Leveraging Mobile Technology to Enhance Both Competition and Cooperation in an Undergraduate STEM Course

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Abstract In this manuscript, we discuss the use of mobile technology in a STEM course to leverage both competition and cooperation among undergraduate students. We have designed an entire course around The Google Online Marketing Challenge, which is a worldwide keyword advertising competition. A competition is an effective strategy to structure a course, is motivating for students, and provides a built-in evaluation mechanism of how the students do relative to others. However, the idea of a competition cannot be taken too far, as learning is also a cooperative event. In order to leverage both competition and cooperation, we designed a mobile app from which the students can access a location-aware and social networked learning assistance. The idea was to make the course material accessible independent of locations and make the interaction among the students possible 24×7. The students also contributed to the course by sharing material and interacted with other students' posted material via likes and comments. The student driven context collection and annotation has already improved the starting point for the course when it is taught next. There was also a notable improvement in the quality of the students' finished products. Of the 16 teams in the course, 3 teams were in the top 15 teams worldwide, with many of the other teams in the top 10 % of teams worldwide.

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Introduction

We are interested in leveraging formal competitions for learning in the classroom. By formal competitions, we refer to competitions where students from multiple universities engage in some sort of competitive educational exercise. Competitions have a built-in mechanism to measure how student performance (and the instruction provided by the professor) stacks up relative to other students. This evaluation is via external, out-of-course metrics. We also believe that these competitions are excellent resume fodder for the students as they enter their professional careers, provide feedback for the institution (e.g., one can say one's instruction is good but competitions are external metrics for assessment), and may be good vehicles for academic–industry collaboration.

Prior Research

Universities want to offer, and college students expect, stimulating and innovative educational experiences in order to maintain student interest and also create worthwhile classroom engagements (Elam and Spotts 2004; Matulich et al. 2008; Ueltschy 2001), which student competitions provide.

Learning research supports the use and benefits of such student competitions, (Shindler 2009) and this finding is confirmed by our own experiences in The Google Online Marketing Challenge which is a worldwide keyword advertising competition. For example, studies have found that simulated play relates positively to exam scores (Wellington and Faria 1991). The researchers concluded that multiple choice exams measure recognition of basic concepts and principles, but simulation develops student decision making skills.

Leveraging advertising and marketing concepts to enhance decision making skills helps prepare students for job market expectations (Gillentine and Schulz 2001). Although simulations are also beneficial, extending the classroom experience from simulations to competitions, such as The Google Online Marketing Challenge, adds the benefits of real world applications, industry standards for evaluating students, and compelling learning experiences that are anchored in an industry context. Gentry (1990) argues that working with live businesses is a prominent pedagogy because of its strong learning potential and value as an experiential learning activity. Finally, a major objective of most university programs, especially in the STEM fields, is to ensure that graduates enter the workplace prepared to succeed.

Therefore, classroom experiences, such as The Google Online Marketing Challenge, that are as similar as possible to experiences of the professional world will benefit students through hands-on experiences, professional competencies, and critical skills (Hawes and Foley 2006; Rundle-Thiele and Kuhn 2008; Stern and Tseng 2002). For example, a survey of students that competed in Students in Free Enterprise and American Advertising Federation National Student Advertising Competition found competition benefits, including positive experience,

emotional attachment to the university, and significantly better learning relative to other project-based classes (Stutts and West 2003). Likewise, students competing in a robotics competition gave the course much higher ratings than the department average with only slightly above average ratings on work load (Murphy 2001).

This prior research on the use of competitions provides both motivating examples of how abstract concepts transfer to practice and meaningful assignments and projects. Competitions also seem to enhance education by benefiting at least three constituents: students, industry, and educational institutions. The real world and practical education of competitions give students lifetime benefits such as entrepreneurial skills, self-confidence, risk-taking propensity, access to mentors, and networking opportunities (Russell et al. 2008). Educational institutions also gain strong community and industry links, which can result in student employment and research opportunities, which also benefits industry.

Personal Experiences

The increased discussion in both popular and academic outlets concerning the return on investment of a university education has put pressure on educators to make the business case for a college education. Although some of the return on investment discussion may be hype, a positive outcome of the discussion is a shift in classroom focus from *what do you know* to *what can you do?*

We have effectively used competitions in several courses to focus the learning process on a measureable outcome (i.e., the competition becomes the vehicle for the learning). Through teaching and research experiences, we have found that competitions are an excellent way to demonstrate competency in a given area and in a measureable way (e.g., *My student team competed in [competition] against [number of other student teams] and placed 1st.*). Competitions also move the course experience from a *talking-head passing out information via a lecture followed by a shallow assessment* to one of an *application of classroom knowledge in a real or near-real world setting* with the professor as mentor, coach, and consultant.

Our concept of competition in terms of the outcomes shifts the focus from *doing well on a test* to *demonstrating competency* and *evaluating performance against assessment criteria* that are many times external to the classroom and individual instructor.

Personally, we have found that competitions encourage students to place increased value on the outcome of the learning effort, which immediately addresses the question that students many times rightfully ask, *Why am I learning this?*.

A potential concern about competitions in the classroom is that it may detract from the cooperative nature of learning. Our experiences have shown us otherwise. With a defined outcome, the students are more cooperative, more willing to share, and more engaged in everyone doing well.

One particular competition that we have effectively engaged in is The Google Online Marketing Challenge.

The Google Online Marketing Challenge

Sponsored search is one of the most financially and impactful innovations on the web (Jansen 2011; Jansen and Mullen 2008). Sponsored search provides the revenue base for major search engines such as Google, Baidu, Bing, and Yandex, as well as many online businesses that rely on traffic driven by pay-per-click (PPC) platforms.

Introduced in 1998 by Overture (which was later acquired by Yahoo!), the sponsored search model impacts search engines, consumers, and organizations. Sponsored search provides the revenue stream that supports the massive and expensive infrastructure current search engines need to crawl billions of webpages, index those documents (including text, images, videos, newspapers, blogs, and audio files), process millions of user queries, and present billions of result links. Without the financial resources provided by sponsored search, it is doubtful that the major search engines could finance anything close to their current infrastructures which provide these free search services to millions. Keyword advertising is critical as a revenue source for the major search engines and appears to be their major business model for the foreseeable future.

Sponsored search technologies, as well as user reactions to them, are complex (Jansen et al. 2007); however, the primary goal of these technologies is to serve relevant ads in front of potential consumers. Therefore, sponsored search platforms provide the mechanisms for businesses to develop advertisements and link them to query keywords that potential customers submit to the search engine.

The Google Online Marketing Challenge (Flaherty et al. 2009; Jansen et al. 2008, 2009b), is a global competition where students work with small to medium sized enterprises (SMEs) to implement a successful online marketing campaign using Google's keyword advertising technology, AdWords. By participating in the competition, students learn critical online marketing, online advertising, and technical skills, including how to maximize targeted traffic to a client's Website. Working in teams, the students employ marketing techniques to refine and improve the effectiveness of their AdWords campaign over a 3-week competition period.

With the focus being online marketing, the Challenge introduces the students to one of the most important and fastest growing sectors in online marketing communications (Rosso et al. 2009). Unlike simulations or fictitious student competitions, the Challenge uses a real SME, a real advertising platform, and real money. The Challenge is a problem-based learning (PBL) approach, whereby student teams engage in facilitated, self-directed learning to solve a complex problem with no single correct answer (Hmelo-Silver 2004).

PBL encourages the development of flexible understanding and lifelong learning skills as "students become reflective and flexible thinkers who can use knowledge to take action" (Hmelo-Silver 2004, p. 261). In the Challenge, students are engaged and active learners involved in an online marketing campaign, facing real pressures similar to those in the professional workplace (i.e., technology issues and changes, client relationships, financial constraints, market competition, and time limitations). Throughout their campaigns, the students continually make finance, advertising,

advertising, technology, and marketing decisions. As such, the Challenge reflects the professional work environment within a PBL educational framework.

There are four key phases to implementing the Challenge in a course:

1. **Recruit SME**: Once students are formed into groups, the students select a team leader. Next, the students recruit an SME (i.e., business, governmental, or nonprofit) with under 100 employees, that has a Website but does not currently use Google AdWords for their team. To guide students, Google's Student Guide includes a section titled "Selecting and Working with a Business or Organization." Once a suitable SME is found, the students present a Letter to Business that explains the Challenge and what SMEs can expect from participation. SMEs simply need to agree verbally that the students may promote their Website using Google AdWords.

2. **Develop Pre-Campaign Strategy**: The student team works with the SME to understand their goals, and the students then structure an online marketing campaign that is documented in a Pre-Campaign Strategy report. This short report contains a client overview and proposed AdWords campaign strategy covering criteria such as keywords, text advertisements, budgeting, and geo-location targeting. The team than uploads the Pre-Campaign Strategy report to the Challenge Website, as well as submit it to their instructor.

3. **Establish AdWords Accounts and Run Campaign**: Students set up the basics of their AdWords account and receive an advertising voucher for the Challenge. During a 3-week Competition period, the students implement their proposed campaign strategy, review their results frequently, run reports, and adjust their campaigns accordingly.

4. **Develop Post-Campaign Summary**: Upon completion of their campaign, students evaluate the campaign, document findings in a Post-Campaign Summary report, upload the Summary to the Challenge Website, and deliver it to their client and instructor. This report addresses how well the students researched their client, provided a reasoned AdWords strategy, and learned from the competition experience. The report includes an industry component, a learning component, and encourages the use of tables, figures, and charts to illustrate campaign results.

Google employees and then a global panel of academics judge the entries, with teams competing for one global and three regional prizes. The Challenge employs a multi-level approach involving an algorithmic evaluation of the students' campaigns, followed by a qualitative campaign evaluation, and then an evaluation of the two written reports. First, Google algorithmically judges each team's campaign statistics such as account impressions, cost-per-click, click-through-rates, keywords, ads, budgets, and more. The proprietary algorithm assesses five aspects of account performance: (1) account structure, (2) optimization techniques, (3) account activity and reporting, (4) relevance, and (5) performance and budget. Based on the algorithmic evaluation, Google trims the thousands of teams to 150 teams.

Next, Googlers manually winnowed these 150 teams to 15. In the final phase, an academic panel of more than a dozen professors selects the eventual winners based solely on the teams' two written reports.

Use of Mobile Technology

Although the students compete against each other in the Challenge, learning is also many times a corporative endeavor (Ocker 2007). Our personal experience has been that, although teams are competitive, the students still desire to see all do well. To facilitate this cooperation aspect, we designed a mobile app to assist the students in both the competition aspects as well as the cooperation aspect of the course. Our experience has been that the use of technology in the classroom can be an effective tool to achieve specific objectives (Jansen 1997; Jansen et al. 2009a; Smith et al. 1999).

Benefits of Mobile Technology in the Classroom

Other researchers have also noted the benefits of mobile technologies. For example, Farooq et al. (2002) enhanced the existing PC based online learning community to a handheld device based community. The enhanced version of the MOOsburg application allows the students to participate in a community education program on ecology and share the findings with their peers via a chat feature-utility of the system.

The use of mobile technology, with its access anywhere and at anytime capabilities, has many educational benefits. The online course materials for many courses are fairly static. The instructor organizes the classroom notes, prepares the presentations, creates activities, sets the assignments, and checks them manually. Once the course is established, it remains fairly unchanged throughout the entire semester, which is a disadvantage from the teaching and learning perspective for both the teacher and the students, as the course's content cannot change based on the current student community.

Mobile App for the Challenge

The mobile app concept for the Challenge course involves "moving off the desktop" to develop course based learning assistant apps that leverage cellular technology and attributes of mobile platforms and social media (i.e., access to peers, creation and exchange of ideas and rich media within peer networks).

Using this approach, students can (1) access the course materials through smartphones, iPods, iPads, etc., when and where they need the materials; (2) post queries or announcements that can be viewed and commented on by the members of the peer group of that particular course; (3) the instructor can upload files and prepare pages that contain extra information relevant to the course in response to changes in course topics or in response to student inquiries; (4) the app can generate an alert to the peer group once any information is updated; (5) the interface can support different tools that are relevant to the course; (6) the app can collect user responses from the social network. Those responses can be used as a knowledge repository that in turn may be utilized for quantitative and qualitative analysis.

Using these concepts as guidelines, we developed a web app. We implemented it in a face-to-face course where students learn about keyword advertisement campaigns and work on related projects in teams for The Google Online Marketing Challenge. As this course is a specialized course, the students needed to be introduced to many tools that marketers use in their profession. Therefore, the web-based application integrates the necessary tools such as Google AdWords, Alexa, and Geoselector to ensure that students access them and can choose the one(s) most relevant to their project needs.

We also have incorporated a social network application (i.e., Yammer) where a dedicated group is formed for this course, and the students can share their views and information by uploading/downloading related artifacts, publishing questions, posting solutions to the problems, or providing feedback. The use of Yammer within the mobile app creates a collaborative e-learning framework to support collaboration among a society of peers (Jansen et al. 2009c), using social interaction to support and enhance the learning of its members. It also facilitates an online conversation among the students and between the students and the professor (Carroll et al. 2012).

We developed the user interface of the app using HTML5 and JavaScript. These languages are the basis of modern web sites and web applications, and they can be interpreted and executed by any contemporary web browser, including those on desktop or mobile platforms. We chose HTML5 and JavaScript for designing the interface as this did not require students to possess any particular mobile platform.

Each URL for the application contained in the app is represented as an image icon of size 80×80 pixels. The GUI contains nine such images. Distribution of the app only requires the most basic of web hosting, technology that most institutions already have in place. This results in a very low to no cost for distribution of the app.

Figure 1 shows the display of the GUI for the app generated by the HTML5 code in the desktop.

Apart from the desktop, the app can be accessed from handheld devices. Figure 2 exhibits the display of the interface on smartphone and iPad.

To organize the sponsored search campaigns students have to be well informed about Google analytics. Student peers upload related material in Yammer that could assist students in gathering the pertinent information, as shown in Fig. 3.

Outcomes and Conclusions

In this research, we focused on three main issues in the classroom, which are the use of competitions in the classroom with cooperation enhanced by mobile technology.

Our app leverages the social network attribute of mobile technology for the students to provide their feedback on the course material designed by the instructor. The mobile app also facilitates the procuring of extra course information that could not be covered in the semester in the classroom. While teaching a course, an instructor designs his/her artifacts accordingly, but there are issues that are typically associated with the course that cannot be predicted beforehand. The issues can be related to specific terminologies or may concern questions raised by students during a
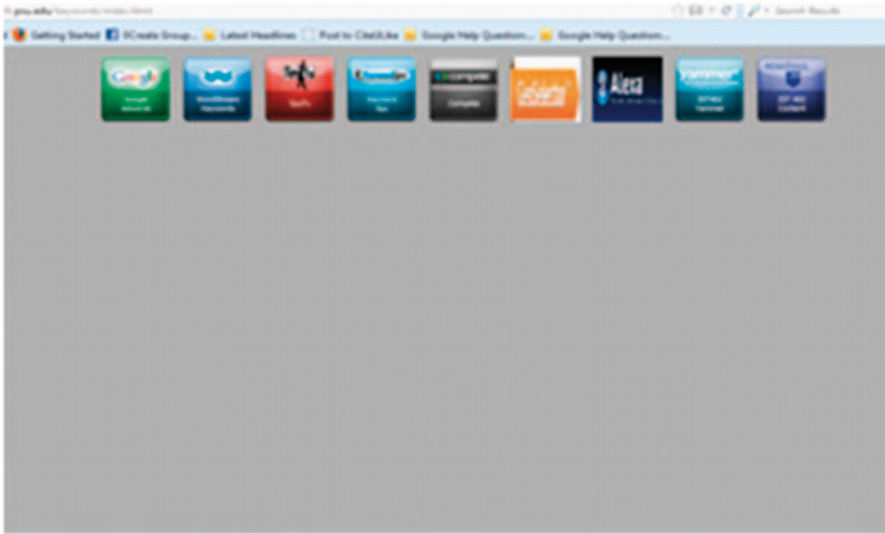
Fig. 1 Mobile App GUI displayed on the desktop with associated tools accessible by the students

Fig. 2 The App interface displayed in iPad and smartphone

particular lesson. As a response to those issues, the instructor can select extra materials that are uploaded to the server and accessible by the students via the mobile app.

In the conventional classroom context, the scope for discussion or publishing information is limited. Either the teachers avoid these additional issues because of time constraint of the class or materials addressing these topics are not immediately available. Our mobile app provides both the course link and the enterprise social
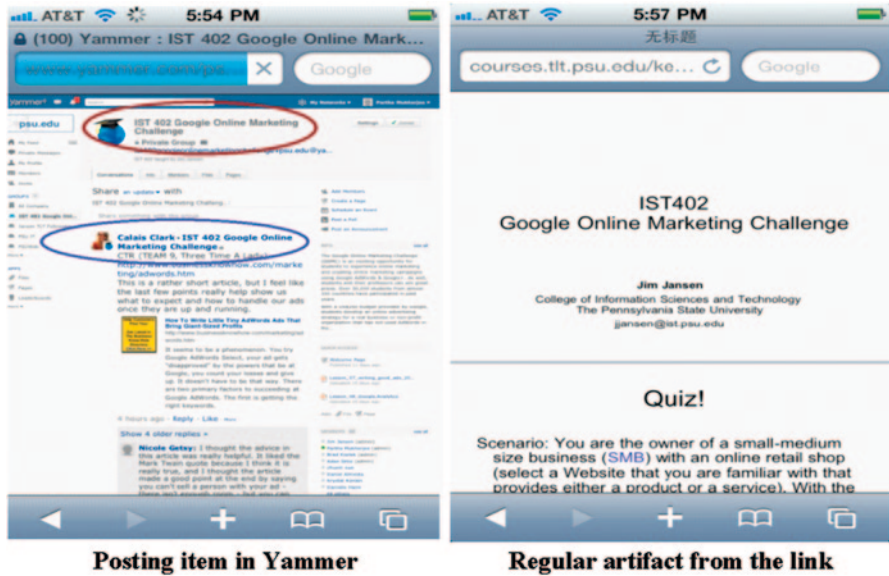
Fig. 3 Snapshots for using Yammer and access of regular course material

network (Yammer) where the instructor (or students) can upload material, and the student can access outside of the confines of the lesson.

The mobile app also encourages collaborative learning, even within the context of a competition. We developed our mobile app containing various web tools that help the students to learn the course material, along with a social network based discussion forum where all the peers share their insights and other information related to the course. The students have a 24/7 an online collaborative environment that utilizes the social attributes of the technology to enhance the cooperative learning, all during a competition.

Our use of the mobile app has had positive benefits. There was also a notable improvement in the quality of the students' keyword advertising campaigns and written reports. Also, of the 16 teams in the course that participated in the Challenge, 3 teams were in the top 15 teams out of more than 4,000 teams worldwide, with many of the other teams in the top 10 % of teams worldwide.

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