AC 2009-1767: LIBRARY-SMART HOUSE COLLABORATION FOR INFORMATION-LITERACY DEVELOPMENT

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Library-Smart House Collaboration for Information Literacy Development

Abstract

The Library-Smart House partnership seeks to design and implement a sustainable, virtual environment for collaboration that will seamlessly integrate project communication and information access. This virtual environment will provide a means for increased collaboration between students, faculty, librarians and outside contributors as well as ensure the sustainability of the project in coming years.

The Smart House is a student-led, multidisciplinary project to retrofit an existing house to be a living-laboratory. The house will be a platform for testing innovations in the areas of energy, health, environment, interaction, and lifestyle. The ultimate goal of the organization is to improve the quality of life for those living and working in an urban residential setting. The Smart House is a collaborative design project not only across different disciplines, but also across student year and domain knowledge levels. This collaboration produces a wide array of student information needs and presents a unique opportunity for library collaboration.

The Library plans to study the effectiveness of information literacy instructional techniques through the contextual setting of the Smart House. The Library seeks to improve the ability of participants to access, evaluate, and use high quality research materials effectively through a variety of instructional strategies. By developing and maintaining a virtual infrastructure for information awareness and access using relevant technologies, the library will be able to assist students at their point of need. More direct instruction will be provided through a series of active learning workshops combined with specialized research consultation. We believe that this project will promote the lifelong learning skills necessary for the Engineer of 2020[1] by providing interdisciplinary collaboration paired with information literacy instruction within the framework of Smart House design.

Smart House

The Smart House organization was founded in 2006 by a small group of students. The goal was to develop a program where students could be engaged both in and out of the classroom and to bring laboratory research into a real world environment. Through the support of faculty and administration, this student-led group has grown to an over 100 student member organization focused on solving modern problems through academic research and real world implementation. At the centerpiece of this organization is an actual "Smart House" where ten students will live and interact on a daily basis with the technology and design that have been developed through the program.

The program has already seen great success having received sponsorship from numerous private sources, grant funding from the Environmental Protection Agency and Green Building Alliance. Two multidisciplinary courses have been developed around the Smart House concept, and a yearlong design competition has been conducted to select the final renovation design for the house located in a local neighborhood near campus. The teams in the design competition were composed of students from architecture, civil and architectural engineering, mechanical engineering, interior design, and even digital media design. While the Smart House is not an engineering specific organization, it provides very unique opportunities for engineers to work with others from different fields. Additionally, it is often the engineering students taking the lead on the research projects and coordinating with the other disciplines. Ultimately, the program fosters collaboration between disciplines, provides innovative learning opportunities, and most importantly enables student-led design realization.

Literature Review

Interdisciplinary Collaboration in Engineering
As predicted in the National Research Council's *Rising above the Gathering Storm*[2], "Increasingly, the most significant new scientific and engineering advances are formed to cut across several disciplines." Engineering students must be exposed to and become active in interdisciplinary projects that prepare them for the growing interdisciplinary needs of the future. The Smart House project has currently included participation from students in engineering, architecture, interior design and media arts fields, among others. By engaging in interdisciplinary experiences at the undergraduate and graduated levels, participants will be able to gain the skills necessary for effective interdisciplinary collaboration in the workplace.

 Virtual Collaboration
Much has been studied in regard to the behavior of collaborators in a virtual setting[3-5], though there are limited materials pertaining to the educational application of the skills necessary to prepare students for virtual collaboration. As engineering design in industry is becoming increasingly global in its scope and operation, the need for virtual collaboration in education is becoming more evident. The growing involvement of multiple disciplines and shifts in emerging technologies require students to gain experience with a wide variety of communication and research tools.

From the results of case studies incorporating virtual collaboration in an educational setting[6-9], students gained valuable skills from the virtual collaboration experience. Students who participated in computer-mediated engineering design teams found that communication skills were greatly improved. These students also felt that the professionalism of the design was heightened. The importance of choosing effective communication tools was evident in all studies investigating the use of virtual collaboration in the engineering curricula.

Library Collaboration

There has been much research regarding the integration of library resources and services into course management systems[10-12]. The main advantage to this form of library involvement is the collaboration between faculty and librarians to promote information literacy through instruction and outreach. Libraries can use course management systems to provide electronic access to library materials, allow direct searching of the library catalog and databases, and suggested library resources that meet the specific goals of the instructor or course. The Library-Smart House collaboration seeks to go beyond the constraints of a single course and provide similar resources and information literacy instruction through collaboration with an ongoing student project. As Jackson recommends in her 2007 study, "Librarians need to proactively engage students with information literacy in collaborative learning environments."

Information Literacy

The need for engineers to be competent in finding, evaluating, and using different types of information is becoming increasingly apparent. As Napp found in his 2004 survey, engineers were responsible for their own information needs at 79 percent of surveyed engineering design firms[13]. This helps support the idea that information literacy instruction is crucial in preparing future engineers for the workforce. This sentiment is echoed in a number of recent publications highlighting the integration of information literacy instruction into engineering curricula[14, 15]. Treating the Smart House participants as a learning community will allow for the study of information literacy learning and development for future research. Collaborative problem-based strategies for teaching information literacy have been explored recently in a number of case-studies[16, 17]. As Hsieh and Knight found in their recent study, problem-based learning can be an effective approach to information literacy instruction for engineering students. It was also noted that this approach to information literacy instruction could be easily integrated into existing problem-based engineering programs. The Smart House project will provide the problem-based structure that has been found to improve student retention, satisfaction, diversity and learning[18].

Library-Smart House Collaboration

The Library involvement with the Smart House initiative began at an early stage when the group invited the current engineering librarian to a meeting to discuss possible collaboration with the initiative. It was apparent that the group was keen on having librarians on board since students involved in this project are required to use appropriate library resources in their research. Since the initiative is interdisciplinary in nature, focusing on areas such as Energy, Environment, Health, Interaction and Lifestyle, it is crucial that students become familiar with a wide variety of both print and electronic resources available from the Library.

As an initial step, the engineering librarian created a blog listing examples of various research topics appropriate for the Smart House project and included appropriate resources matching those topics. Once the blog entry was created, a library instruction session highlighting these

resources was conducted. In addition, several freshman and senior engineering design projects were developed that integrated elements of the Smart House project. Each design group had a different focus such as, home automation, green buildings or sustainability. The engineering librarians provided individual consultations to these groups as needed. It was found that the consultation sessions were extremely helpful for both the students and the librarians. For example, a student may make a request such as, "I am doing research into a foliage air filtering system which we are interested in designing for the Smart House and I could use some help doing deeper research." Specific questions such as the ones above help in structuring consultations better since students are already aware of what they are looking for. Often, consultations result in a dialog that inspires students to develop new ideas for their projects and helps the Library by identifying areas of potential collection development.

The multidisciplinary aspect of the Smart House project affords the Libraries a unique opportunity to explore information seeking behaviors of participants and enhance students' information seeking skills. Research guides, blogs and feeds will be used to increase students' information awareness and group research communication. Librarians will also take an active role in imparting important information evaluation skills through consultations, workshops and seminars. Students involved with this project are expected to build life-long information literacy skills in a collaborative, real world context. As Hannon et al. found in their Smart Home Technologies course experience[19], students need formalized instruction and extensive coverage of the research process. Students who are used to having fairly well-defined solutions will encounter a different experience when researching smart house topics. Also, keeping abreast of current research is key to making informed design decisions when dealing with an emergent field such as smart house technologies. Active learning strategies are recommended for learning in knowledge-centered endeavors where not everything can be taught, but there exists an increasing need for new knowledge[20]. The Library currently uses active learning techniques with freshman design classes, the details of which can be found in Roberts and Bhatt, 2007[21].

Students Collaborating with Students

Since some freshman design students work on projects dealing with the Smart House, it is important that seniors who are also working on these projects become mentors to the freshman design students. In a way this will also bring continuity in projects since outgoing seniors will be replaced by incoming students with experience and therefore, projects will continually be conducted without the fear of losing students. Moreover, as students continue to involve themselves in various projects, they also can become future role models and mentors for incoming newer students.

Ultimately, a more collaborative environment will ensure that Smart House will retain all of the knowledge and information needed for a new team to pick up the project at any point in time while also keeping the organization and faculty aware of all progress at all times. The Library

will be assisting in the coordination of the data collection/recording, ensuring that the data is organized effectively. Additionally, the Smart House organizational tools will be integrated with Library information awareness technologies so that students will be able to conduct research activities through the new web tools just as they would with the Library's existing system, but with the added benefit of storing the research within the Smart House "cloud". Smart House system of communication and collaboration technologies include: website, wiki, blog, forum, project management platform, Google apps (docs, calculator, chat, mail), and mailing lists. Detailed discussion of these tools is beyond the scope of this paper and will be explained in another paper in future.

Virtual Collaboration Model

Virtual collaboration is not a new idea; however, to be a true success, a new model is required. Rather than having contributors work in individual environments and intermittently post updates of their work to a common virtual portal, contributors need to work within a virtual shared domain. Should the paradigm not shift toward the creation of a shared collaborative environment, it is less likely that current work will be archived and readily available for the use of future collaborators. And, in some cases, work may even be lost.

To establish continuity and afford scalability, the Smart House currently employs a mixed model consisting of the combination of curricular integration, online tools, and university resources. This current model is essential to the success of the organization because it is student-run. The student membership consistently experiences a high turnover rate: members graduate, take on additional external responsibilities, move for co-op, and more. When compared with a more traditional employer-based model, the student members have lower incentives to adopt complex methods for collaboration. The creation of this virtual collaboration model is necessary for the Smart House to maintain its current endeavors and to enable effective growth and the pursuance of new projects and ideas.

There are three major components to this model:

1. The organizational structure
2. The virtual education and work environment
3. The coordination with faculty for integration into the educational curriculum

Ultimately, it is and will be the Smart House organizers that manage all of the work and research taking place within the model. Because much of this work spills out of real-world meetings into the online collaboration environment, it is necessary that the organizers be able to successfully use the virtual environment to coordinate all work, online and off, with students, faculty, staff, and administration.

The Smart House organization has had great success in retaining faculty to sponsor research projects that facilitate the development of the students' intellectual capital. Often, this collaboration takes the form of the faculty member serving as the Primary Investigator in pursuance of grants and other funding for the project. In the past, faculty members have been retained to conduct special topics courses for various early stage research by students to benefit the Smart House. Most of these past courses have resulted in projects that continue to develop, with some ultimately receiving grants for prototype work.

A new approach that is beginning to be implemented is the integration of Smart House into the university curriculum. The first prototype of such integration is occurring with the help of the College of Engineering. Currently, Smart House is working with the College of Engineering curriculum coordinators and Engineering Librarians to integrate a Smart House module into freshman engineering classes. This integration is just one step toward our mission of educating students about sustainable research and design.

It may seem that much of this work takes place in the classroom. In reality, however, most work that begins in the classroom extends well beyond and into both the university and the virtual environs. In this scenario, faculty are still heavily involved in every project, advising each team and keeping them on track as well as serving as Primary Investigators on grants. Librarians must also remain a constant virtual presence for research assistance and information literacy instruction.

The goal for the online environment is that it becomes the strongest link between the organization, which coordinates the overall research and design efforts, and the faculty sponsored research or course-work. Overall planning is taken on by the Smart House and research project ideas are either developed or approved by this group. Individual projects are then assigned to what is considered the best environment for development. This could be freshman design, senior design, an engineering project-based class, or non-class research. This has resulted in significant project management and data collection/recording requirements. The nature of the organization is so spread out that it is often hard to coordinate this through traditional means. The online environment will provide both students and faculty with tools for managing projects (or for faculty, assigning tasks/homework) and also recording the resultant data in a standardized format. This will allow for projects to be easily paused and resumed as one class project or team will be unable to complete all of the work to bring a project from idea to prototype to implementation in the Smart House.

Information Awareness Technologies

The Library seeks to implement a variety of information awareness technologies in order to meet the varied needs of Smart House participants. This will also allow for the evaluation of information awareness technologies with respect to effectiveness.

RSS Feeds
There are many electronic databases and electronic journals that now provide RSS feeds. Databases may provide RSS feeds that automatically update the results of saved search queries. The Library currently provides blogged instruction on subscribing to RSS feeds from databases such as IEEE Xplore, Ei Compendex and INSPEC. There are also posts related to electronic journal, magazine and standards updates.

Blogs
There are currently two blogs actively maintained by the engineering librarian. The Englibrary blog lists new print and electronic resources available from the Libraries in the fields of engineering and biomedical engineering. There is also an Engineering Library Instruction blog that is aimed at helping engineering faculty and students develop their information literacy skills. It highlights important instructional tutorials on using various electronic databases and FAQ based instructional tips focused on learning specific features available in a particular database.

A blog dedicated to the Smart House initiative has already been started. Several new projects, new initiatives, and new research can be included in this blog. There can be a new category for librarians within this blog where they can post and highlight new resources and tools for the students. In addition announcements like, 'Summer Term Sustainability Seminar Course INTR 799 - SUSTAINABILITY SEMINAR' can assist librarians to keep current with availability of new courses that would help them to build new collections, provide library instruction session, and provide consultations to students enrolled in this class. The blog includes a link to specialized Smart House resources.

Specialized Research Guides
The Library currently offers specialized research guides for the major engineering disciplines such as civil, architectural & environmental engineering, and computer science & software engineering. Other research guides have been developed focusing on the fundamentals of engineering research, finding patents, nanotechnology and other areas of student need. Just as there are pathfinders in place for the main engineering disciplines, more specific research guides for Smart House-related topics such as Home Automation or Green Buildings will be created over a period of time. In order to foster collaboration, librarians and students will be involved in determining the best print, electronic and web resources to be included in the guides.

Research guides on Engineering Standards and Patents are also available from the Engineering Research guides section of the Library web site. Currently, students can refer to an instructional blog entry to locate Building Codes through the Library's subscription MAD CAD database. Engineering Librarians have access to all ASTM and ISO (International Organization for Standardization) standards through a subscription as well. If a student wishes to acquire one or more of these standards, they can do so by contacting the engineering librarians; students are not charged for available standards.

It is expected that in addition to engineering resources, students will need to explore Architecture related print and electronic resources. The Media Arts and Design Librarian has compiled a research guide on Architecture. This research guide is aimed at helping students find information on areas such buildings, building types, building construction details, architectural standards and building codes, images and other routine needs such as those for books, journals and magazine articles.

Embedded IM
The web pages that contain the Engineering Research Guides and blogs also have IM widgets embedded within them so that students can ask the librarians about any information that they are looking for in a virtual environment. 531 questions were answered using virtual chat features available from the Library web site in the period between September 2007 and August 2008. We hope that once Embedded IM is available from research guides and blog entries, the number of virtual questions related to the Smart House Project will increase.

While many of these technologies are currently implemented in some form, students will be more likely to use the resources if they can be accessed through a contextual environment. Instead of using the library website as the main portal, the new virtual environment will serve to house both the Smart House organizational materials and the specialized research resources. Students will be able to search for relevant information, collaborate with their peers, and pass on meaningful work to subsequent design teams. As Wilczynski and Jennings noted, web collaboration tools are not enough to maintain effective virtual design projects. In order for projects to be successful, these tools must be a part of a large scale organizational structure complete with operations plans, training materials and other virtual project documentation.

Assessment

In order to evaluate the information awareness technologies that will be used, a combination of informal and formal assessment must be conducted. Students will be observed during class sessions and group consultations with respect to actions relating to information awareness. For example if students have a specific item they are looking for, the engineering libraries can question the students as to where they feel they could find that information. It will also be useful to know where students seek information, but do not find information they deem useful. These accounts will be compiled into an anecdotal record that can be used to inform future information awareness decisions. Since the engineering librarians will be actively involved with various student groups working on different research projects, instructional support will be more specific depending on the information needs of groups consulted. Observations, dialogue and interaction will help librarians gauge how effectively students are succeeding or needing some more help in their projects. In a more formal assessment, an online multiple choice survey will be used to

evaluate students' perceived value of information awareness technologies and frequency of use.

As for the information literacy instruction as a whole, again formal and informal assessment techniques will be implemented. The informal assessment will again focus on questioning strategies used with students in the classroom and group consultation settings. The engineering librarians will be able to use the feedback found through the informal assessment to modify instructional approaches. The classroom instruction will include elements of problem-based learning and active learning as in previous years, though modifications may be made to length of time for direct instruction, group responsibility, complexity of session deliverable, etc. The formal assessment of the information literacy instruction as a whole will take on a two-pronged approach. Similarly to Flaspohler's information literacy program assessment[22], we plan to evaluate the information literacy instruction with a questionnaire that students comment on how frequently they use specific library research tools as well as a series of questions that require students to demonstrate specific information literacy competencies. This questionnaire will be used with both engineering students involved with the Smart House project and engineering students not involved with the Smart House project. The second formal assessment technique will involve the analysis of design project bibliographies. A rubric will be created that accounts for citation type, quality and quantity. This rubric will be applied to design project bibliographies for freshman design reports from years prior to the Library-Smart House collaboration and to those reports from groups that experienced the Library-Smart House collaboration.

Expected Outcomes

This plan seeks to serve as an example of library/student/faculty collaboration and as a sustainable student initiated design project. The virtual, collaborative environment will allow for better organization and communication for Smart House participants among themselves and with faculty and other university members interested in the project. The Library's involvement in this endeavor will serve as a model of fully integrated information literacy instruction.

The interactive, visual and flexible nature of this collaborative environment will help to quickly identify and assess research and information needs of faculty and students involved in the project. This awareness of information needs is essential for envisioning methods and procedures to successfully satisfy those needs.

We will continue to monitor our progress through properly identifying student information needs as projects evolve and continually think, implement and assess new methods of information delivery through active collaboration and interaction with students involved. We hope to present any new data, findings and our observations from our learning in future conferences.

References

1. National Academy of Engineering. 2005. *Educating the engineer of 2020: Adapting engineering education to the new century.* Washington, DC: National Academies Press.

2. National Research Council. 2005. *Rising above the gathering storm: Energizing and employing America for a brighter economic future.* Washington, DC: National Academies Press.

3. Henri, F. and B. Pudelko. 2003. Understanding and Analyzing Activity and Learning in Virtual Communities. *Journal of Computer Assisted Learning* 19:474-487.

4. Rutkowski, A.F., D.R. Vogel, M. Genuchten, T.M.A. Bemelmans and M. Favier. 2002. E-Collaboration: The Reality of Virtuality. *IEEE Transactions on Professional Communication* 45(4):219-229.

5. Wilczynski, V. and J.J. Jennings. 2003. Creating Virtual Teams for Engineering Design. *International Journal of Engineering Education* 19(2):316-327.

6. Peters, M.R., R.J. Ocker, and M. Rosson. 2008. Collaboration in a Distributed World: Technology Support for Partially Distributed Teams. *Eighth IEEE International Conference on Advanced Learning Technologies.*

7. Rutkowski,A.-F., D. Vogel, M. Genuchten, and C. Saunders. 2008. Communication in Virtual Teams: Ten Years of Experience in Education. *IEEE Tansactions on Professional Communication* 51(3):302-312.

8. Whitman, L.E., D.E. Malzahn, B.S. Chaparro, M. Russell, R. Langrall, and B.A.Mohler. 2005. A Comparison of Group Processes, Performance, and Satisfaction in Face-to-Face Versus Computer-Mediated Engineering Student Design Teams. *Journal of Engineering Education* 94(3):327-334.

9. Wilczynski, V. and J.J. Jennings. 2003. Creating Virtual Teams for Engineering Design. *International Journal for Engineering Education* 19(2):316-327.

10. Bell, S.J. and J.D. Shank. 2004. Linking the Library to Courseware: A Strategic Alliance to Improve Learning Outcomes. *Library Issues* 25(2):1-4.

11. Jackson, P.A. 2007. Integrating Information Literacy into Blackboard: Building Campus Partnerships for Successful Student Learning. *The Journal of Academic Librarianship* 33(4):454-461.

12. Shank J.D. and N.H. Dewald. 2003. Establishing our Presence in Courseware: Adding Library Services to the Virtual Classroom. *Information Technology and Libraries* 22(1):38-43.

13. Napp, J.B. 2004. Survey of Library Services at Engineering News Record's Top 500 Design Firms: Implications for Engineering Education. *Journal of Engineering Education* 93(3):247-253.

14. Andrews, T. and R. Patil. 2007. Information Literacy for First-Year Students: An Embedded Curriculum Approach. *European Journal of Engineering Education* 32(3):253-259.

15. MacAlpine, B. 2005. Engineering + Information Literacy = One Grand Design. *Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition.*

16. Harris, B.R. 2008. Communities as Necessity in Information Literacy Development: Challenging the Standards. *The Journal of Academic Librarianship* 34(3):248-255.

17. Hsieh, C. and L. Knight. 2008. Problem-Based Learning for Engineering Students: An Evidence-Based Comparative Study. *The Journal of Academic Librarianship* 34(1):25-30.

18. Dym, C.L., A.M. Agogino, O. Eris, D.D. Frey, and L.J. Leifer. 2005. Engineering Design Thinking, Teaching, and Learning. *Journal of Engineering Education* 94(1):103-121.

19. Hannon, C., M. Huber, and L. Burnell. 2005. Research to Classroom: Experiences from a Multi-institutional Course in Smart Home Technologies. *SIGCSE Bulletin* 37(1):121-125.

20. Horvath, I., M. Wiersma, J. Duhovnik and I. Stroud. 2004. Navigated Active Learning in an International Academic Virtual Enterprise. *European Journal of Engineering Education.* 29(4):505-519.

21. Roberts, J.C. and J. Bhatt. 2007. Innovative Approaches to Information Literacy Instruction for Engineering Undergraduates at Drexel University. *European Journal of Engineering Education* 32(3):243-251.

22. Flaspohler, M. 2003. Information Literacy Program Assesment: One Small College Takes the Big Plunge. *Reserves Services Review* 31(2):129-140.