

# The Effect of **Real-World Capstone** Project in an Acquisition of **Soft Skills** Among **Software Engineering Students**

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# Motivation

- there is a **growing expectation that IT professionals** should **possess** both hard skills also known as "technical skills" and **soft skills** also known in the literature as "non-technical skills", "people skills", "social skills", "generic competencies", or "human factor" (Maturro 2015)
- “soft skills give hard skills the required plasticity to develop and keep up-to-date in changing circumstances” (Cimatti 2016)
- to accomplish this, upcoming IT professionals need to **develop** their soft skills in a **realistic environment** during their study

# Capstone projects

- “the high point : crowning achievement” (Merriam-Webster)
- opportunity to undertake a significant software engineering task, deepening their understanding of many of the knowledge areas forming the SEEK (ACM/IEEE SE curricula guidelines 2014)
- students apply the previously learned skills, deepen the understanding of the acquired knowledge, extend the area of knowledge, and apply their knowledge and skills in a realistic simulation of professional experience in the university environment (Mahnic 2012)

# In this study

- (i) **examine the effect of capstone course in the acquisition of soft skills** among graduate students after working closely on a real-world project with the representative from public and private organizations
  
- (ii) **map the results of the findings** to the desired requirements of soft skills in various roles in the software industry identified from the previous literature

# Related work on soft skills in software industry

- literature review found out that

*communication, interpersonal, analytical and problem-solving skills, team player, organizational, ability to work independently, open and adaptable to changes, attitude, aptitude, commitment, responsibility, eagerness to learn, motivation, leadership, customer orientation, cultural fit, fast-learner, work ethics, understand business drivers, proactiveness, ability to work under pressure, focus on details, and focus on quality*

- are the desirable soft skills in various roles in the software industry.

# Our use case: 3 years of capstone course

- 3 years of development (2016-2019) of the course and the last implementation
- Follows ACM guidelines, especially  
*Where possible, a project should have a “customer” other than the supervisor so that the student gains fuller experience with product development life-cycle activities*
- Instructor responsible negotiated with the representative from Finnish private and public organizations to act both as the client and a mentor to the students

# Learning objectives of our course

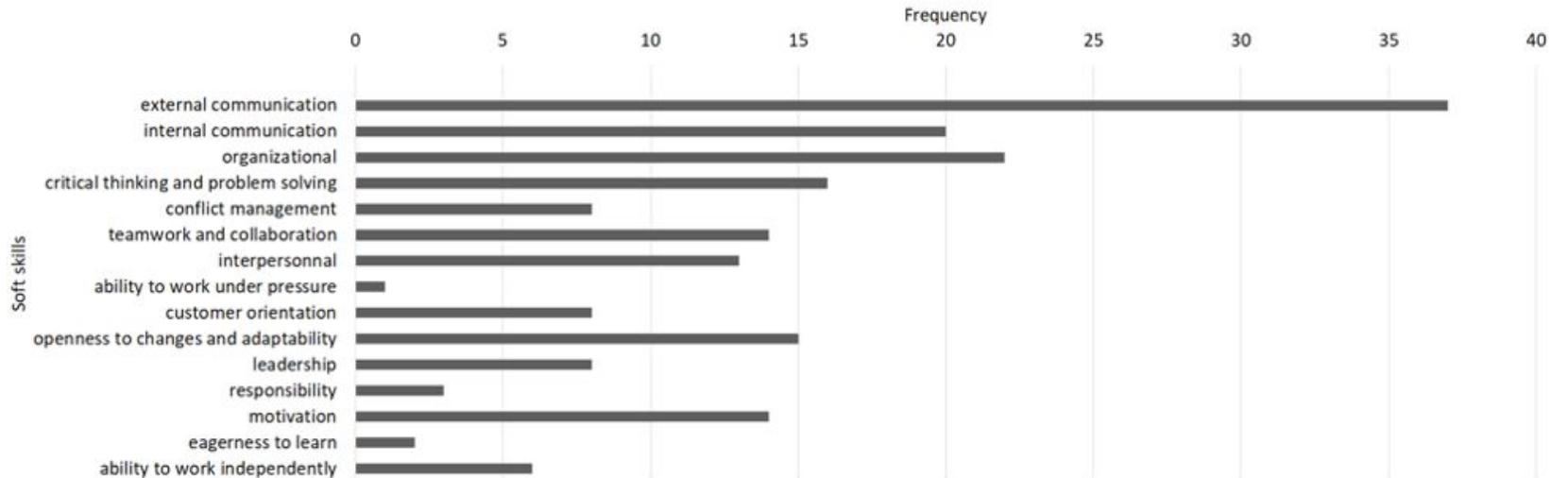
- Plan, estimate and monitor a software project iteratively and incrementally;
- Understand design thinking methods and usability techniques and, their practical application into a project's lifecycle;
- Implement as software system from scratch;
- Familiarize with contemporary development tools and environments;
- Use modern software engineering practices to plan, monitor and deliver a realistic software project that **meets the Stakeholders needs**, is highly usable and sustainable;
- Understand the new business challenges and opportunities for their software projects.
- Collaborate in small groups towards a common goal to **align with customer and end-user needs**;
- Design a solution based on the problem presented so that it is meaningful and have an effect on individuals and communities;
- **Customer satisfaction** with the project deliverables

# Data collection and analysis

- Based on a written reports of the students and teacher instructions
- Reflection of project life cycle to
  - project management;
  - involvement and interaction with the customer;
  - technical development aspects;
  - future plans with the project;
  - the overall team what team acquired from the course;
  - what each individual acquired from the course.
- Thematic analysis of the reports
- Using template to extract data
- Frequencies and reflection on skills

# Identified soft skills

- Reports revealed 15 soft skill categories (# of students reflected)



# Reflection on the skills

External and internal communication skills - emphasis of 2019 course

- "Working with real customers has given me a lot of new experience and this process has solved many of my puzzles about how to cooperate with real customers, such as how to communicate with customers and whether we should rigidly design according to customers' original requirements when we think there is a better solution. I believe these experiences will bring me a lot of benefits in my future career"
- "I learned how to, as a team via project manager, interact with the customer and how important it is to communicate with the customer as often as possible."

# Reflection on the skills

## Organizing skills (and teamwork)

- “The project made me realize that it is not as easy to allocate different jobs to different people and expect them to make the same effort towards the project”
- “Lot of small tasks come up in the project, and they should be allocated according to personal skills and resourcing situation”
- “I needed to be on time for our meetings and do the tasks given to me”

# Reflection on the skills

## Critical thinking and problem solving skills

- “Because sometimes, customers cannot clearly express their will. At this point we need to have a better understanding of what the customers are trying to achieve and how the users are using the application”
- “for every project, we need to analyze provided data to find the potential requirements that customers did not mention.”

# Reflection on the skills

## Conflict management

- “I learnt to make compromises in situations where one or more team members have very strong opinion that I disagree with”
- “We had to do compromises, because not everyone is going to agree on everything and still the work needs to be done”

# Mapping the identified skills to desired soft skills

- the majority of identified soft skills in this course corresponds to the desirable soft skills employers in the software industry
- ... student did not pinpoint every skill set what they acquired during the course

List of desirable soft skills in the software industry	frequency of each soft skill categories acquired (number of students out of 48)
external communication internal communication	37 10
interpersonal	13
critical thinking and problem solving	16
team player	14
organizational skills	22
ability to work independently	6
adaptability and openness to changes	15
motivation	14
leadership	8
customer orientation	8
responsibility	3
eagerness to learn	2
ability to work under pressure	1
attitude, aptitude, commitment, cultural fit, fast-learner, work ethics, understand, business drivers , pro-activeness , focus on details, focus on quality	Not mentioned

# Discussion

- “Large software development projects involve multiple interconnected teams, often spread around the world, developing complex products for a growing number of customers and users” (Smite, 2017)
  - The acquisition of communication skills during the project may help students to fulfill one of the requirements set by most of the employers and help them to find employment.
- **soft skill set student gained through this course, might be useful**
  - to handle the complicated situation, collaborate with a diverse workforce work, efficiently use the collaborative platform, collaborate with the number of customers and users, including experienced mentors and coaches
  - to facilitate open discussion, collaboration, team working, cultural and diversity awareness, respectful and supportive behavior in their future career

# Teacher reflections

- Team contract to avoid free riding
  - Still failure with one large and one distributed team
- “Contract” with the customer to guarantee effort
  - Customers were overly satisfied
- Difficulties matching course/student and business schedules
  - Failure in customer negotiations (course instructor)
- Projects had life after course
  - Start-up
  - Taking the product into production on some companies

# Conclusion

## Benefits

- (i) better engagement of the teams due to external real-world customer;
- (ii) more effective development process due to the PBL approach, i.e., separation of theoretical aspects from the actual development;
- (iii) more complex requirements management

## Potential improvements

- (i) timely communication in online team communication tools;
- (ii) an unequal load of team members;
- (iii) overall project management