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Practicing and Evaluating Soft Skills in IT Capstone Projects

Guangzhi Zheng
Kennesaw State University
1100 South Marietta Parkway
Marietta, GA 30060
1-678-915-5036
gzheng@kennesaw.edu

Chi Zhang
Kennesaw State University
1100 South Marietta Parkway
Marietta, GA 30060
1-678-915-3428
chizhang@kennesaw.edu

Lei Li
Kennesaw State University
1100 South Marietta Parkway
Marietta, GA 30060
1-678-915-3915
li_lei@kennesaw.edu

ABSTRACT

Information technology (IT) professionals have constantly stressed the importance of soft skills and used them as a key factor in hiring and career development. The soft skills are often difficult to be practiced and evaluated in IT curriculum, specifically in a subject or a skill focused course. We took on the challenge in an IT capstone course where students complete a term-long real-world team project. We redesigned the IT capstone course to systematically embed soft skill requirements in the team project, facilitate the training of soft skills, and evaluate students' soft skill competences. In this paper, we present our experiences and findings on curriculum improvement and students' soft skills development and assessment.

Categories and Subject Descriptors

K.3.2 [Computer and Information Science Education]: Information systems education

Keywords

IT capstone, project, soft skills, curriculum design.

1. INTRODUCTION

IT professionals have constantly emphasized the importance of soft skills and used them as an important factor in hiring and career development [1, 7, 9]. Soft skills usually include cross domain skills such as communication, presentation, documentation, research, dealing with challenges, and time management. Some of these skills are general for all professionals, while others are more specific to the practitioners in the IT industry. Compared to the technical skills, it is often more difficult to define and evaluate the soft skills in IT curriculum. In this paper, we survey and define common soft skills perceived by the IT professionals, and demonstrate how some of these skills can be practiced and evaluated in an IT capstone project course. Experiences and findings on student's soft skills development and evaluation are reported.

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2. SOFT SKILLS

2.1 General Soft Skills

Soft skill is a broadly defined term to cover a large set of personal and interpersonal traits and capabilities. Compared to hard skills, which are specific to a functional task, knowledge domain or industry, it is difficult to define soft skills, and many popular definitions are general and inconsistent among them. For example, TechTarget simply defines soft skills as individual's abilities to interact with others [12], while Wikipedia takes a broad perspective in defining soft skills as "associated with a person's 'EQ' (Emotional Quotient), the cluster of personality traits, social graces, communication, language, personal habits, friendliness, and optimism that characterize relationships with other people" ([13]). More specific examples of soft skills are shown in Figure 1 [11].

<ul style="list-style-type: none"> • Communication skills • Critical and structured thinking • Problem solving skills • Creativity • Teamwork capability • Negotiating skills • Self-management • Time management • Conflict management • Cultural awareness • Common knowledge 	<ul style="list-style-type: none"> • Responsibility • Etiquette and good manners • Courtesy • Self-esteem • Sociability • Integrity / Honesty • Empathy • Work ethic • Project management • Business management
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Figure 1. Examples of Soft Skills [11]

Soft skills are often organized in a structured framework such as using categorization of taxonomy. For example, Han [5] broadly categorized soft skills as people skills (interpersonal skills) and self-management skills, and listed attitudes separately (Figure 2).

Technical Skills programming, database design, security, etc.	People Skills communication, leadership, teamwork, etc.
Self-Management Skills awareness, emotion-control, confidence, etc.	
Work Attitude loyalty, accountable, etc.	
Professionalism appearance, courtesy, etc.	

Figure 2. Building Block for Career Success [5]

The author summarized ten skills for self-management skills and 18 for people skills [6]. The APLU's report [4] proposed a better categorization of the skills. It organized soft skills in seven clusters including experiences, team skills, communication skills, leadership skills, decision making/problem solving skills, self-management skills, and professionalism skills (Table 1).

Table 1. 10 Self-Management skills and 18 People Skills [6]

Soft Skills List – Self Management Skills	Soft Skills List – People Skills
<ol style="list-style-type: none"> 1. Growth mindset 2. Self-awareness 3. Emotion regulation 4. Self-confidence 5. Stress management 6. Resilience 7. Skills to forgive and forget 8. Persistence and perseverance 9. Patience 10. Perceptiveness 	<p>(Conventional)</p> <ol style="list-style-type: none"> 1. Communication skills 2. Teamwork skills 3. Interpersonal relationship skills 4. Presentation skills 5. Meeting management skills 6. Facilitating skills 7. Selling skills 8. Management skills 9. Leadership skills 10. Mentoring / coaching skills
	<p>(Tribal - usually not advertised)</p> <ol style="list-style-type: none"> 1. Managing upwards 2. Self-promotion skills 3. Dealing with difficult personalities 4. Dealing with difficult/unexpected situations 5. Handling office politics 6. Influence / persuasion 7. Negotiation skills Networking skills

Soft skills are commonly ranked by importance in the eyes of employers and professionals. A number of surveys revealed some common important skill sets, including communication and team work. The surveys made clear that these universal skills across academic disciplines are very important to employers.

The National Association of Colleges and Employers ran a survey [8] in 2014 where it asked hiring managers what skills they plan to prioritize when they recruit from the class of 2015 at colleges and graduate schools. Among them, the top 5 skills are all soft skills:

1. Ability to work in a team structure
2. Ability to make decisions and solve problems (tie)
3. Ability to communicate verbally with people inside and outside an organization
4. Ability to plan, organize and prioritize work
5. Ability to obtain and process information

In another survey conducted online by Harris Poll in 2014 on behalf of CareerBuilder among 2,138 hiring managers and human resource professionals (employed full-time, not self-employed, non-government), the top ten most popular soft skills that companies look for when hiring include ([3]):

- 1) strong work ethic – 73 percent
- 2) dependable – 73 percent
- 3) positive attitude – 72 percent
- 4) self-motivated – 66 percent
- 5) team-oriented – 60 percent
- 6) organized, can manage multiple priorities – 57 percent
- 7) works well under pressure – 57 percent
- 8) effective communicator – 56 percent
- 9) flexible – 51 percent
- 10) confident – 46 percent

The survey by Millennial Branding [10] also found similar top three attributes that companies are currently looking for: a positive attitude (84%), communication skills (83%) and an ability to work as a team (74%).

2.2 Soft Skills in IT and IT education

The demand for soft skills in the IT industry is as strong as other industries. Aasheim et al. [1, 2] conducted two surveys where IT managers were asked to rate the importance of various skills on a scale of 1 (low) to 5 (high), and soft skills were rated high (Table 2). Among other popular views on IT soft skills, communication, teamwork, presentation, analytical skills, flexibility, and creativity are constantly mentioned [14, 15]. ABET (Accreditation Board for Engineering and Technology) also specifies two student outcomes in its criteria for accrediting computing programs: “ability to function effectively on teams to accomplish a common goal” and “ability to communicate effectively with a range of audiences”.

Table 2: Results from Aasheim’s Two Surveys

Aasheim et al., 2009	Aasheim et al., 2012
Honesty/integrity 4.62	Honesty/integrity 4.55
Communication skills 4.54	Attitude 4.49
Analytical skills 4.51	Willingness to learn new skills 4.44
Ability to work in teams 4.49	Communication skills (oral and written) 4.42
Interpersonal skills 4.37	Analytical skills 4.40
Motivation 4.37	Professionalism 4.38
Flexibility/adaptability 4.33	Ability to work in teams 4.37
Creative thinking 4.18	Flexibility/adaptability 4.32
Organizational skills 4.13	Motivation 4.31
	Interpersonal skills 4.23
	Creative thinking 4.12
	Organizational skills 4.10

However, in many IT curriculum, the education and training on soft skills are not taken to the same level as the technical subjects. There are few independent courses offered completely on soft skills. And even if soft skills are designed as part of the learning outcomes in the courses, it is still challenging to design specific course work to assess them. The traditional assessment, including quizzes, exams, and assignments are often used to assess individual performance. However, they are not able to accurately measure soft skills such as interpersonal and leadership skills [16]. Course team projects provide excellent opportunities for soft skill training, but they take significant amount of time and work for students in a regular course. It is best to practice and assess soft skills in a term-long group project, which is often offered in a capstone project course.

3. SOFT SKILLS IN A CAPSTONE COURSE

3.1 Course Design on Soft Skill Practices

In the capstone course in our undergraduate IT program, students work in teams to develop a real-world IT solution integrating the knowledge acquired in preceding IT courses. The project is scoped to be finished in about 3 months, by a team of 3 to 5 people (with at least 120 hours of total project time per person).

The project emphasized the components including technical design, research, documentation, project management, leadership, team work, and communication skills. The final deliverable of the capstone project is an IT solution addressing a typical business or organizational need such as data management or networking, to be evaluated by faculty members, Industrial Advisory Board (IAB) members, and project owners. Most of the projects involve IT related design, development, implementation, analysis and research, in the real-world contexts. Students thus have an invaluable opportunity to experience many non-technical challenges such as requirement ambiguity, communication difficulty, and scheduling conflict.

The course provides an opportunity for students to apply all of their prior learnings and trainings in a real-world environment and solve a problem. To achieve this goal, they need to apply both their technical skills and soft skills, as described in the two main course objectives: 1) Apply IT concepts, applications, best practices, and standards to create a solution or report that addresses real business needs; 2) Practice soft skills such as project planning and management, research and learning, communication, writing, presentation, and team work, problem definition, project management, writing, documentation, presentation, virtual collaboration, in a real-world IT project. This capstone project also requires students to learn and practice new knowledge and skills.

Based on our literature review of soft skills, feedbacks from IAB board member, and our prior experience teaching the course, a variety of soft skills are designed into the capstone course work and project requirements. The following eight skills are particularly emphasized and evaluated:

- 1) Communication: students are required to communicate effectively with all stakeholders, especially the project owner. This includes but is not limited to proper emailing, meeting and discussion efficiency, mutual understanding in discussion, regular status report. Students need to learn to use virtual communication tools as well.
- 2) Presentation: this includes a formal group presentation and a poster session to the department faculty, project owner, and IAB members, and three informal milestone presentations to the project owner.
- 3) Planning: students are required to write project plans, estimate workloads, break down work structure, and other tasks needed in the planning stage.
- 4) Team work: a group consists of three to five people, with one designated team leader. The team works together to achieve the goals and will receive the same grade for the project performance (except for the peer evaluation part).
- 5) Time management: milestones and various deadlines are set to facilitate the project progress. Failure to meet deadlines will impact grades, and it requires detailed explanation and specific plan on follow-up actions.
- 6) Dealing with challenges: all projects are in real-world contexts, and with real-world challenges besides just technical difficulties, for example, time conflict among members, lack of timely response from project owners, requirements change, etc.
- 7) Independent learning: students may need to learn new skills and knowledge on their own to complete the project.

8) Writing/Documentation: every project has a writing component including documentation, report, and other technical documents.

3.2 Evaluation of Soft Skills

The evaluation of soft skills is done by all major stakeholders, each with a different focus (Table 3). A total of 90 points are allocated to the complete project, and another 10 points are allocated to an assignment of career profile/portfolio. The instructor gives 30 points in total particularly on project progress reports, such as project plan, milestone reports, and final report. The project owner gives 20 points; faculty and IAB members give another 20 points; and teammates give the last 20 points. Each evaluation party is given an evaluation form with specific scoring rubric. The items on soft skills are assigned specific weight in all of the project evaluation forms.

Table 3: Evaluators for a Capstone Project

Soft Skills	Evaluated by			
	Instructor	Project Owner	Faculty/IAB	Student Peer
Communication	*	*		*
Presentation	*	*	*	
Planning	*	*		
Team work	*	*	*	*
Time management	*	*		*
Dealing with challenges	*	*		
Learning	*		*	
Writing	*	*		
<i>Total Points</i>	30	20	20	20

The evaluation of the soft skills is as follows:

- 1) Communication: the project owner evaluates communication between the group and the owner; each student evaluates communication within the group; the instructor evaluates communication among all parties.
- 2) Presentation: the instructor and the project owner will evaluate three milestone report presentations while faculty will evaluate the final presentation and poster session.
- 3) Planning: the instructor is the main source of evaluation. The evaluation is heavily based on how well students use the Gantt chart tool for the planning of project.
- 4) Team work: team work is evaluated by all of the four parties. The faculty will evaluate this based on students' self-reported experience and the other three parties will evaluate this based on actual experience throughout the semester.
- 5) Time management: the instructor and project owner evaluate how students meet deadlines. Students also evaluate their team members on the timeliness of assigned task completion.

6) Dealing with challenges: the instructor and project owner are the best choice to evaluate students' experience of challenges. The evaluation is subjective but reflects instructor and project owner's view through personal experiences throughout the project process.

7) Independent learning: the instructor is primarily responsible for evaluating student learning in the project, through a number of evidences including milestone report meetings, research reports, and other conversations. The faculty members evaluate this skill through student self-reported experience in the final presentation.

8) Writing/Documentation: this skill is mainly evaluated by the instructor as students turn in the final project report. Project owners also evaluate the quality of documentations. Research reports are part of the evaluation if they are part of the required deliverables.

3.3 Student Reflection Analysis

How student perceive and value their soft skills practiced in the project is an important factor of their overall project experience. At the end of the project, each student reviews his/her experience in the past three months and is required to write an individual reflection as part of the final project report. One component of the self-reflection is to provide a particular piece of advice to the future students who will take this course.

To analyze their perception of the value of soft skills from their own experience, we examine student reflections from the capstone projects in the fall 2014 semester. All relevant advice are selected from their project report and compiled into an advice list. Out of the 30 students who completed the course, 24 valid responses are included in the data set. Six students either did not submit the individual reflection or did not provide specific advice.

The authors of this paper took a template analysis method to code the student responses. Using a pre-established coding scheme which consists of all of the nine soft skill categories described in the prior section, each coder read the student response and labeled them using these categories. If a theme did not fall into a particular category, then a new code would be created. After individual coding was done, all coders compared the results and discussed the differences extensively until reaching consensus. In the end, all mentions of each soft skill were summed up. A total of 14 themes were mentioned, with eight new themes emerged from the analysis, and two of the original themes with no mentions at all (writing, presentation). The frequency of the top five soft skills mentioned in student comments is shown in Table 4. The top five items are consistent with what the industry widely perceived.

The students' responses reflected the importance of soft skills in capstone projects. Out of all of the 24 responses, only two responses directly mentioned about technical skills. It clearly indicated that students highly valued the practice of soft skills from their capstone project experience.

4. DISCUSSION AND CONCLUSION

Soft skills are important factors in hiring and career development. IT professionals also value soft skills greatly. Currently there are some difficulties to assess soft skills in regular IT technical courses, but the capstone course is a good venue where students can specifically practice and develop their soft skills, and receive evaluation and feedback to improve them.

Table 4: Summary of the Soft Skills in Student Advice

Soft skills mentioned	Number of times	Selected Exemplar Quote
Time management	13	Time management is one of the most important things students should consider. Take into account the workload of other courses as well as job schedules.
Communication	9	Make sure the communication process for the team is clearly established prior to leaving the first meeting.
Planning	8	Spend some time to plan the project and try always to go ahead in the schedule.
Teamwork	7	Team collaboration is probably one of the most important aspects to the overall group's success.
Motivation	6	Make sure to be involved throughout the whole project. Do not be afraid to take challenging tasks, there are plenty resources out there to assist you.

In this paper, we reviewed recent literature and survey results on soft skills in general and in the IT industry, and we described how we designed the capstone course at the Department of Information Technology at Kennesaw State University to emphasize soft skills. The course was developed to provide a more systematic way of facilitating the development of soft skills and assessing the students' competence on such skills. An examination on student reflections found that the participants highly recognized the importance of soft skills and well practiced the soft skills designed into the course.

We plan to extend our study in the following directions: 1). we had more data yet to be analyzed, which include student reflection data submitted through the past three years, more student comments than just advice, project fact information, among others. The analysis of the complete set of data will increase the validity of our findings; 2). The evaluation of soft skills is still preliminary at this stage. We are working toward a better justified assessment framework for soft skill evaluation.

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