commonly used type in modern VLSI circuits.
D3	A	Feedback signals from single-bit memory elements help generate the next memory value in FSMs. Diagram a Moore FSM using the most common FF.
D5	N	Feedback signals from FFs help generate the next memory value in FSMs. Examine textbook problem 5.8 and determine if it is a FSM.
D7	N	Feedback signals from FFs help generate the next memory value in Moore and Mealy FSMs. Categorize textbook problem 5.2 as Mealy or Moore.
D10	S	The size of a FSM depends on type and FF choice. Synthesize textbook problem 5.35 using all four classic single-bit memory elements.
D13	E	Judge the quality of the textbook problem 5.20 machine. Can using a different FF or using Mealy instead of Moore improve it?
D17	E	Engineers optimize speed, size, power, and cost. Justify DFF elements over JKFF elements even though the JK FSM design may be smaller.
D21	S, E	Design the smallest FSM recognizer for the code 10110111 using the best choice of FF and machine type. Submit tomorrow for grading.

Figure 5: Instructor Timeline for Spaced Repetition with Taxonomy Climb

This example uses very simple assessment planning. The instructor releases the tweets and responds to comments from students sent through standard email or Twitter replies (directed back to the instructor through the @ symbol or to the group as new tweets). There is no risk of outsider noise because the tweets are directed to a class account that only contains students that have been approved by the instructor through Twitter follower requests. Instructors must choose if they will tell students that the final tweet will provide a graded assignment. This exercise was used once during the last academic year and students were told about the graded assignment in advance. This year, a controlled study will examine the effect of telling some classes while withholding the information from other classes. Grade comparisons will be made to see if graded assignments are the only motivator for students to follow the exploratory learning path suggested by the tweets.

The exercise shows one way a low difficulty index tool like Twitter can be used to supplement classroom instruction. There are many ways to modify the use of Twitter, however, to increase the social aspect as well as the assessment complexity. The next example will illustrate by describing the collaborative creation of concept maps using Twitter.

5 Example: Collaborative Concept Mapping

The first example was targeted toward a basic engineering course and focused on students constructing knowledge potentially without collaboration. In contrast, this example uses the constructive collaboration natural in social media tools to monitor and assess students near the end of their engineering studies. The example should be assigned at the start of the last course in a multi-course sequence on embedded systems design. Thus, the students should have both a solid knowledge base as well as academic maturity. The goal of the exercise is a concept map designed collaboratively with Twitter that shows the group understanding about prerequisite topics. Concept maps are directed graphs that show interrelationships between items under study [25]. At the end of the exercise, students are assessed based on

collaborative contributions and the instructor uses the final map as a guide to reinforce weaker prerequisite material identified by the map. The complete planning checklist is shown in Figure 6.

Plan	
Set Goal	Students create a concept map for embedded systems.
Set Difficulty	Students must design a mature concept map that interconnects both structural nodes that illustrate embedded systems components with evaluative nodes that illustrate embedded systems lifecycle design.
Set Model	This exercise uses Concept Mapping. Students must use is-a, has-a, uses-a, requires-a, needs-a, with-a, guides-a, is-example, should-be, and other similar concept map arcs to illustrate interconnections.
Set Limits	Private tweets to class follower group. Students must label concept mark arcs with correct hash tags. Nodal nouns are not marked with hash tags. example tweet: A thermister #is-a sensor. example tweet: Embedded systems #need requirements.
Problem Statement	This exercise uses Concept Mapping. This week, use tags like #is-a or #needs-a to illustrate your collective knowledge of embedded systems.

Figure 6: Completed Planning Checklist for Concept Map

The level of interaction and learning is very different than in the first example. Not only will the students construct the final product actively as a team, but the instructor will also need to monitor the student progress to prevent blatant errors from misdirecting the collective work. The instructor assigns the Twitter exercise by tweeting the problem statement shown in Figure 6. The exercise is designed to last one week and the instructor timeline showing the planned tweets and interaction with the student work is shown in Figure 7.

Timeline	
Day	**Instructor Activity (A) or Tweet (T)**
D1	This exercise uses Concept Mapping. This week, use tags like #is-a or #needs-a to illustrate your collective knowledge of embedded systems. (T)
D2	Ignore exercise (A)
D3	Draw the student map, evaluate for errors, tweet correction if needed. (A)
D4	Ignore exercise (A)
D5	Draw the student map, evaluate for errors, tweet correction if needed. (A)
D6	How mature does your map look? Is the lifecycle model reflected? Is the map too small or too large? Anyone made contribution corrections? (T)
D7	The exercise is over. You will be evaluated based on your contributions. I will bring a diagram of your map to the next lecture. (T) Draw the student map, evaluate for errors, tweet corrections if needed. (A) Identify missing or weakly mapped concepts for lecture reinforcement. (A)

Figure 7: Instructor Timeline for Spaced Repetition with Taxonomy Climb

It is natural to ask why this exercise was designed for Twitter when there are on-line collaboration tools that would allow creation of visual diagrams. These tools are most effective on larger screens. By using Twitter, students can easily contribute from their mobile telephones, do not need to learn a new collaboration tool, can be easily identified by their

tweets, and are forced to update either a mental mind map or a pencil-drawn map with each new tweet contribution.

The assessment plan is reflected in the instructor timeline and shows a much higher level of instructor involvement than the first exercise. It is assumed that students will be drawing their collaborative concept map during study time. The exercise includes monitoring by the instructor every two days to ensure that the students do not expand the map with significant conceptual errors. An "encouragement" tweet is planned for day six in order to stimulate a final creative push. Finally, the instructor must identify immature concepts from the collaborative map and reinforce these areas in lecture.

6 Conclusion

Social media tools provide an important and evolving learning environment. Engineering educators should consider the benefits and risks of using social media to supplement classroom instruction. Activities based on tested educational models can easily be adapted as social media exercises. This paper provides two examples for use with Twitter. With proper lesson planning, delivery, and assessment, social media exercises can enrich the educational experience of twenty-first century students.

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