Submitted to EEE'13 - The 2013 International Conference on e-Learning, e-Business, Enterprise Information Systems, and e-Government, Las Vegas, NV, July 2013

Android Exchange (AEx) - A Virtual Community for Students on eTeams

Ravi Shankar, Professor, Computer and Electrical Engineering and Computer Science, College of Engineering and Computer Science, FAU, Shankar@fau.edu

Fran McAfee, Associate Professor, School of Communication and Multimedia Studies, College of Arts and Letters, FAU, mcafee@fau.edu

Michael Harris, Associate Professor and Chair, Anthropology, College of Arts and Letters, FAU, mharris@fau.edu

Ravi Behara, Associate Professor, Information Technology and Operations Management, College of Business, FAU, rbehara@fau.edu

James Fowlkes, Director, Director, Instructional Design, Center for eLearning, Academic Affairs, FAU, jfowlkes@fau.edu

Common Mailing Address:

Florida Atlantic University, 777 Glades Road, Boca Raton, FL 33431

Corresponding Author:

Ravi Shankar, shankar@fau.edu, (561) 306-5625

Keywords: e-Learning, Design and Methodologies, Virtual Learning Environment, Team Projects, and Open-source Platform

Submitted to EEE'13 - The 2013 International Conference on e-Learning, e-Business, Enterprise Information Systems, and e-Government, Las Vegas, NV, July 2013

Android Exchange (AEx) - A Virtual Community for Students on eTeams

Abstract: A group of faculty members from engineering, arts, anthropology, and business have jointly taught courses (for 3 years) on smart phone App development to undergraduate students. The students with academic background in these disciplines have come together to form teams and to develop unique smart phone Apps. Industry professionals from these disciplines evaluated these projects.

An eLearning version of the joint course was taught recently. Android Exchange (AEx), a virtual community environment, is proposed here to build on that experience and on existing social and professional networks to connect participants with peers, mentors, professionals, and businesses for mutual benefits of learning, collaboration and jobs. This may also help with retention, motivation, recruitment, and scaling. AEx is enhanced by developing four other open source learning tools, for (1) learning and project asset annotation, (2) intelligent asset and web search, (3) video profiles of team partners, professionals and projects, and (4) team (learning, project and social) management skills.

I. Background: NSF defines cyberlearning as the use of networked computing and communications technologies to support learning (NSF 2008). They use the term 'cyberlearning' to evoke both cyber-infrastructure technologies and theoretical connections to cybernetics. This NSF taskforce poses the question: Why cyberlearning and why now. They conclude that few teaching innovations from the past have resulted in large-scale systemic changes in education. The perceived value is also shifting from products to solutions to experiences. "Today's learners live in that online experiential environment; today's schools do not." Design based research (DBR) into learning, a practice-based research methodology, has come a long way in the past decade to address this (Anderson and Shattuck 2012). We are integrating both the cyber-infrastructure and the learning sciences into a sustained and engaging environment. We mentor student teams across multiple disciplines that make up a typical authentic (or real-world) project team; this addresses yet another national need – to cut across various disciplines and educate students who can productively function in a 'multi-cultural' environment. Our team projects focus on the development of smart phone Apps, thus incorporating another global trend in the increasing use of smart phones and the consequent potential for jobs and business start-ups. We are also building similar infrastructures in other areas. See Robotics (2011) and Semantic Web (2011). We also almost exclusively use open source tools, thus providing for portability and scalability. App marketing in niche areas and the benefit of long-tail marketing (Brown & Adler 2008) will aid program sustenance.

II. Infrastructure For Android Exchange (AEx): Over the past three years, we have developed a mobile App development infrastructure at our university that spans multiple colleges and disciplines (Android 2010, Shankar et al. 2013b). About 450 students from grade 10 to the graduate level (and beyond) have been involved in team projects in developing marketable Apps, with each team representing strengths in arts, engineering, business, and content as appropriate. Certification in eLearning and a joint summer eLearning course (with only arts and engineering students) has given the first two co-authors experience in managing such team efforts online. We have also identified areas for further improvement, with authentic learning (Lombardi 2008), team management, peer networking, and tailored access to relevant material; these will be incorporated in our proposed socio-technological solution, as follows: we will develop a virtual community (a tool) called Android Exchange (AEx) of students, professionals, and small and large businesses, and connect them for mutual benefit of jobs, collaborations, and /or consulting. This has the potential to facilitate our eLearners in multiple ways. This will (1) improve learning effectiveness, (2) provide an opportunity for social and professional networking, and (3) address the issues of scalability, usability, sustenance, and portability, essential for widespread adoption.

Some of the AEx environment is built with loose coupling to existing tools for (1) Learning management systems (LMS), (2) Social and professional networking, (3) Team collaboration, (4) Assessment, and (5) Video Conferencing. Most tools are available free or at low cost. Our goal is to utilize these resources and supplement them with the missing pieces to help the eTeams thus: (1) Find information quickly at the right granular level, (2) Be motivated to achieve at a high level, and (3) To find partners, experts, mentors, and job providers, during the various phases of this course, program, or later as a professional. We will develop AEx as well as the following new open source tools and integrate them with AEx: (1) Annotator (**ANT)**, (2) Semantic search engine (**SSE**), (3) Video archival **(VAr)** tool, and (4) Team Quality Control (**TQC)** plugin. We will track the usage processes and automate later (with a Meta tool) to reduce costs. To develop our five tools, we will use open source tools, such as Eclipse for software development, Eclipse Modeling Framework for auto code generation (Shankar et al. 2013a), and Jena for semantic web (Islam et al. 2012, 2013).

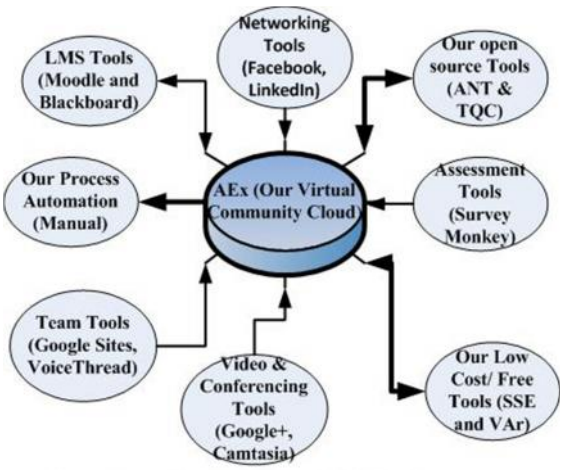

Figure 1: AEx and its associated tools (from others or our own).

III. Current Teaching Flow: We have taught joint courses (for engineering and arts students) since summer 2010, at high school, undergraduate, or graduate level. Here we document our recent efforts at wider collaborations, with undergraduate students and faculty from four disciplines of business, arts, sociology/anthropology, and engineering (BASE), and migration to eLearning. In spring and summer of 2012 we designed and taught these expanded courses. Each of us taught relevant material pertaining to our respective disciplines, then brought students together (after a mid-term summative exam to ensure that the students could contribute productively) to form cross-disciplinary teams to build mobile Apps. See the syllabi at eTeams (2012). The courses were on (1) software and system development for smart phones (for engineers), (2) animation and graphics for mobile applications (for artists), (3) App design and project management (for business majors), and (4) directed independent or research study (for anthropology majors). The first course emphasized a software component-based top-down system design approach for App development. The second course dealt with tools for asset (graphic and animation) buildup, and the aesthetic aspects in mobile application design. The third course focused on business theories, marketing strategies, project management, and work breakdown. The fourth course advised anthropology students on research methods to observe, document, and advise the project teams. Students met regularly, separated by disciplines, and a few times together, during the class hours. They were encouraged to meet outside the class with their team members from the paired courses. The hope was to mix visual artists, analytically minded engineers, and venture-oriented business students together in small teams to catalyze innovation, with anthropology students as ethnographers.

By mid-semester, the students presented their project ideas and got to work creating the applications. The combined team first had two week-long common project assignments: (1) story-boarding of their App, and (2) technical mockup. The student teams made presentations to the professors face-to-face (F2F) or online and were given feedback on technical, artistic, and marketing feasibility, similar Apps, and useful links. After that they had three additional week-long project assignments, on (3) discipline specific development, viz., of software components, graphic assets and marketing plan, (4) integration and testing, and finally (5) a portfolio presentation to BASE professionals to evaluate these Apps. The team presentations included a slide presentation, a marketing video, a live phone demo, etc. (Videos 2012). To sum it all, there was frustration and misunderstanding, but most teams managed to deliver a good App. To quote an anthropology student, *"oh, how the forced relationship can make a wonderful experience."*

eLearning Facilitator Certification: The three teaching professors on this team have undergone an intensive semester long eLearning designer and facilitator certification at our Center for eLearning (CEL). This qualified us to teach the eLearning course last summer. CEL (2012) fosters the "pedagogic integration of technology into the design of teaching and learning processes through collaborative efforts with faculty and other instructional technology personnel. It is where teaching, learning and technology intersect to meet the rapidly changing educational, social and economic environments in today's global society." The eLearning course used backward design of Wiggins and McTighe (2005) and assessment techniques based on Angelo (1993), Dunn (2004) and Mueller (2005). It had us design our *summer joint course* as a class requirement and covered the following topics: manage the various LMS tools and functions; explain the basics of instructional design; apply policies and procedures appropriately; create learning objectives; create, manage, and maintain assessments; maintain standards and organization; manage course content and delivery; create, manage, and maintain learning activities and assessments; create, manage, and maintain communication; plan and facilitate active learning within a course when appropriate; evaluate an eLearning course based on a designated course evaluation rubric; and present to colleagues the key components of our designed course. Fowlkes (2007 and 2010), one of the co- authors on this paper, and Orozco et al. (2012) designed and taught this course.

Role of Embedded Anthropology Students: A central issue with regard to new pedagogical and workplace formations that count the web as their primary modality is: how are ordinary F2F interactions, upon which local culture is built, transformed and adapted to internet-based interaction? While the obvious social fact is the proliferation and active involvement of individuals in myriad social groups across the web (Kelty 2005), there appears to be a dearth of information concerning how individuals interact in the course of workplace team activities in the electronic realm (Mackey and Jacobson, 2011).

During spring 2012, anthropology majors joined other undergraduate students to form BASE teams. Their role was that of social observers of team dynamics. They observed the team dynamics and cultural interactions, and also provided content. The research brought to light a number of hurdles to overcome in the formation of interdisciplinary teams. Foremost among them was the coordination of activities and this coordination ramified from the top level (the professors) to the bottom (the students). The creation of teams depended greatly on communication between the interdisciplinary professors, on coordinating activities in such a manner that each individual discipline was proceeding in a manner that recognized the parallel work of others. We now are actively developing a joint timetable to address this (eTeam, 2012). Especially problematic, though, were the types of activities that students themselves developed for working through application, process, and design issues. Each small group appeared to understand the end product and their role (as programmer, graphic designer, or marketer), but each was uniformly bereft of knowledge or skills for working together in a coordinated, team-centered manner. We are developing the TQC tool to address such issues.

The challenge is the resolution of these issues. The summer online course incorporated many of the recommendations from the embedded anthropology students; but more coordination problems ensued because of the eLearning dimension. For example, the student count dropped from 60 to 30 even before the first lecture. We may have overwhelmed the students with information at the Blackboard site. We will track such students now on and determine how to improve. The remaining 30 stayed with the course and completed their team Apps satisfactorily. Some advantages were also gained, for example via the 'lab' hour concept (see above).

IV. Technology Implementation: The AEx Tool (Figure 1) will loosely couple with many existing tools (that is, accept their outputs in a portable format), but will integrate well with our four other tools. The first author has earned a Sloan-C certificate on "Web 2.0 tools to improve learning." Bovard (2012), the course teacher, cites at her site the following criteria in deciding on the right web 2.0 tools: (1) the tool should support your course's learning objectives; (2) Apply the following web 2.0 technology selection objectives to narrow the search space: access, usability, privacy & intellectual property, workload & time management, and fun factor; and (3) Apply one of the following to map the tools to the objectives: Sloan-C's Five Pillars (Sloan-C 2012), Swan's list on interactions and learning in online environments (Swan, 2004), or Chickering and Elhrmann's Seven Principles (1996). Swan (2004) lists research findings and their implications for practice in three different interaction categories, with (1) content, (2) instructors, and (3) classmates. We list below their mappings to AEx.

Research Finding	**Implications for Practice**	**AEx Mapping (and Tools to be used)**
Online learning better for divergent thinking (vs. F2F)	Open-ended questions	Choose among Quiz questions and the semester long project (via Blackboard)
Online learning worse for convergent thinking (vs. F2F)	Have written assignments, group collaboration & self-testing (Lorenzo 2006).	For final report use Team Wiki (via Google Site); and Small intra-disciplinary groups for the quizzes & Weekly Self-assessments (Via Blackboard)
Teaching presence is linked to student learning	Enhance design & organization, discourse, and instruction	Good video tutorials (via Camtasia), Interactive (VoiceThread)* slides, and recorded lectures (via Blackboard)
Teacher & student Interactions linked to student learning	Provide timely & supportive feedback	The embedded anthropology student will help the team and provide alerts to faculty members. This research focus will lead to best practices and an automated TQC tool.
Ongoing assessment and immediate feedback helps much.	Automate testing & feedback when possible	Use Blackboard tool for this purpose. Allow students to retake the test to score a minimum. Randomize question selection.
Learning occurs socially within community of practice	Design community building activities (Sloan-C 2012)	Teams will learn from each other via Wikis, TQC, and feedback at Wikis provided by judges and professors. Use ANT and SSE to seek content or a contact.
Verbal Immediacy behaviors may reduce the psychological distance	Encourage Students to share experiences (Sloan-C 2012).	Grading will occur on an absolute scale, so the teams do not compete with each other. Team Wikis will be graded for helpfulness.
Learning is related to the quantity and quality of on line discussions.	Develop grading rubrics for discussion participation (Sloan-C 2012)	See above about Team Wikis. The Rubrics will be developed with the help of the instructional designers
Vicarious interaction in online course discussion may be important for learning.	Require discussion summaries. Use human tutors when possible. (Sloan-C 2012)	Each team will summarize their Wikis every week and send as RSS feeds. Each student will reflect on their App revisions and team development for a grade.
Flagging of unread notes helps with motivation	Explore new interfaces (Rheingold 2010)	Provide a mini schedule page which lists the deliverables, due dates, grades, and instructor comments.
Eliminate irrelevant elements and on-screen text	Present words in spoken form. Use both words and pictures simultaneously.	VoiceThread may be useful for this. Need to explore further.
Better learning occurs when the presentation is organized and learner-controlled	Help the student pace the presentation by better organization of concepts	Both VoiceThread and Blackboard provide this ability.

* For use of VoiceThread, see (Burden & Atkinson 2008, Shankar 2012).

Blackboard community provides somewhat similar functionality, but AEx site will capture knowledge, share files, and manage projects, while being available on the web, for immediate 360^{o} feedback with alerts, responses, and RSS feeds (Dziuban 2008).

We will now discuss the four additional tools:

(1) Semantic Search Engine (SSE): An Internet search using any of today's popular search engines may return thousands or even millions of results for a given set of keywords, with only a few of them relevant. The user may have to repeat the search with different keywords. In an academic environment, this process wastes time and hinders productivity. There is thus a need for an application which automates the process of obtaining relevant results from Internet searches. We propose to develop a system that has the necessary intelligence to locate only those online documents that are relevant to a given user's needs. Students learning Android (2012) App development will use SSE to customize searches for information related to their development projects. Google's Android site is Google-search based and lists every conceivable link, which is often daunting to search through. Further, there are other useful online sites (including ours). Our tool will integrate all such sites. No static search method will suffice, since this is an ever expanding field, with releases of newer versions, technologies and fixes.

Our search methodology addresses the limitations of conventional Internet searches through the use of domain ontologies, reasoners, user profiles and a web crawler. See Figure 2. An ontology is a graph of the relationships between terms that are relevant to a particular topic. A reasoner is a program which interprets these relationships to find terms related to a specified term. To assist in searches for information related to Android App development, the methodology defines domain ontology with terms of general interest to Android users and programmers. The user creates a user profile as a second ontology to help the search engine find the right type of information to meet the user's particular needs. The benefit of utilizing ontologies is that they are easy to customize. The Web Ontology Language application programming interfaces (OWL 2012) enable the search App to access and modify the ontologies as needed. The reasoner checks the validity and consistency of the ontologies after each modification. Once the ontologies have been sufficiently customized, the user selects search terms from the domain ontology and the user profile. The Reasoner adds terms in the ontology that are related to the terms the user selected. The Web Crawler engine then uses the terms to search exhaustively through online databases that are related to the topic. The engines generate search results, and the reasoner sorts them by relevance to the user's needs, taking the user profile into account. Thus, our methodology can obtain valuable results that might otherwise be missed, discard irrelevant results, and rank the results in order of interest to the user. We have applied this methodology to the creation of a desktop App for diabetes management (Islam, et al., 2012). We organize both the domain ontology and the user profile ontology as two-level lists (Horridge 2011). The domain ontology consists of 'categories' of terms ('keywords') related to Android development. The user profile ontology is divided into 'parameters', each of which may have one or more 'values'. The user may select any desired combination of parameters, values, categories and/or keywords.

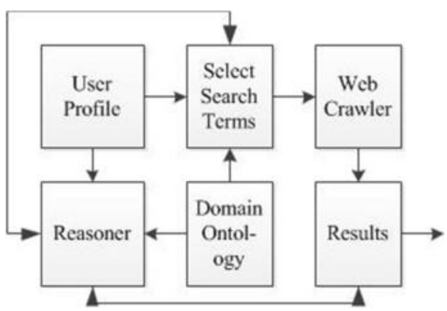

Figure 2: Search Methodolgy

(2) Annotator (ANT) Tool : Fishman et al., (2004) develop a framework to address usability, scalability, and sustainability that is typically lacking in DBR studies. We add one more, that of portability, given that there are multiple learning management systems (**LMS**). diSessa and Cobb (2004) recommend ontological innovation in which scientific terms must "cut nature at its joints," that is, they must make distinctions that truly make a difference, ignore the ones that are inconsequential, and enable explanations of interesting phenomenon. "We must develop theoretical constructs that empower us to see order, pattern, and regularity" in these complex settings of learning. Chi (1997) provides an eight step objective and quantifiable segmentation process, for verbal data such as explanation, interviews and protocols. These can also be used for gestures and videotapes, as with our archived App videos and conferencing sessions. We will first develop a taxonomy for granular tagging of the App assets and artifacts that we have already accumulated over the past three years. All future student teams will be expected to submit their material with proper tagging. The tool will facilitate this process. The tool will provide a good UI and an XML-based database for archiving and accessing all these entities.

(3) Video Archival (VAr) Tool: VAr will be developed to tag and search videos, created by student teams, professors, and professionals. The videos may be bio sketches, tutorials, lectures, App tear downs, business and professional profiles, team App presentations, App promotional videos, and interviews of teams and professional judges.

(4) Team Quality Control (TQC) Tool: Technological enhancements will require a strong backbone built from anthropological work. We call it "electronic ethnography" which is applied to undergraduate Android App development teams. The ethnographic method is built on firsthand observation and interaction with subjects, what anthropologists refer to as participant observation. Trained anthropology undergraduates will join Android teams. Their primary role is that of electronic participant observer (EPO). EPOs will focus their observations on communication strategies, the development of team member roles, and attempt to come to an understanding of the individual team dynamics. Traditional anthropological methods of participant observation (Spradley 1980, Schensul et al. 1999, Pelto and Pelto 1970) were developed in the context of personal F2F interaction; we will put them to use in the electronic domain. Textual interviews and communication between students will be the primary research modality; Skype, Google+ hangout, and Blackboard Collaborate tools for web-based meetings will also be used as opportunities for participant observation. Records of team interactions will also be tagged and archived for further research. Due to the small-size teams, these anthropological methods are workable; methods will include open-ended questioning/interviewing and analysis of archived data.

Text mining research will be a top-down approach; it will complement the bottom-up approach cited above. This will involve the development of a text-analysis based solution to mine relevant unstructured (natural language text) data from the team. We will use existing open-source text mining tools. Similar to business information (Grimes n.d.), much of team communications will be found in unstructured contexts in the form of natural language text, viz., blog and wiki postings, video conference notes, discussion forums, audio and email or text messages to teammates, and assignment submissions. This raw and unstructured text is structured through patterns and trends such as statistical pattern learning. Some of the task are: classifying text documents, analyzing syntax, identifying relationships among documents, understanding questions expressed in natural language, extracting meaning and sentiment from messages, and summarizing them. See Fig. 3.

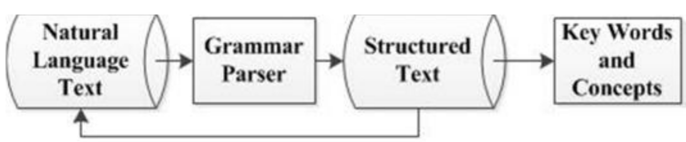

Figure 3: Natural Language Text Mining

Natural language processing (NLP) is used to parse unstructured natural language text using grammatical rules that mimic human communication. This converts it to structured text for further analysis. Key words and concepts can then be extracted from the structured text (Miller 2005, Behara 2007). Text mining has also been used in education to reveal valuable patterns in students' learning behaviors in a technology environment, and help develop solutions to improve their learning experience (Abdous and He 2011, Yu et al. 2011). Ming and Baumer (2011) used it to discover meaningful patterns in online discussion and thereby improve learning through appropriate facilitation styles. We will apply text mining to develop the TQC tool where students can access related (and relevant) information to help in their specific project. We will build a database of Frequently Asked Questions (**FAQ**). TQC will search for such terms in student text (at their wiki site, emails to faculty members, etc.), search the FAQ database and send appropriate responses to the initiator. The tool will also generate alerts to professors for course queries/comments, or to the graduate students for any new terms, so appropriate action can be taken. TQC will also use ANT and SSE, initially for local searches.

IV. Discussion: We discuss briefly the theoretical, technical, and big data perspectives. Expected outcomes and effectiveness metrics are not addressed due to lack of space.

Learning Theories: Barab and Squire (2004) describe **DBR** as a learning science that is interdisciplinary and draws on multiple theoretical perspectives and research paradigms which will potentially lead to understandings of the nature and conditions of learning, cognition, and development. The authors remark that learning, cognition, knowing, and context are irreducibly co-constituted and cannot be treated as isolated processes. DBR focuses on understanding the messiness of real-world practice, with context being a core part. Participants are not “subjects” assigned to treatments, but instead are co-participants in design and analysis. Thus DBR has a pragmatic philosophical underpinning. “The focus on advancing theory grounded in naturalistic contexts sets DBR apart from lab experiments or evaluation research.” DBR pioneers Collins, et al. (2004) discuss Herbert Simon’s research in 1960s, to show how both engineering and education are design (or ‘artificial’) sciences. Both have lacked rigorous theories. However, since those early days, systems engineering has developed approaches to achieve optimal (not the best) design for a complex system, given a multitude of dependent and independent variables. They use a systems engineering perspective in developing an optimized framework for learning, while also providing for both formative and summative evaluations. We will apply our systems expertise here to good effect (CSI 2012).

Technological Solutions for Learning: Sloan Consortium’s effective practices site (Sloan-C, 2012a) show-cases technological approaches, often leading to new tools that have proven effective in enhancing learning. In *Peer-led eTeams* Varma-Nelson, et al. effectively replicated the face-to-face (**F2F**) interactions of live class teams, with the aid of web conferencing software; Hubble enhanced peer learning with student groups contributed notes for a chapter and questions for another chapter; Ice et al undertook top-down *semantic analysis* for the business curriculum. It provided for robust content repositories that have granular associations between course components and over-arching ontologies. This improved consistency, made the knowledge accessible at the right granular level, and aided with accreditation; Sener raised the quality of presentations with the requirement for electronic *peer review*; Sax and Colle formed a *common online learning community*, providing for supportive interactions among students, mentors, and instructors; and finally, SUNY researchers (Shah-Nelson & Miller) developed an online help portal that can put a student in *direct contact* with people and resources using mostly *open source web 2.0* tools. Outside of Sloan-C publications, Ko and Rossen (2004) discuss solutions for *online projects*. Roberts (2006) discusses self and peer assessment for eLearners. *The italicized concepts, along with authentic learning, will be incorporated in AEx.*

Big Data Approaches: Bienkowski et al. (DoEd 2012) have articulated the role of big data in terms of educational data mining (EDM) and learning analytics (LA). Over the next few years, much ‘big data’ will be collected from our collective experience and will be subject to conventional data mining techniques, to improve course pedagogy and the tool infrastructure. Our tools, however, will also provide dynamic real-time support. We list here such application areas (DoEd 2012) and their mapping to AEx: (1) User knowledge modeling - EDM from SSE queries; (2) User behavioral modeling - LA from TQC (and FAQ) queries; (3) User experience modeling - EDM from surveys and VAr; (4) User profiling - EDM and LA from judges’ rubric-based scores and comments/feedback, respectively; (5) Domain modeling - From ANT; (6) Learning Component analysis and instructional principle analysis - EDM from AEx usage statistics (longer term); (7) Trend Analysis - EDM on App maturity and skill level from judges’ comments/ feedback, and from App marketing successes (longer term); and (8) Adaptability and Personalization - LA from TQC (and FAQ), and personalization of SSE.

V. Conclusions:

We have developed an eLearning tool architecture that is ideal for facilitating eTeams. We believe that the following outcomes will be positively impacted: (a) sustenance, portability, scalability, and usability for LMS tools, and (b) retention, motivation, and recruitment for students. The tool infrastructure and potential for big data analytics provides for significant improvements in teaching and learning over the next few years as the tools are deployed and used in our online courses for students on eTeams.

VI. References:

Abdous, M'hammed and Wu He (2011). Using text mining to uncover students' technology-related problems in live video streaming, *British Journal of Educational Technology*, 42 (1), 40-49.

Anderson, T., and Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher*, Featured Article, *41*(1), 16-25. Retrieved from http://edr.sagepub.com/content/current

Android (2010). Florida Atlantic University’s website for Android smart phones. http://android.fau.edu/

Android (2012). Android developers website. Retrieved from http://developer.android.com/index.html

Angelo, T. A., & Cross, K. P. (1993). Classroom Assessment Techniques: A Handbook for College Teachers (2nd Ed.). San Francisco, CA: Jossey-Bass.

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground, *Journal of the Learning Sciences*, *13*(1), 1-14. Retrieved from http://learnlab.org/research/wiki/images/a/ab/2004_Barab_Squire.pdf

Behara, R.S. (2007). Anatomy of Service Failure, *Proceedings of the 38th Annual Meeting of the Decision Sciences Institute*, November 17-20, 2007, Phoenix, AZ.

Bovard, B (2012). *Web 2.0 Selection Criteria*, Tek Trekker's blog. Retrieved from http://tektrek.wordpress.com/2009/03/02/web-20-selection-criteria/

Brown, J.S., & Adler, R.P. (2008). Minds on fire: Open education, the long tail, and learning 2.0. *EDUCAUSE Review*, *43*(1), 16–32.

Burden, K., & Atkinson, S. (2008). Evaluating pedagogical affordances of media sharing web 2.0 technologies: A case study, *Proceedings of ASCILITE*, Melbourne, AU, 121-125.

CEL (2012). Florida Atlantic University's website for Center for eLearning. http://www.fau.edu/cel/

Chi, T.H. (1997). Quantifying qualitative analysis of verbal data: A practical guide. *Journal of the Learning Sciences*, *6*(3), 271-315.

Chickering, A. & Ehrmann, S. C. (1996). Implementing the seven principles: Technology as lever, *AAHE Bulletin*, October, 3-6.

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodical issues, *Journal of the Learning Sciences*, *13*(1), 15-42. Retrieved from http://treeves.coe.uga.edu/EDIT9990/Collins2004.pdf

diSessa, A.A., & Cobb, P. (2004): Ontological innovation and the role of theory in design experiments, *Journal of the Learning Sciences*, *13*(1),77-103.

DoEd (2012) Bienkowski, M., Feng, M., and Means, B., Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics, US Department of Education, October 2012, www.ed.gov

Dziuban, C.D., Brophy-Ellison, J.C., & Hartman, J.L. (2007). Faculty 2.0 - EDUCAUSE article on the changing role of faculty. *EDUCAUSE Review*, *42*(5), 62–77.

Dunn, L., Morgan, C., O'Reilly, M., & Parry, S. (2004). The Student Assessment Handbook: New Directions in Traditional & Online Assessment. New York, NY: RoutledgeFalmer.

eTeams (2012). FAU Professor's wiki site for joint course development. http://eteams.pbworks.com/w/page/61784805/FrontPage

Fishman, B., Marx, W., Blumenfeld, P., Krajcik, J., & Soloway, E. (2004): Creating a framework for research on systemic technology innovations, *Journal of the Learning Sciences*, *13*(1), 43-46.

Fowlkes, J. K. (April 2007). Blooming Hybrids and Online Learning. *18th Annual International Conference on College Teaching and Learning*, Ponte Vedra Beach, FL.

Fowlkes, J. K. (July 2010). The Yin-yang of Learning. *Education Partnership Conference*. Sanford, FL.

Grimes, S. (n.d.). Unstructured data and 80 percent rule. BridgePoint Article. Retrieved September 09, 2011, from http://www.clarabridge.com/default.aspx?tabid=137&ModuleID=635&ArticleID=551

Horridge, M. (2011, March). A practical guide to building OWL ontologies using Protege 4 and CO-ODE Tools Edition 1.3, The University Of Manchester.

Islam et al. (2012). Islam, S., Freytag, G., & Shankar, R. Intelligent health information system to empower patient with chronic diseases, *IEEE IRI Workshop on Health Informatics*, August 2012. Las Vegas, NV.

Islam et al. (2013). Islam, S., Shankar, R., & Freytag, G. Leveraging semantic web to retrieve customized medical information, *IEEE Systems Conference*, April 2013, Orlando, FL, paper submitted. Draft available at http://eteams.pbworks.com/

Kelty, C. (2005). Geeks, social imaginaries and recursive publics. *Cultural Anthropology 20*(X): 185-214.

Ko, S. & Rossen, S. (2001). *Teaching online: A practical guide.* Boston, MA: Houghton Mifflin.

Lombardi, M.M. (2008). Making the grade: The role of assessment in authentic learning, Educause Learning Initiative, ELI Paper 1: 2008. Retrieved from http://www.educause.edu/library/resources/making-grade-role-assessment-authentic-learning

Lorenzo et al. (2006). Lorenzo, G., Dziuban, C.D., & Oblinger, D. How choice, co-creation, and culture are changing what it means to be net savvy. White paper. *EDUCAUSE Learning Initiative (ELI)*

Mackey T. P. & Jacobson, T. E. (January 2011). Reframing Information Literacy as a Metaliteracy. *College & Research Libraries 72*(1), 62-78.

Miller, W. (2005). *Data and Text Mining: A Business Applications Approach*. New Jersey: Pearson.

Ming, N.C., & Baumer, E.P.S (2011). Using text mining to characterize online discussion facilitation. *Journal of Asynchronous Learning Networks*, 15(2).

Moodle (2012). Moodle Open Source Course Management System. Retrieved from https://moodle.org/
Mueller, J. F. (July, 2011). Authentic assessment toolbox [website]. Retrieved from http://jfmueller.faculty.noctrl.edu/toolbox/ .
NSF (2008). Fostering learning in the networked world: The cyberlearning opportunity and challenge: A 21st century agenda for the National Science Foundation. A report of the NSF task Force on Cyberlearning. June 24, 2008, Christine L. Borgman (Chair). Retrieved from http://www.nsf.gov/
Orozco, M., Fowlkes, J., Jerzak, P., & Musgrove, A. (March 2012). Zero to sixty plus in 108 days: Launching a central eLearning unit and its first faculty development program. *The J of Asynchronous Learning Networks*.
OWL (2012). OWL API. Retrieved from http://owlapi.sourceforge.net/documentation.html.
Palomba, C. A., & Banta, T. W. (1999). Assessment Essentials: Planning, Implementing, and Improving Assessment in Higher Education. San Francisco, CA: Jossey-Bass.
Pelto, P.J., & Pelto, G.L. (1970). *Anthropological Research: the Structure of Inquiry*. Cambridge University Press.
Rheingold, H. (2010). Attention, and other 21st-century social medial literacies. *EDUCAUSE Review*, *45*(5), 14–24.
Roberts, T. S. (2006). Self, Peer, and Group Assessment in E-Learning: An Introduction. In T. S. Roberts' (Ed.) *Self, Peer, and Group Assessment in E-Learning* (pp. 1-16). Queensland, Australia: Central Queensland University.
Robotics (2011). Florida Atlantic University's website for robotics. http://robotics.fau.edu/
Ruthven, K., Laborde, C., Leach, J., & Tiberghien, A. (2009). Design tools in didactical research: Instrumenting the epistemological and cognitive aspects of the design of teaching sequences, *Educational Researcher*, *38*(5), 329-342. Retrieved from http://edr.sagepub.com/
Schensul, S., Schensul, J.J., & LeCompte, M. (1999). *Essential Ethnographic Methods.* AltaMira Press.
Semantic Web (2011). Florida Atlantic University website for Semantic Web Technologies. http://semanticweb.fau.edu/
Shankar, R. (2012) Presentation to the Dean, Undergraduate Studies, FAU. https://voicethread.com/share/3837779/
Shankar et al (2013a). Shankar, R., Dickson, J., & Mozelny, C. A tool for ABET accreditation, *2013 ASEE Annual Conference*, June 2013, Atlanta, GA, draft accepted. Available at http://eteams.pbworks.com/
Shankar et al (2013b). Shankar, R., McAfee, F., & Harris, M. Smart phone app development: A multi-college approach, *2013 ASEE Annual Conf.*, June 2013, Atlanta, GA, draft accepted. See http://eteams.pbworks.com/
Sloan-C (2012). *The Five Pillars*. Retrieved from http://sloanconsortium.org/5pillars
Sloan-C (2012a). Sloan-C Effective Practices site. http://sloanconsortium.org/effective
Spradley, J. (1980). *Participant Observation*. Harcourt Brace Jovanovich.
Swan, K. (2004), Relationship between interactions and learning in online environments, The Sloan Consortium. Retrieved from sloanconsortium.org/publications/books/pdf/interactions.pdf
Videos (2012). Florida Atlantic University webpage with links to all student marketing videos and media articles, http://faculty.eng.fau.edu/shankar/research/smart-phone-apps/
Wiggins, G., & McTighe, J. (2005). *Understanding by Design* (2nd Edition). Pearson: Upper Saddle River, NJ.
Yu, Chong Ho, Samuel A. DiGangi, & Angel Jannasch-Pennell (2011). Using Text Mining for Improving Student Experience Management in Higher Education, in *Cases on Innovations in Educational Marketing: Transnational and Technological Strategies*, Purnendu Tripathi and Siran Mukerji (Editors), 196-213.