AC 2008-2246: INFORMATION GATHERING ACTIVITIES IN ENGINEERING DESIGN

Stephen Ekwaro-Osire, Texas Tech University

Innocent Afuh, Texas Tech University

Peter Orono, Indiana University-Purdue University-Indianapolis

INFORMATION GATHERING ACTIVITIES IN ENGINEERING DESIGN

Abstract

There is a growing librarian-led movement across institutions of higher learning that seeks to inculcate into students the ability to locate, evaluate, utilize and disseminate information in all formats using the appropriate media to the targeted audience. The need for such "blended" students becomes more critical because of demand by industry for broadly qualified graduates. In their previous paper, the authors analyzed the student information gathering patterns using only the students' final reports at the end of the semester. An assessment rubric and scoring for the students reports was proposed. In this paper, additional to the final reports, the student design notebook and presentation slides are also analyzed. An assessment rubric and scoring are proposed for the design notebooks and the presentation slides. The data collected is used to map the information gathering activities across the whole design process. Using the information obtained, information literacy is integrated into a capstone syllabus. Information literacy may inculcate in the students the ability to develop search strategies that will come up with more meaningful results. Reading through the results, they will see and learn how to relate and use information not only in their final reports, but also in their design notebooks and presentations. The rubrics developed here are applied at two major engineering programs. The rubrics were used in a capstone course. The implications of the results in the context of engineering design education are discussed.

1. Introduction

Engineering design education is a central element of student training in engineering schools. Design projects are usually open ended and thus present students with challenges. This requires them to sift through large amounts of information in all formats. Blake and Pratt[1] opine that new technology and changes in publishing practices continue to increase the quantity of literature available to the academic community leading to information explosion. Therefore information gathering and or research skills have become an essential asset. Zimmerman et al.[2] opine that good information gathering skills can help you solve problems, focus your inquiry, generate alternative approaches to problems, save time and money, keep you abreast of current developments in your field of study as well as investigate other fields.

The millennial generation use technology constantly. In fact they are "wired up" in social networking but when it comes to more in depth academic work requiring research and critical thinking skills, they are inept. Forster[3] argues that "The Net generation, it turns out may not be so tech savvy after all". They rely almost exclusively on Google, Wikipedia and other such search engines as major information sources, oblivious of its credibility, reliability and validity for research. They pay little attention to peer reviewed scholarship. Thus while they may be

computer literate, they are not necessarily information literate although the later uses skills of the former. The set of skills needed to find, retrieve, analyze and use information is termed information literacy (IL). According to the Association of College and Research Libraries (ACRL) a division of the American Libraries Association, IL is not only closely tied to course-integrated instruction but extends beyond the coordination between the reference librarian and individual faculty member to students demonstrating competencies in formulating research questions and their ability to use information as well as an understanding of ethical and legal issues surrounding information. Achieving this lofty goal requires a culture of collaboration (faculty-librarian-administration) and focuses on active student learning. The need for such blended students becomes more critical because of demand from industry for broadly qualified graduates/engineers and this can be achieved through collaboration to create an atmosphere where students are involved in active learning by being connected with libraries and being taught soft skills during their training.[4-6] They will build upon these skills, horn them and evolve into lifelong learners.

Sapp et al.[7] used a treasure hunt assignment to teach students various sources of engineering information and its contents. Slivovsky et al. [8] presented methods and strategies of integrating reflection into engineering design class. The engineering design notebook was one of the reflection methods developed and a well defined rubric was used to analyze it. The reflective exercises presented were successively shown to guide the students in their reflective thinking during the design course.

Well formulated design notebooks have been shown to have pedagogical and cognitive benefits [9]. To reap these benefits however, it is very important to teach the students how to complete an effective design notebook [10]. Svarovsky and Shaffer [11] used design notebooks in conjunction with design meetings to shed light on the learning processes of undergraduate students during an engineering design course. Seepersad et al. [10] demonstrated that design notebooks were an essential element for effective experiential learning. Essentially, the construction of design notebooks, reflective thinking, and design thinking, takes place in a team environment [12].

The objective of this study therefore, is to map the information gathering activities of students across the whole design process. From the information obtained, information literacy is integrated into a capstone design course. The data will be extracted from a capstone engineering design course.

2. Methodology

Students are introduced to essential elements of reflective thinking in engineering design, the design process, and teamwork. A pedagogical approach developed by two of the authors is used to guide the students to the completion of their engineering design project [13]. This pedagogical approach to creative engineering design education has previously been shown to establish a close relationship with and within design teams of students. The students were also instructed on the writing of effective design notebooks. The design notebooks were evaluated on five essential elements based on developed rubrics. A separate tool for peer evaluation of the team members

was developed and applied. The correlation of the data obtained from design notebooks to that from the peer evaluation was discussed. Suggestions were made on how design notebooks could be enhanced to provide information on the performance of teams.

For this study, the students were trained on how to use the design notebooks. Specifically, they were instructed on the five essential elements of design notebooks. In this study, the elements of the design notebooks were grouped into five categories, namely, date, content, continuity, duration, and signatures. The coding used in this study is similar to that in Ekwaro-Osire et al.[14] which was adopted from Atman et al.[15] The coding consisted of nine elements, namely, problem definition, gather information, idea generating, modeling, feasibility analysis, evaluation, decision, communication, and other. Since the thrust of this research was on information gathering activities, the "gather information" element was further broken up into nine distinct information gathering activities, namely,

1. ask client-expert
2. library research
3. internet use
4. ask other-expert
5. plan to gather
6. gather info (general)
7. parts: plan to gather info
8. parts: gathered info
9. procedure: gather info

Furthermore, the "communication" element was also broken up into

1. Citation
2. Presentation or written report
3. Report writing: Set goal
4. Other communication activities

Each entry (e.g., phrases, sentences, calculations, and sketches) was coded. Furthermore the context of occurrence of each activity was also noted in the coding.

In the fall semester of 2006, two sections of the capstone course participated in this study. Section 1 had a total of 36 students, and Section 2 had a total of 30 students. The students worked on a total of 17 projects. The projects were a mix of faculty projects, industry supported projects, student initiated projects, and projects for design competitions. Some of the projects had team members across the two sections. A report was written at the end of the semester. This report was a proposal of what the team would be constructing in the spring semester of 2007. The report also included preliminary designs of the team's project. In the spring semester of 2007, one class of the capstone course participated in this study. The class had 25 students working on 7 different projects. A final report was written at the end of the semester. Since this was the end of the project, the report included the final designs and the discussions of the deliverables set in the previous the semester.

For this study two different teams were selected from the spring semester of 2007 (who had also attended the fall semester of 2006). The first team (referred to as Team 1 in paper) worked on a wind energy project and second team (referred to as Team 2 in paper) worked on an automotive project. Both Team 1 and Team 2 had four members each.

The two papers from each team were coded based on a rubric that considered six criteria developed in reference [16]. The criteria in the rubric consisted of: number of references, type of references, currency of reference, consistency of citation style, context of citation, and usage of references across paper.

In the Introduction to the Engineering Profession class, freshman engineering students were instructed on information gathering. Two classroom meetings were allocated for a librarian to come and instruct the freshmen on the resources available at the University library and how to access and use them. The instruction included hands on projects on use of the major engineering databases. They were also instructed in the use of commercial search engines. With commercial search engines the focus was on rating the credibility of the websites and their information content. The data collected in the freshman engineering class was not sufficient enough to be included in the analyses of the following section.

3. Results and Discussions

The results of the information literacy assessment for the wind energy project (Team 1) are presented in Figure 1. The results of the information literacy assessment for the automotive project (Team 2) are presented in Figure 2. There was a general improvement of the score from the fall semester 2006 to spring semester of 2007. [16] The lowest score in both semesters was in the "usage of references across paper." Also in both semesters the "consistency of citation style" score was below average. They made good use of internet resources which ironically seems to be the predominant types of information that they used. One would have expected them to use more textbooks, handbooks and other reference materials. This is an indication of the skewed nature of their research thought process which assumes that the internet has the best answers. Use of professional organization and scholarly societal websites was noteworthy. By and large, there is need for the students to be taught how to evaluate online resources for credibility and worthiness as material of scholarly value.

The coding results of the design notebooks are shown in Figure 3. It is noted that the students spent 6.9% of their document activities on gathering information. The greatest portion of this activity took place in the context of the whole team. The students spent 0.1% of this activity on "Library Research." Furthermore 3.2% of the activity was spent on "Plan to gather". Based on the analysis, it seemed that either the students never followed up on most of their intentions to gather information or they did not document their follow up actions. Also it is noted that the citation of their data collected was only 0.5%.

4. Conclusion

The information gathering activities of students across the whole design process was mapped using written projects and design notebooks. Results of both Team 1 and Team 2 show a marked improvement in the quality of research output from fall 2006 to spring 2007. This can rightfully be attributed to the inculcation of the IL component in the curriculum. In relation to the design notebooks, it was noted that the frequency of the documented information gathering effort was

less than 10% of the overall effort in the design process. This number is low compared to what would usually be expected in the design process of amateur designers. This might also be an area to focus IL component in the curriculum. Teaching the students how to access, use and evaluate information within an ethical perspective, inculcates in them critical thinking skills. These skills remain useful in all aspects of their studies and an asset in lifelong learning as an engineer.

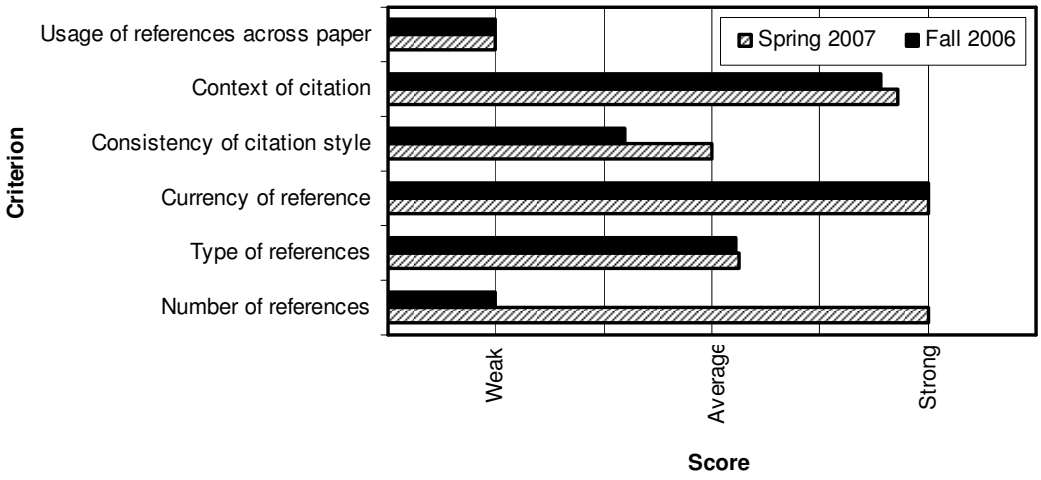

Figure 1 Information literacy assessment for wind energy project (Team 1)

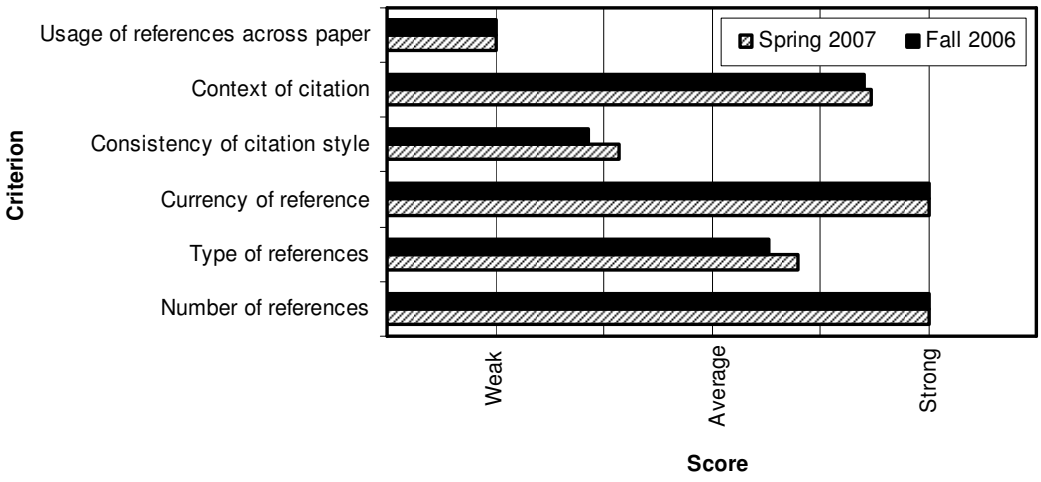

Figure 2 Information literacy assessment for automotive project (Team 2)

Activity	Context				Percentage of Whole Activity
	1 Expert/Client Meeting	2 Whole Team Actions	3 Partial Team Actions	4 Individual Actions	
PROBLEM DEFINITION	**5**	**0**	**4**	**32**	**5.5%**
GATHER INFORMATION	**7**	**33**	**4**	**7**	**6.9%**
1.1 - Ask Client-Expert	2	2	0	0	0.5%
1.2 - Library Research	0	1	0	0	0.1%
1.3 - Use Internet	0	0	0	2	0.3%
1.4 - Ask Other-Expert	0	2	0	0	0.3%
1.5 - Plan to gather	0	20	2	2	3.2%
1.6 - Gather info (general)	0	6	0	0	0.8%
1.7 - Parts: Plan to gather info	3	2	2	3	1.3%
1.8 - Parts: Gathered info	0	0	0	0	0.0%
1.9 - Procedure: Gather info	2	0	0	0	0.3%
GENERATE IDEAS	**3**	**2**	**2**	**0**	**0.9%**
MODELING	**0**	**0**	**2**	**117**	**16.0%**
FEASIBILITY ANALYSIS	**0**	**6**	**3**	**4**	**1.7%**
EVALUATION	**6**	**10**	**8**	**15**	**5.2%**
DECISION	**15**	**12**	**15**	**16**	**7.8%**
COMMUNICATION	**38**	**68**	**83**	**190**	**51.0%**
2.1 - Citation	0	3	0	1	0.5%
2.2 - Presentation or written report	7	14	10	2	4.4%
2.3 - Report writing: Set goal	4	0	1	0	0.7%
2.4 - Other communication activities	27	51	72	187	45.4%
OTHER	**13**	**4**	**13**	**6**	**4.8%**
Frequency	**87**	**135**	**134**	**387**	**100%**

Figure 3 Coding data of a design notebook (spring semester 2007)

5. Acknowledgements

The authors would like to acknowledge the assistance, in the design notebook coding, from Professor R. Taraban and Mr. C. Craig in the Department of Psychology at Texas Tech University.

6. Bibliography

1. Blake C, Pratt W. Collaborative information synthesis i: A model of information behaviors of scientists in medicine and public health. Journal of the American Society for Information Science and Technology 2006;57(13):1740-9.
2. Zimmerman DE, Muraski ML. The elements of information gathering : A guide for technical communicators, scientists, and engineers. Phoenix, Ariz.: Oryx Press; 1995.
3. Foster AL. Information navigation 101. Chronicle of Higher Education 2007;53(27):A38-A40.
4. Arnold J, Kackley R, Fortune S. Hands-on learning for freshman engineering students. Issues in Science and Technology Librarianship. 2003 [Online]. Available: http://www.istl.org/03-spring/article2.html [Febraury 29, 2008]

5. Feeney M, Martin J. The business of science: Cross-disciplinary information literacy in the applied sciences and business. Issues in Science and Technology Librarianship. 2003 [Online]. Available: http://www.istl.org/03-spring/article2.html [Febraury 29, 2008]
6. Quigley BD, McKenzie J. Connecting engineering students with the library: A case study in active learning. Issues in Science and Technology Librarianship. 2003 [Online]. Available: http://www.istl.org/03-spring/article2.html [Febraury 29, 2008]
7. Sapp M, Fosmire M, Epps AV, Harding B, "Next generation of tutorials: Finding technical information at purdue," in Proceedings of the 2007 Annual ASEE Global Colloquium on Engineering Education, Istanbul, Turkey, 2007.
8. Slivovsky LA, Derego Jr. FR, Zoltowski CB, Jamieson LH, Oakes WC, "An analysis of the reflection component in the epics model of service learning," in Proceedings of ASEE 2004 Annual Conference and Exposition, Salt Lake City, UT, 2004, pp. 419-28.
9. Sobek II DK, "Use of journals to evaluate student design processes," in Proceedings of 2002 ASEE Annual Conference and Exposition, Montreal, Que., Canada, 2002, pp. 10787-95.
10. Seepersad CC, Green MG, Schmidt KJ, "Learning journals as a cornerstone for effective experiential learning in undergraduate engineering design courses," in Proceedings of 2006 ASEE Annual Conference, Chicago, Illinois, 2006.
11. Svarovsky GN, Shaffer DW, "Design meetings and design notebooks as tools for reflection in the engineering design course," in Proceedings of 2006 Frontiers in Education Conference, San Diego, California, 2006, pp. M2G-7-M2G-12.
12. Dym CL, Agogino AM, Eris O, Frey DD, Leifer LJ. Engineering design thinking, teaching, and learning. Journal of Engineering Education 2005;94(1):103-20.
13. Ekwaro-Osire S, Orono P, "Pan-mentoring in creative engineering design - the coordination of individual and team creativity," in Proceedings of 2005 Frontiers in Education Conference, Indianapolis, Indiana, 2005, pp. S2J-7-S2J-11.
14. Ekwaro-Osire S, Taraban R, Orono P, Craig C, "Using design journals to track students' cognitive patterns in engineering design," in Proceedings of the 2007 Annual ASEE Global Colloquium on Engineering Education, Istanbul, Turkey, 2007.
15. Atman CJ, Adams RS, Cardella ME, Turns J, Mosborg S, Saleem J, "Engineering design processes: A comparison of students and expert practitioners," 2007.
16. Ekwaro-Osire S, Afuh I, Orono P, "Collaboration between librarian and design faculty to harness students' research skills in engineering design," in Proceedings of the 2007 Annual ASEE Global Colloquium on Engineering Education, Istanbul, Turkey, 2007.