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The Blurred Line Between Failure and Success in Student–Industry Projects

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1 Introduction

Student–industry activities are often heralded as win–win–win activities in which students gain knowledge of their future professional fields, companies access student knowledge, and universities both offer students stimulating learning opportunities and strengthen ties with industry. Student–industry projects can be defined as an active learning methodology characterized by pedagogical values such as improving student understanding of the concepts, motivation, interest in the subject, and work efficiency (Barak, 2009). Biggs and Tang (2009) find that a stimulating learning environment relies on three main components: 1. an open environment, 2. worthwhile tasks, and 3. demands that students can realistically hope to meet. In the same vein, Perkins (1991) stresses the importance of learners' attitudes towards the learning situation and of students' "buying in" to the instruction agenda, factors that are much more easily stimulated when students are confronted with real problems by stakeholders than when presented with constructed problems in simulated situations. Leenders and Maufette-Leenders (2010) argue that a fictitious scenario will not appear credible and not engage students the way an authentic situation does. Authentic learning "focuses on real-world, complex problems and their solutions" (Lombardi, 2007, p. 2), and introduction into a professional environment helps students become "enculturated" into the discipline, a crucial concept according to Lave and Wenger, as "a training program that consists of instructional settings separated from actual performance would tend to split the learner's ability to manage the learning situation apart from his ability to perform the skill" (1991). University representatives generally agree that student–industry activities make students more employable after graduation (Dawson et al., 1997). Seen in this light, one may wonder why so many student–industry activities are established, only to survive a few iterations. Student–industry activities are by no means homogenous, and include a wide variety of collaboration models ranging from short undemanding meetings between students and industry representatives to long complex relationships demanding considerable effort from universities, companies, and students alike. We have no reason to believe that the success factors for these widely divergent collaboration models are identical. In approaching the concept of "success", we find it desirable to distinguish between various student–industry activities in a defined framework. In the project management field, critical success factors are often discussed and identified (Pinto and Prescott, 1988; Westerveld, 2003); to better the odds of survival of student–industry activities, the same needs to be done in the field of university–industry collaboration to create more stable student–industry activities.

2 Research questions

The research presented here investigates the collaboration between industry and higher education institutions and identifies possible success factors in a specific student–industry collaboration model. More specifically, we seek to answer the following questions:

- How can various collaboration models be categorized?
- How can a successful "Industry Link" project be described?
- What are the success factors for Industry Link projects?

3 Study

The research presented here investigates the collaboration between industry and higher education institutions and identifies possible success factors on four levels (Fig. 1).

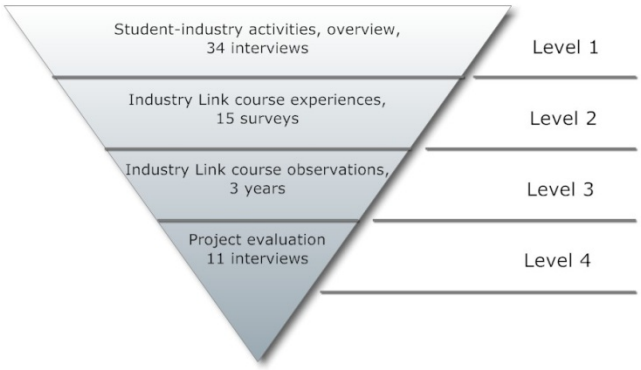

Fig. 1. Structure of the present research

The top level and starting point of this study is the initial interview study involving 34 in-depth interviews. The interviews were based on a flexible design (Robson, 2002) incorporating semi-structured (i.e., open-ended) questions. This top-level study focuses on engineering education, understood broadly, in order to include a variety of student–industry activities. All interviews except one face-to-face interview were conducted over the phone and lasted 20–30 minutes. The interviewees were staff from thirteen companies, eight teachers representing four universities, and thirteen students; all interviewees had experience of student–industry activities. Before the analysis, all interview material was fully transcribed. The material was coded according to predefined categories and analysed and discussed by us before the results were recorded. From the results of the interviews, two main collaboration models were identified: 1. collaboration models delivering real results to industry (e.g., projects and theses), and 2. collaboration models not delivering real results to industry (e.g., guest lectures and study visits). A third hybrid category was also identified: 3. collaboration models in which the output depends on the interpretation and implementation of the collaboration model (e.g., workshops and practical training). These three categories were then used to further categorize the various collaboration models according to their characteristics.

We designed a framework for describing and grouping student–industry activities that would allow a structured approach to the various activities. The framework describes student–industry activities in terms of their relative positions on three scales capturing: 1. type of contact between student and company; 2. student activity in relation to the company, and 3. degree of student responsibility in relation to the company. We then decided to examine, in greater depth, a specific collaboration model belonging to the first category, i.e., collaboration models delivering real results to industry. The "Industry Link" project course was chosen for this closer scrutiny in what constitutes level two of the study. Industry Link is taken by students in their third year of a three-year computer engineering programme. The course lets students prepare for their future professional careers and facilitates their introduction to the industry. More specifically, the students should be able to work in teams and to participate actively in a project-driven environment in collaboration with industry. Students taking the course are divided into project teams of 5–7 members, and each team is assigned to a company and presented with a problem formulated by the company. Several companies are involved, and each project team works on a unique problem. From a pedagogical perspective, the central aim of Industry Link is that students should achieve learning outcomes that foster understanding of the project development process and, specifically, of their own roles in projects. The Industry Link project is a subset of the whole course.

The 15 students who took the course in the same semester were surveyed using paper questionnaires. This survey derived and documented broad experiences of the collaboration model represented by the Industry Link course. We then analysed and discussed the gathered material before substantiating the results.

To identify the success factors for Industry Link, during level three of this study, the course was observed and logged for several years. All experiences, changes, and evaluations were logged and documented in a study protocol. The observations and documents regarding Industry Link were coded, first, in a first-level coding into key areas and then in a second-level pattern coding in which the initial codes were broken down into a number of subareas. We then analysed and discussed all the coded material, drawing conclusions after reviewing the coded text. The results of the survey and observations were used as a framework for level four of the study: an interview study of 11 students who had participated in the course. The interview study aimed to pinpoint what makes a project in a project course, such as Industry Link, successful from the student perspective. Projects from the Industry Link course were randomly selected, and the students

involved in the selected projects were contacted and interviewed. As in the top-level interview study, the interviews were based on a flexible design using open-ended questions. Seven interviews were conducted over the phone and four were conducted in person; all interviews lasted 20–40 minutes.

The final deliveries from the student teams to the companies (logged during level three of the study) were evaluated against the initial project descriptions and divided into three categories: 1. successful delivery according to project description, 2. partly successful delivery according to project description, and 3. unsuccessful delivery according to project description. The student evaluations of the Industry Link project, derived from the level-four interview study, were then mapped against the company delivery categories. Two more mappings were also conducted: the second mapped student evaluations of the company relationship against student evaluations of the Industry Link project, while the third mapped student evaluations of company relationship against delivered results.

3.1 Validity

According to Yin (2003), validity can be categorized as construct validity, internal validity, external validity, and reliability. Construct validity can be threatened by participant bias, i.e., the participants may misunderstand terms or questions and interpret them differently, which is a threat in both interview and observational studies. To reduce this threat in the four levels of this study, the interviewer was able to give explanations during the interviews to prevent misunderstanding. Participant bias could still pose a threat in this study if interviewees deliberately answered incorrectly, for example, focusing excessively on their own side of the story, articulating a distorted view of reality, and trying to defend their own actions. There is also a risk that interviewees might feel they were being evaluated, since the university commissioned the interviews, even though the interviewers were external and it was initially explained to the students that this was an independent study. A threat to external validity is that participants may not be representative of the target population; to reduce this risk, all interviewees were required to have personal experience of student–industry collaboration activities. While we sought to reduce internal validity threats, we drew no conclusions as to causal direction. Researcher bias must not affect the interpretation of the material, since this would threaten reliability, so after the interviews and observations were completed, we provided valid descriptions of them. Observer triangulation (Robson, 2002) was implemented by having two researchers with different roles cooperate during the study, and by considering alternative interpretations and explanations. Both observer and data triangulation were used to reduce the risks of reactivity (Robson, 2002) and respondent bias. Using data from a range of sources, i.e., interviews, observations, questionnaires, and documents, we achieved data triangulation.

4 Results

4.1 Framework for defining and grouping student–industry activities

The level-one interview study revealed a large number of differently named and structured student–industry activities, some of which shared some similarities. There is little doubt that the activities also differed in applicability, as any given collaboration model will be better suited to certain learning situations than to others. Likewise, the success factors for one activity will differ from those for another. A tool is obviously needed for describing and grouping collaborative activities. As our main concern here is student–industry dynamics, the framework used is based exclusively on the interaction between student and company. The collaboration models encountered in the level-one interview study would typically differ (or be alike) in relation to three sets of parameters. We therefore suggest a framework for describing various student–industry activities in terms of their relative positions on three scales. The first scale concerns the *type* of contact between student and company. Activities that help students get an inside view of the company, to understand its internal structures and processes, may include: individual contact with company representatives, being present in the company, and participating in company activities. A different type of activity, such as guest lectures, may offer students inspiration, but does not give them firsthand experience of the company and its day-to-day activities; such activities can be said to give students an outside view of the company. Accordingly, a student–industry activity can be described by its relative position on an inside view–outside view scale. The second set of parameters concerns the degree to which a student is *active* in relation to the company, i.e., whether or not the student is working actively on a company assignment, is forced to relate to company requirements, or has to deliver some sort of result to the company. The second scale describes the degree to which a student participating in an activity is expected to be active or passive. The third set of parameters concerns how much *responsibility* is placed on the student. As our main concern is the relationship between student and

company, the parameters we include in our description of responsibility concern responsibility for an activity, for maintaining relationships with company representatives, for following the agreed-on time schedule, and for ensuring the delivery to the company is timely and of the right quality. When applicable, the parameters may also indicate whether the project outcome has potential to affect the company.
Three collaboration models, one from each of the three main categories (i.e., successful delivery according to project description, partly successful delivery according to project description, and unsuccessful delivery according to project description), illustrate how relative placement on the three scales can describe the student–industry activity. It should be noted that, as several variations have been encountered in the study, the charted value is what is typical of the encountered models.

Project courses, as a type, exemplify collaboration models that deliver real results to the company. Students participating in such courses must typically work actively and be responsible for both process and outcome; although they are collaborating with the company, they are not as a rule involved in the company's ordinary workflow (Fig. 2).

Fig. 2. Project course, a type of collaboration delivering real results to the company.

Guest lectures exemplify collaboration models that do not deliver results to the company. When students attend guest lectures they may become inspired and gain new insights, but the guest lecture offers no first-hand company experience, the activity is performed by the lecturer, and students have no responsibility for carrying out the activity (Fig. 3).

Fig. 3. Guest lecture, a type of collaboration delivering no real results to the company.

Internships represent the hybrid category of models, in which the output depends on the interpretation and implementation of the model. The form of internship encountered in the study was one-semester placements at a company; in these, students participated actively in day-to-day activities at the company, but were not personally responsible for processes or projects (Fig. 4).

Fig. 4. Internship, a hybrid type of collaboration.

4.2 Industry Link course: three dimensions of success

The Industry Link course belongs to the subcategory "project course" in the category "collaboration models that deliver real results to the company". The project part of the course is student driven and the student teams bear responsibility for all communication with the company. They are also fully responsible for both the project process and final delivery to the company.

Traditional university courses involve two parties, university and students, and the relative success of a university course is usually determined using two instruments: an examination and a course evaluation. The examination allows university representatives to describe, as objectively as possible, the degree to which students have achieved the course's learning outcomes, while the course evaluation encourages students to describe their relationship with the university and to assess their own learning. The moment we engage in student–industry activities, the dynamics of the learning situation change

fundamentally: a third party from outside – a company – is introduced. Involving industry directly in education adds a new dimension to determining the relative success of a course. Not only should students achieve the learning outcomes formulated by the university, find the course worthwhile, and have a satisfactory relationship with the university; in addition, interaction with the company should be rewarding and, in the case of student–industry projects, students should also deliver a result to the company. From a pedagogical perspective, we may wish to view industry, in this context, as an extension of the university, providing valuable learning environments for students, but industry's main concern is not educating students. A company will bring its own definition of success to the collaboration. An earlier study (Jensen and Lindholm, 2011) of the motives of universities, students, and companies for entering into student–industry collaboration demonstrated that the single most important reason for a company to engage in student projects was to access student knowledge to create value for the company: A company hosting a student project expects the student team to deliver an acceptable result.

The studied university formalized its concept of success by formulating learning outcomes for the course and by examining and grading students. Every interviewed student in the Industry Link study had passed the course exam at the time of the interview; one student had initially failed the exam, but passed it on a second attempt at a later date. By university standards, every student in the study had succeeded.

As the main reason why companies collaborate with students is to access the value they generate, we may regard successful delivery to the company as indicating that the company believes that the activity is successful. The scope and planned results of an Industry Link project are described in the student team's project plan, and a more detailed description is found in the requirement specification; both the project plan and requirement specification are continually revised during the project process and discussed with both company representatives and university supervisors. Frequently, a company will rethink the project goals, as the team's and their own knowledge of the problem increases, and these changes are then reflected in an updated project plan and requirement specification. This results in a final project plan and requirement specification that together outline the delivery the company expects at the end of the project. Comparing the student teams' actual deliveries to the companies with the teams' project plans and requirement specifications indicated that six of 11 Industry Link interviewees had participated in projects with results that met company expectations, three had participated in projects with results that partly met company expectations, and two had participated in projects that did not meet company expectations.

Success from a *student* perspective was explored in the interview study. During the interviews, students were asked to describe whether they considered their Industry Link project a success or a failure: seven interviewees declared their projects successes (i.e., a positive evaluation), two partial successes (i.e., a neutral evaluation), and two unequivocal failures (i.e., a negative evaluation).

4.3 Student evaluation of the Industry Link project

At first glance, it would seem that a positive, neutral, or negative student evaluation should largely coincide with a successful, partially successful, or unsuccessful delivery to the company. However, when student evaluations are mapped against the three categories, a surprising picture emerges (Fig. 5). In seven of 11 cases, the relative success of the delivery is not correlated with the student evaluation of the project.

Fig. 5. Mapping student evaluations against successful, partially successful, and unsuccessful deliveries to hosting companies.

Obviously, students evaluate the Industry Link projects independently of the delivery to the company. The interviewees were clearly aware of the status of the final delivery to the company, but this did not influence how they judged the project. “The result was a success – we delivered what we were supposed to, but it wasn’t a very good experience”, one student commented. Another student said, “I think it was good, because you got to see how you worked on projects – that was overall a useful experience”; later in the interview, that same student went on to describe practical problems and concluded “… so we didn’t finish the project”. Notably, the student who, throughout the interview, most consistently expressed a positive attitude to the Industry Link project, had participated in a project in which the team failed to deliver acceptable results to the company: “It was a fantastic project. We had difficulties. It was really tough – we just wanted to skip the whole project. But now afterwards … we have learned valuable lessons. I am grateful that we had this project and that we had these problems”. Later in the interview, he added: “I am glad that we made our mistakes in school – better than making them as professionals. Now I know what to do – think ahead, every step of the way – not just jump in”. Interviewees who had participated in teams that delivered adequate results expressed satisfaction that the project assignments were completed and met company requirements and expectations, but this did not automatically lead them to describe the project activity as successful. Likewise, some, but not all, of the students whose teams had failed to deliver the expected results to the companies expressed mild regret that their teams had not delivered the planned results, but none of them rated the Industry Link course in accordance with the quality of their team’s delivery.

Nine of 11 interviewees mentioned experience of and insight into professional working situations as positive outcomes of the Industry Link course. Five interviewees also mentioned personal contact with companies and company representatives as a positive outcome, while four interviewees stressed that they had come to trust their own judgment more and come to see the importance of taking one’s own initiative.

4.4 Industry Link project: three relationships

Students engaged in Industry Link projects have three types of working relationships: with fellow team members, university supervisors, and company representatives.

4.4.1 Team relationships

One learning outcome of the Industry Link course is the ability to work in a team. The student teams are free to create their own internal organization, but must be able to describe the team structure; the individual members must formulate what they themselves bring to the team and what they expect from their fellow team members. All interviewees expressed satisfaction with their teams. Most interviewees (eight) had clearly defined roles and responsibilities in their teams; several of these commented on the positive effects of clearly defined roles, which were found to be especially useful when handling internal conflict. One student, whose team did not have a clear distribution of roles and responsibilities, regretted this and described this lack as a “failure”.

4.4.2 Relationships with supervisors

One defining feature of Industry Link projects is student ownership of the projects; accordingly, university supervisors primarily concern themselves with how the teams are handling the project process and are seldom actively involved in the team’s actual problem analysis, design, or implementation. This is reflected in how students from Industry Link projects comment on their relationships with their supervisors. Ten of 11 found the relationships “OK” or “good”, while one found the supervisors “distant”. Eight interviewees thought that their supervisors had exerted little influence on the project outcome, while three found the supervision constructive. Several interviewees commented that they found the different expectations of the company and university (as represented by their supervisors) disconcerting: the company wanted a delivered result, while the university also expected students to analyze and question suggested solutions.

4.4.3 Relationships with company representatives

While the interviewees differed little in their evaluations of both team relationships (very good) and supervisor relationships (acceptable), they had markedly dissimilar experiences of company relationships. Six interviewees described their relationships with company representatives as very good, finding that they were highly accessible, answered questions promptly, readily gave feedback, and reacted quickly to requests. Three students rated their relationships with company representatives as very poor. They all described that their first interactions with the company went as planned, but before long, company representatives repeatedly postponed or cancelled meetings, were slow responding to e-mails, and were unresponsive to phone messages. Two students had experienced unengaged company representatives, who had at times been difficult to contact and slow to answer questions, so these relationships were described as only partly

acceptable. When mapping students' evaluations of their company relationship against their evaluations of the Industry Link project as such (Fig. 6), it appears that, in eight of 11 cases, students' evaluations of the Industry Link project were consistent with the quality of their relationships with the company, in two cases partly consistent, and in one case inconsistent. It is hardly surprising that the relationship with the company is important to how most interviewees evaluate the Industry Link project. To three of the interviewed students, however, other factors were obviously more influential than were company relationships when evaluating the Industry Link project. All three of them cited the same reason for their diverging evaluation: experience of their future professional field. Valuable experiences caused two students with poor and adequate relationships with their company to rate the Industry Link project a success. They commented: "Actually, it was very good, because you got to see what the working field was like, you learned how to contact people at a company" and "I thought it was good, because you got to know how to work on a project and how everything works. You learned to take the initiative. It was a good experience". The third student who had experienced a good relationship with his company, but found the Industry Link project only partly satisfying (rated "neutral" in Fig. 6), explained that he already had years of professional experience, so working with a company presented little that was new, although he was convinced that his fellow team members had benefited greatly from being confronted with the company's expectations and requirements.

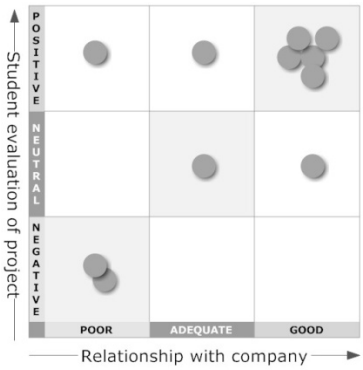

Fig. 6. Mapping student evaluations of company relationships against student evaluations of the Industry Link project.

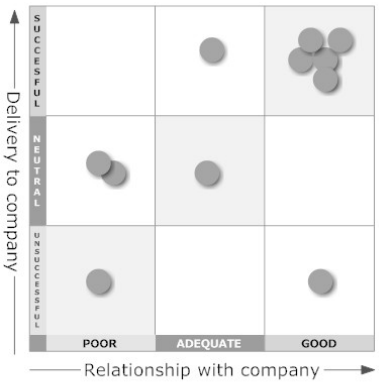

Fig. 7. Mapping student evaluations of company relationships against delivered results.

Mapping students' evaluations of their company relationships against the quality of the results delivered (Fig. 7) reveals that in seven of 11 cases the students' evaluations of their relationships with the company are consistent with the quality of the delivered results. Three students delivered more successful results to the company than would be expected from their poor or mere adequate evaluation of the company relationship. All students cited good working relationships in the team as the most important reason for their relative success. One student reported that, despite having a well-functioning relationship with the company, his team failed to deliver an acceptable result. This student said that the working relationships in the team were good, but that the team found the project process difficult to handle; notably, a number of process restarts are recorded in the logged material for this project team.

5 Discussion and conclusion

The Industry Link case indicates that it is not a foregone conclusion that student–industry projects lead to win–win–win outcomes. Projects delivering results that meet company requirements may fail to fully satisfy student aspirations, while other projects, which fail to meet company expectations, may nevertheless be considered rewarding by students. In fact, one project examined in this study, which failed to deliver an acceptable result to the company, gave rise to an exceptionally positive evaluation by a participating student. Student learning is one of university's main concerns and, from a *pedagogical* perspective, it is irrelevant whether or not a project delivery satisfies a company, as long as students

achieve the learning outcomes and evaluate the learning experience positively. However, from a *strategic* point of view, it is in a university's best interest that companies involved in student activities should find the collaboration rewarding. A company that is satisfied with the project outcome is more likely to continue collaborating with the university and to have a positive impression of both students and university. The challenge facing the university is to groom as many projects as possible to be true win–win–win enterprises. The Industry Link interviews highlight the importance of the relationship between students and company representatives, as the quality of the relationship clearly influences both how students perceive their activities and the results delivered to the companies. Regarding *how students perceive* the project, a less than perfect company relationship can be compensated for by valuable experience, for example, yielding insight into professional working conditions and how projects are conducted at companies; when it comes to the *result* delivered to the company, a weak student–company relationship can at least be partially compensated for by an internally well-functioning student team.

The Industry Link project belongs to the group of student–industry activities that deliver results to companies, and one of its characteristics is a high degree of student responsibility for both process relationships and outcomes. The Industry Link case indicates that three success factors relating to a student perspective are essential for an overall successful outcome when engaging in this type of student–industry collaboration. The first and most important is a well-functioning relationship between student team and industry representative. This implies that the university should devise strategies for supporting the personal relationship between student and company, preferably without undermining student responsibility for the enterprise. The second success factor is well-functioning student teams. Effective tools supporting stable and well-functioning teams, including clearly defined roles and clear division of responsibility between team members, seem to increase the probability of successful outcomes. The third success factor is the scope and quality of student experience. Course directors and teachers may support this by constructing frameworks and assignments that lend themselves to varied experiences in terms of both project processes and interaction with the company.

As the success factors for the Industry Link course are closely connected to the type of student–industry activity and its characteristics, further study will be needed to investigate the success factors in other collaboration models.

References

Barak, M.(2010) Motivating Self-Regulated Learning in Technology Education, International Journal of Technology and Design Education, Vol. 20 Nr. 4 pp. 381-401.

Biggs, J., Tang, C. (2009) Teaching for Quality Learning at University, 3rd ed. Open University Press, New York.

Dawson, R.J., Newsham, R.W., Fernley B.W. (1997) Bringing the "real world" of software engineering to university undergraduate courses. IEEE Proc-Softw. Eng., 144 (5–6), 287–290.

Jensen, L., Lindholm, C. (2011) University–industry–student: a volatile triangle. Proceedings of the 2nd International Conference on Society and Information Technologies (ICSIT 2011), International Institute of Informatics and Systemics, Winter Garden, Orlando, FL.

Lave, J., Wenger, E. (1991) Situated Learning: Legitimate Peripheral Participation. Cambridge University Press, Cambridge, UK.

Leenders, M. R., Maufette-Leenders, L. A., Erskine, J. A. (2010) Writing Cases, 4th ed. Richard Ivey School of Business, London, ON, Canada.

Lombardi, M. M. (2007) Authentic Learning for the 21st Century: An Overview. ELI Paper 1: 2007.

Perkins, D. N. (1991) What constructivism demands of the learner. Educ. Technol., XXXI (9), 19–21.

Pinto, J. K., Prescott J. E. (1988) Variations in critical success factors over the stages in the project life cycle. J. Manage., 14 (1), 5–18.

Robson, C. (2002) Real World Research, 2nd ed. Blackwell Publishers, Oxford.

Westerveld, E. (2003) The Project Excellence Model®: linking success criteria and critical success factors. Int. J. Proj. Manag., 21 (6), 411–418.

Yin, R. K. (2003) Case Study Research Design and Methods, 3rd ed. Sage, Thousand Oaks, CA.