Supervising for Independence
– A Case Study of Master Science Projects in Higher Education

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ABSTRACT: Students completing a Swedish Master's degree in engineering should have knowledge and skills to independently solve engineering issues. This autonomy should be developed and demonstrated within the M.Sc. project course. But, how can supervisors encourage independence? We have explored this in a case study through semi-structured interviews with students, supervisors and examiners of two M.Sc. projects. We investigated their view of independence, and how supervision correlates to independence. The results identify areas relevant to independence, namely supervision roles and relationships, student characteristics, M.Sc. process, and view on independence. The results confirm previous findings that students' knowledge of and motivation for the topic support independence. The supervisor's role is to guide and support through frequent peer-level discussions and to act as a discussion partner, while the student should have the main responsibility for the project. We conclude that it is important for supervisors to encourage students to take ownership of their M.Sc. projects and to design their own solutions, while providing the overall process and timelines.

1 INTRODUCTION

The main aim of the Master projects at the technical faculty of Lund University is to allow the student to 'develop and demonstrate knowledge and ability required to autonomously work as an engineer' [2]. We wanted to investigate how supervisors and students interpret this, in order to support supervisors in encouraging student autonomy. We defined the following research questions:

RQ1 How is the formal requirement for independence interpreted by student, supervisor and examiner?
RQ2: How does the independence influence the student-supervisor feedback loop?
RQ3: How does knowledge and motivation affect the independence of a M.Sc. project?

These questions were explored in a case study at the technical faculty of Lund University. The study involved six semi-structured interviews with the student, supervisor and examiner for two MSc projects.

Related work is discussed in Section 2, while the two cases are presented in Section 3. The research method is outlined in Section 4, results presented in Section 5 and summarised in Section 6.

2 RELATED WORK

The transition from a consuming student to an independent scholar or 'a producer of knowledge' has been compared to creative performance by Lovitts [3]. Lovitts presents five factors that can enhance creative performance and thus independence, namely intelligence, knowledge, thinking style, personality and motivation. The academic environment (supervisor, department, educational institute and system, and the discipline) can influence the student and facilitate him/her in realising their creative potential and maturing in independence of work. Supervisors who produce many PhDs have been found to support the behaviours and thought processes required for creative and independent research. Furthermore, they enact a peer collaboration when nearing PhD completion.

For each of the five factors influencing independence Lovitts [3] presents a number of pointers to how the environment can boost or hinder the process of becoming an independent and creative scholar or researcher, as follows.

- *Intelligence* is needed but the correlation to creativity is low for high IQ [5]. Being successful entails a combination of analytical, creative and practical intelligence [5]. It is possible to teach in a

way that increases creative and practical intelligence [6]. A correlation was also found between high levels of creative and practical intelligence, and ethnical, racial and socio-economic diversity.

- *Knowledge* is needed to add to existing knowledge and to contribute with new aspects and theories. In particular, a deep understanding of the discipline or speciality area (as opposed to surface learning) including informal or tacit knowledge of the area is required. This can only be obtained through socialisation into the community of the discipline and requires spending time, observing and interacting with supervisor, faculty and more senior peers.
- *Thinking style* 'signifies how a person prefers to use her abilities' and is believed to be a key ingredient in creativity [5] that affects how well a task is performed. Sternberg states that thinking styles can be modified through social interaction (e.g. with a supervisor) and by rewarding and encouraging, thus inducing creativity [5][6]. However, this requires that the supervisor is comfortable with a student that takes a more creative, and often less conventional and potentially safe approach.
- *Personality*. Creative people frequently display the following: self-discipline, perseverance, independent judgement, tolerance of ambiguity, autonomy, internal locus of control, willingness to take risks, self-initiated and task-oriented striving for excellence. These inherent traits may be developed in a social context and even taught explicitly through guidance and support.
- *Motivation* 'is a key factor that mediates between what a person can and will do.' [1] Research shows that students who choose their own activities (e.g. thesis topic) are more internally motivated than those who have been presented with what to do [1]. Motivation can be stifled by insensitive mentoring, rigid environments, bureaucratic requirements and stress.

3 THE CASES

The two investigated M.Sc. projects were initiated by and performed at two departments within the technical faculty at Lund University. The first project focused on improving an existing technical system. The department has an established process for MSc projects which includes milestones over the expected length of the project. The second case had a research focus and was performed in a research group that applies an iterative and prototype-based MSc process. For both cases student-supervisor meetings were held approximately every other week.

4 METHOD

We performed a case study [4] of two MSc projects with the aim of investigating how the concept of 'independence' is interpreted and to understand the factors involved. Recently completed projects were sampled from two departments at the technical faculty of Lund University. To reduce the number of varying factors, only projects performed at LTH were considered, i.e. not projects performed in industry.

Semi-structured interviews were held with student, supervisor and examiner for each case. An interview guide was constructed based on literature and on research questions. The interviewees were ensured confidentiality and anonymity. Each interview was audio recorded, transcribed, and the summary sent to the interviewee to ensure a correct understanding. At least two researchers attended each interview.

A cross-case analysis was performed on the information gained through the interviews and through the review of the M.Sc. reports. This was done at a workshop where all the authors jointly identified and compared findings from the two cases. The outcome is presented below and summarised in Table 1.

5 RESULTS

The insights gained from the interviews are presented in six categories: general categorisation of case projects, supervision roles, process used, student characteristics, relationships between the roles, and the interviewees' views on independence. An overview of the findings per case is shown in 5.5.

5.1 General

For both cases student independence and project outcome were judged as excellent by all interviewees. In the second case, the student completed the project including the thesis with one month's delay. For the first case, the project results have been presented while the thesis was not yet completed (18+ months after the presentation).

Table 1. Overview of results per case.

Case 1	Case 2
Very good degree of independence	Very good degree of independence
General	
-Clear stakeholders. Examiner and supervisor had pre-existing interest in topic -High-level specification of problem by supervisor and examiner. The student specified the details. . -Very good technical results. -M.Sc. project not yet completed +18 months since presentation. Written report needs updating.	-Clear stakeholders. Examiner and supervisor had pre-existing interest and stake in the work. -The examiner specified the problem. -Excellent research results providing basis for a scientific publication. -M.Sc. project completed with 1 months delay.
Supervision Roles and Relationships	
-Supervisor with long experience -Minor differentiation between supervisor and examiner role. -Examiner – student: viewed as technical expert but still a student -Supervisor – student: developed into peer relationship	-New supervisor with experience from 1 previous M.Sc. project. Wanted more control of details. -Minor differentiation between supervisor and examiner role. -Examiner – student: student-professor -Supervisor – student: peers
Student	
-Top student with expert technical knowledge within topic. -Driven and motivated by interest -Mostly worked from home. -Employed as a technician before M.Sc. project -Now employed at technical function within the university	-Top student with expert skill in programming. -Previous web programmer. -Goal-oriented. -Now pursuing a PhD within the research group
M.Sc. Project Process	
-First 2 weeks, the student writes a problem description to demonstrate understanding. -Clear milestones set in time from project start.	-An iterative process -Early prototype to gain understanding. -Iterations (agile approach). -Work cut off by time.
VIEW ON INDEPENDENCE	
The Examiner View	
Student -responsible for running the project -performs the work himself. -details the problem. -argues for design choices. -analyses data.	-Student works and finds information by himself (even if working in a group). -Professional attitude. -Cultural difference in degree of student independence.
The Supervisor View	
Student - performs the work himself - responsible for designing solution Independence is connected to motivation and focus on the task.	-Focus on student development. -Student can work with others.
The Student View	
Student - control and responsibility of designing the solution. - own ideas. -'Owns' the problem, possibly by taking on an initial problem definition.	Student - understands and develops solutions based on a problem statement. - handles practical problems.

Both projects have a clear set of stakeholders. For case 1, these were technical functions within the university in which the supervisor and examiner had a personal interest. For case 2, the research group of the supervisor and the examiner was a stakeholder in the project.

5.2 Supervision Roles and Relationships

The supervisor in case 1, had long experience of supervision. He encouraged and expected students to be responsible for problem solution and project progress. He saw his role as ensuring that the student was moving in the right direction. In contrast, the supervisor for case 2 only had experience of supervising one prior M. Sc. Project. This supervisor expressed that he would have liked more control of the project, e.g. through more frequent supervision meetings. For both cases, the examiner had an active and partly overlapping role with the supervisor due to their personal interest in the topic.

Both supervisors stated that they viewed their relationship with the student as peer-level. The more experienced supervisor (for case 1) said that this was a gradual development. Both examiners described their relationship as a more traditional professor-student relationship.

5.3 The Student

Both investigated students were top performers with expert knowledge from previous work experience. For case 1, the student was strongly motivated by an interest in the topic and is now employed at a technical function within the university. For case 2, the student was goal-oriented, and is now a Ph.D. student within the research group.

5.4 M.Sc. Project Process

The two case projects followed different processes although both had a clear cut-off in time. A milestone-based process was applied for case 1 with clear expectations on timely deliverables from the student. For example, two weeks after start a problem definition was expected, and similarly there were clear deadlines for when the thesis and the oral presentation should be completed.

For case 2, an iterative process was applied where the student read literature and implemented a prototype until a certain point in time when the iterations were stopped and the project completed.

For both cases the student got to demonstrate understanding of the problem at an early stage. For case 1 this was done through the problem description, while for case 2 this was done through prototyping. For case 1, the problem description was used as an agreement of what should be achieved for a successful completion of the project. These problem descriptions were seen as an important agreement of the scope and extent of the project, in particular for industrial M.Sc. projects.

5.5 View on Independence

Each interviewee shared their view of *independence* in a M.Sc. project. For case 1, all interviewees expressed the importance of student responsibility for solution design and analysis, and for performing the work. The examiner for this case expected the student to argue for his design choices and thereby further demonstrate understanding, skill, and independence. The student reflected this same attitude but from his perspective, i.e. that the student is in control and has the freedom to design a solution. Furthermore, the (experienced) supervisor for case 1 stressed the importance of a personal interest and internal motivation on the part of the student, both of which lead to a good independence in the work.

For case 2, the interviewees expressed the importance of student responsibility for the solution, while also stressing that independence can be achieved when working with others. The examiner expressed that independence is part of a professional attitude and also described cultural differences concerning independence. For example, in some countries it is very common that students live with their parents for longer and are less independent than students who have their own accommodation.

5.6 Threats to Validity

As for all studies there are limitations with this study and the obtained results. We will discuss the threats to description and interpretation validity and generalizability according to guidelines by Robson [4].

Description. The main threat to a valid description is the risk of misunderstanding the interviewees. This risk was mitigated by transcribing each interview and asking the interviewee to review this transcript.

Interpretation. The risk of imposing preconceived views on the interviewees was largely mitigated using open questions that allow freely expressing views. However, in the few cases when clarification was needed there is a risk that the researchers' preconceived view of the factors was unconsciously imposed.

Generalizability. As for all case studies, the results should be considered in the light of the case contexts. Considering the specificity of our case contexts we consider the results valid for internal (non-industrial) M.Sc. projects with top students within the two studied departments / research groups. Transferability to other cases may be considered on a case-by-case basis by comparing the case characteristics.

6 CONCLUSIONS

The M.Sc. project is the final part of the engineering programmes where the student is to practice and demonstrate that he/she has obtained sufficient knowledge to qualify as an engineer. An important part of this is the student's ability to independently solve engineering problems, as is expressed in the course programme goals. But, what does this mean in practice and can the supervisor encourage this? Our investigation of two M.Sc. projects provides some insight into this and to our research questions.

The formal requirement for independence is interpreted by all involved roles (RQ1) to mean that the student should design the solution and do the actual work. The exact degree of freedom vs. control and the feedback loop between student and supervisor (RQ2) varied for the cases. While both had bi-weekly supervision meetings, somewhat more control was imposed for case 2, thus less freedom. We attribute this to two factors, namely supervisor's level of experience and degree of personal interest in the project. A less experienced supervisor may feel less secure and compensate by requiring more control. Furthermore, there is a risk that when supervisor and/or examiner are stakeholders in the M.Sc. project they want more control, and thus risk limiting student freedom and independence. Furthermore, more control might be required for finishing on time depending on the student's ability to focus on tasks.

Finally, our study confirms previous findings [3] that knowledge and motivation affect independence (RQ3). Both interviewed students had a high degree of these factors. In contrast, one supervisor had experience of other student projects where lack of knowledge negatively affected student independence.

We conclude that it is important for supervisors to encourage students to take ownership of their projects and to design their own solutions. The supervisor should guide and support by providing overall timelines and guidelines, e.g. a process, completion dates. Through peer-level discussions supervisors should act as constructive discussion partners, not take over the responsibility for the project. Especially in cases where the supervisor, or examiner, are project stakeholders these interests should not impose control. Rather the student's development as an independent engineer should be the main focus.

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