BALANCING FREEDOM AND SUPERVISION IN A REAL-LIFE EDUCATIONAL PROJECT*

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Abstract. The practicum course Information System Development, offered by the faculty of Mathematics and Computer Science of the Vrije Universiteit, has two main goals: (1) to give students hands-on experience with different aspects of working on a 'real-life' IT project, and (2) to let them apply previously learned techniques and methodology in a rationalized and integrated way. These goals imply a project setting that mimics reality as close as possible, giving students the possibility to experience a 'real-life' situation in which they can apply previously learned knowledge and methodology. At the same time, students need a fair amount of supervision to guide them through the project and to ensure that they correctly apply the appropriate techniques and methodology. In this paper, we present an overview of the practicum, its goals, and our approach to balance the amount of freedom and supervision in order to create a true learning experience for our students.

Keywords. Software engineering education, Software development project, Real customers, Experience report.

1 Introduction

After their graduation, students with a degree in Business Informatics or Computer Science are expected to be able to work in interdisciplinary teams to solve complex automation problems in different organizational settings. Often, the problems of organizations are not clearly described, political factors may cause additional problems, and the wishes of the client may not be realizable within the project at hand. Universities are more and more expected to educate people that not only have a thorough notion of the theory of computer science, but that also have the social and communicative skills to deal with these situations.

One of the courses offered by the faculty of Mathematics and Computer Science of the Vrije Universiteit is targeted especially at giving students practical experience with the aspects mentioned. This course, called practicum Information System Development (ISD), lets students apply their previously acquired theoretical knowledge to a real client organization that is experiencing several automation related problems. The two main goals of the practicum are (1) to give students hands-on experience with the different aspects of working on a 'real-life' IT project, and (2) to let them apply previously learned techniques and methodology in a rationalized and integrated way.

In order to reach the first goal, the practicum has to offer a situation that is as close to reality as possible, and in which students work on the problems of the client with as little intervention as possible. On the one hand, this implies a considerable amount of freedom

*Published in the Proceedings of the Software Engineering Education Symposium, Poznan, Poland, 18-20 November 1998, pp. 77-84.

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for the participating students, thereby simulating reality. On the other hand, since students usually have no project experience, some amount of supervision is needed to ensure sufficient progress and a successful result. Hence, a balance needs to be found between independent functioning of the students and supervision of the project.

To reach the second goal, the students need supervision, monitoring and guidance to ensure the correct application of knowledge. However, we do expect students to make motivated choices from their available arsenal of techniques and methodologies themselves. Again, an equilibrium must be reached between freedom for students to make their own decisions on the one hand and supervision on the other hand. In this paper we report on the approach we used to reach such an equilibrium, after having given the practicum four times. In [1], a report on the first year of the practicum can be found.

This paper is structured as follows: in the next section, we give a short overview of the course. In section 3, we describe the goals of the practicum in more detail. Next, in section 4, we discuss the tradeoffs in design choices for the practicum with respect to freedom and supervision. Finally, in section 5, we present our conclusions.

2 Practicum overview

In this section, we give a quick overview of how the practicum is organized. We distinguish four different roles in the practicum, which are played by students, teachers and one or more real companies:

The project group Students are divided in one or more project-groups each having its own customer. Typically, a project group consists of 6 to 10 students.

The customer The customers are existing companies, selected by the mentor. Usually, the customer has one or more – non-critical – IT problems that it wants to have solved by the student project group.

The steering committee Besides the real life customer, students have to deal with a steering committee. This committee is formed by university staff and plays the role of project supervisor. It provides the students with advice, asked and unasked, and monitors how the project is done. The steering committee is put together by the mentors.

The mentors Finally, two mentors attend the students on a daily basis. This often means reviewing documents produced by the students. Furthermore, these mentors coordinate the practicum from a didactic point of view.

The practicum consists of three phases: (1) the contract phase, (2) the project phase, and (3) the evaluation phase. During the contract phase, the students negotiate an agreement between the project group and the customer. At the end of this phase, it should be clear for both students and customer what the end result of the project will be. To show to the mentors and the steering committee that the end result is indeed feasible, a sound project plan must be made. The contract phase takes about 4 to 5 weeks.

The deliverables mentioned in the contract are being produced during the project phase, which takes approximately 8 weeks. These deliverables are expected to contain one or more designs of solutions. The students are not expected to code and implement a solution.

The evaluation phase is the last phase. The students present and deliver the results to the customer. The students are then marked by the customer, the steering committee and the mentors.

Finally, it should be noted that each student is supposed to spend 240 hours on the project, which is about 20 hours weekly.

3 Goals of the Practicum

As mentioned in section 1, the practicum has two important goals:

Goal 1. *Students experience different aspects of working on a real-life Information Technology (IT) project*.

There are a number of aspects of IT projects we think that students should experience, and become aware of, in the course of this practicum:

- The difficulty of assessing the problem of the customer organization, packaging the problem in a concise problem statement, and setting a number of realizable goals.
- The difficulties of working in a large project group.
- The complexity of most IT problems in organizations, and especially the relationship between IT problems and organizational problems.
- Working within the limitations of time and own capacity. Students should become aware of the fact that they cannot, and should not try to, solve all problems. They should set goals that are reachable within the amount of time available. Also, students should only tackle those problems that are within their capability to solve.

Consequently, the practicum should offer the students a project setting that is as real as possible, provides the possibilities and the freedom to make their own decisions, but also prevents blatant mistakes that hinder the completion of the project (or could damage the customer).

Goal 2. *Students apply previously learned knowledge and methodology in a rationalized and integrated way*.

To solve the problems of the customer, students should use methods and techniques learned during previously followed courses. Examples include project management, conceptual modeling, quality management, and software engineering.

To guarantee the correct application of relevant knowledge and methodology, the mentors of the practicum need to be able to monitor the application of previous learned knowledge and skills and the progress of the students, intervene when necessary, and mark the students, both as a group and individually.

As one can see, there are two opposite forces that have to be balanced in the practicum. On the one hand students should be functioning relatively independently to create a realistic situation, but on the other hand, students need to be monitored and guided to ensure a successful result.

4 Design choices made

In the previous section, we have seen that in order to reach the two goals of the practicum, we need to balance the amount of freedom versus the amount of steering and supervision. In order to reach an equilibrium we have to decide:

- which parts of the practicum are prescribed by the mentors *in advance*, and which parts can be decided upon by the students themselves, and,
- the amount and way of intervention *during* the practicum.

Both decisions directly impact the balance between freedom and supervision.

With respect to the first issue, we decided to prescribe certain (parts of) documents that the students need to produce, such as a problem statement, a goal statement, and a project planning. In addition, we demand that students clearly relate these documents to each other and support their claims. However, we do not prescribe particular technical solutions, nor particular methodologies.

To be able to steer and intervene during the project, we need to be able to monitor the students. We use a number of instruments to do so. The most important of these are the coaching by the mentors, steering committee meetings, and progress reports. Based on these instruments, intervention can take place either by the mentors or by the steering committee. But, the point of departure is that we do not intervene, unless necessary to reach the practicum goals.

In the next sections, we describe these decisions concerning freedom versus steering in detail and show how they have contributed to the goals mentioned in section 3. We illustrate these decisions by giving examples from situations that actually occurred during the practicum. Examples are typeset *like this*.

4.1 The contract phase

Consider the following example: *In the practicum manual used two years ago, we stated that students should use an explicit software development approach. As an example, we suggested a waterfall approach. One of the assignments that year concerned the investigation of the possibilities of electronic commerce for one of the customers. The students proposed a project plan, fully based on the waterfall approach. However, the customer had little knowledge of the web, and its requirements for the application of electronic commerce were vague. A prototyping approach was clearly more appropriate in this case.*

This example shows that one should carefully consider which parts of the practicum should be prescribed and which parts should be left to the students. Even suggestions are dangerous, because students tend to follow them without much thought.

Of course, the contract is a necessity. The contract must contain a motivated problem and goal statement. In addition, the contract should state the general approach that will be used to execute the project. This should convince the customer that the goals will be met. Also, all deliverables have to be stated explicitly. We require students to select (elements of) methodologies taught in their study. However, we do *not* prescribe a particular methodology, nor the actual content of the contract. Also, students are free to add topics to the contract they think are useful.

The requirements we defined for the contract are in line with what is happening in practice. Many companies have strict guidelines concerning contracts. Therefore, we think that our demands do not violate our first goal, showing students a real life project. The

second goal, the usage of techniques and methodologies, is enforced by prescribing usage of appropriate techniques without doing suggestions for particular techniques.

During the contract phase, it is necessary to steer and intervene to a certain amount: *One project group negotiated a contract promising a complete design of a routing registration system for the Internet. The customer was a company coordinating routing on the backbone of the Internet in Europe. The problem analysis did not discover all problem owners, causes of the incorrect functioning of the system in use and the fact that routing in itself is very complex. Intervention was necessary to come to a more detailed problem analysis and to a more modest goal that was feasible to reach. This goal turned out to be to propose a solution for a particular type of inconsistency in the current routing registry system.*

In our opinion, the quality of the problem and goal statement is crucial for the rest of the project and practicum. The problem and goals have to be stated clearly enough, so that students can make a concrete projectplan. Furthermore, the goals should be realistic.

The example given is a typical example of how students underestimate the complexity of the clients' problems and overestimate their own capacity. Last year, we tried to make students more aware of this problem by giving them more detailed instructions on how to produce a problem and goal statement. However, this did not result in a better initial statement. Apparently, students have to make this mistake themselves, before they realize they have underestimated the problem.

We currently use the following approach: students are given three weeks to produce a first version of the contract, which they present at the first steering committee meeting. The steering committee points out the shortcomings in the contract. The next two weeks are used to produce a revised version of the contract, which is then presented to the customer.

Monitoring is done by the mentors, who review intermediate versions of the contract. The mentors particularly pay attention to the usage of appropriate problem analysis techniques. The steering committee meeting is used to assess the overall quality of the problem analysis and the feasibility of the goals and the planning.

Usage of a steering committee is in line with a real life project, therefore contributing to our first goal. The second goal is supported by having the mentors monitor the students work on a daily basis and assure the application of appropriate methodology.

To summarize, we only prescribe that a contract should contain a problem and goal statement, a development approach and a list of deliverables. Furthermore, we stress the importance of these. Students are allowed to muddle through the contract phase for a limited period of time. They are allowed to make errors, and we use the steering committee to point out those errors. This makes the steering committee our main tool to guide and steer the students in this phase of the project.

4.2 The project phase

During the contract phase, we prescribe the usage of a projectplan. The necessity of such a requirement can be illustrated by the following example: *Last year, students more or less refused to make a sound projectplanning. They especially did not see the benefit of making a resource allocation. Their main argument was: 'We all do the same study, so we all have the same knowledge. People can easily be interchanged'. Halfway the project they discovered that the specific knowledge of a person increases during the project, and thus people become less interchangeable than they thought.*

We prescribe certain parts of a projectplan such as a list of activities and dependencies, milestones and resource allocations. However, students are free to define the activities

necessary to reach the goals stated in the contract. In real-life, a project plan is necessary to manage the project and to assure timely delivery of products. Remember that the projectgroups consist of about 7 students, so coordination is important. Prescribing a proper projectplan directly supports the first goal of our practicum. Also, the correct application of project management techniques contributes to our second goal.

During the project, it is necessary to monitor and steer students: *One projectgroup wanted to contact several suppliers of database technology to investigate the suitability of their products for the problem at hand. However, the letter prepared by the students contained information about the client that – while not exactly classified information – was rather sensitive.*

In this case, the mentors prevented the students from directly using this letter without permission of the client. The client did not want its name to be used in the letter, and the letter was changed accordingly. This example shows that it is necessary for the mentors to be able to prevent these kinds of mistakes that would damage the relationship between the university and the client.

The next example shows that monitoring and steering is not only needed to prevent mistakes, but also to correct bad process: *Last year, a project group gave each mentor and each steering committee member documents which were all of different versions. This resulted in a steering committee meeting with all members having different versions of the same document. This happened more than once.*

In this case, we forced the students in question to develop a procedure to be used for the distribution of documents.

However, in some cases we do not intervene: *One project group decided to specify a system using a formal technique, viz. the language Z. The customer however, was represented by a person with few IT-skills.*

Students have to discover themselves that Z does not work in this situation. The choice of such a method is discussed afterwards, and we expect them to evaluate the decision in their personal evaluation (see section 4.3).

Being a mentor, we want to be able detect these kinds of situations. We have several monitoring instruments, which closely resemble instruments used in real life projects:

- Mentors review deliverables. This can be seen as quality control in real life.
- Each student reports his/her hours spent on activities to the project management and to the mentors on a weekly basis. In real life, one also has to report effort spent.
- Each project group has to submit a two-weekly progress report. They can also use this report for the customer.
- Students have to present their work during steering committee meetings.

By using monitor tools used in real-life, the practicum keeps its reality value. At the same time, we can get a clear picture of the project and for instance monitor the application of techniques. However, it should be said that we allow many mistakes. In the case of the example outlined above, students have to discover themselves that a formal specification method does not work in this situation.

With respect to the project plan, we use the same approach as for the contract. The first two weeks students are free to make a projectplan. However, some intervention is always needed to come to a sound planning, which forms the basis for the rest of the project and the practicum.

It should be mentioned that the customers are without exception very satisfied with the deliverables made by the students. However, the way students organize their work is of much less quality. Therefore, supervision is concentrated on project management aspects, again using the steering committee to make students aware of the importance of project management and planning.

4.3 The evaluation phase

The project is concluded with a compulsory final presentation of the students' work at the customers site: *Last year, students did not investigate the amount of interest in their work at the customer. When they prepared their final presentation – to be held at the customer's site – they had an audience of about three people in mind. However, 15 employees showed up. This caused some practical problems, for example the lack of overhead sheets and a projector and too few handouts. Moreover, the employees were asking very detailed questions since they had read the deliverables carefully.*

We do not feel we need to prevent these kinds of mistakes. In fact, we think this is a good learning experience. Students are left free on how to present their final results to the customer. Since the customer plays a role in marking the students, students are stimulated to present their work well.

After the final presentation, the students are marked. This mark consists of a group mark and an individual mark. The group mark is determined by the customer and the steering committee. The individual mark is based on evaluation reports written by the students: *Two years ago, each student had to give in an essay regarding the project. Some group members had not functioned well, according to their own words, because of bad project management. However, the project manager complained about some bad behaving project members.*

How should these statements be interpreted, who is right? It is very difficult to assess such essays. Therefore, last year we prescribed a list of topics (contract, project plan, and in this case, two deliverables) to be discussed. Furthermore, for each topic, we defined aspects that were to be discussed (such as planning of the topic, quality, etc.). Students had to write an essay in which each aspect of each topic was discussed. We then simply checked whether each aspect of each topic was discussed, and whether students motivated their opinion. Surprisingly, the individual marks corresponded well with the subjective ideas we had about the students. Again, such an evaluation is well in line with real-life practices. Companies more and more perform post-mortem analyses of projects, for instance to be able to adjust their software engineering process.

Regarding our first goal, a real-life project, students have to become aware of the fact that expectations of the customer should be managed. Moreover, this should cumulate in a well-organized final presentation. Regarding our second goal, students should apply presentation techniques they learned during other courses such as project management. Also, by having them evaluate the practicum, we force them to rethink the decisions they have made, what went wrong, what went right, and why.

To summarize, we prescribe the structure of the personal evaluation. Also we prescribe a final presentation at the customer site. However, students themselves are responsible for the content.

5 Conclusions

In this paper, we have presented an overview of the practicum Information System Development. We have explained how the goals of the practicum – giving students 'real-life' experience and the rationalized and integrated application of knowledge – lead to contradicting demands on the practicum that need to be balanced somehow. On the one hand, students should be left free in their execution of the project; on the other hand, supervision is needed to guide them through the project and to ensure that they apply the right techniques and methodology the right way.

In order to reach this balance between freedom and supervision, we have taken two different kinds of measures: (1) specifying *in advance* certain minimal requirements on documents to be produced by the students, and (2) implementing several instruments to both monitor and steer the students *during* the project. For both kinds of measures holds that we have striven to integrate these measures in the real-life context of the projects. This ensures that we are able to satisfy both practicum goals: on the one hand, the practicum resembles real-life closely; on the other hand, students are forced to apply previously learned techniques and methodology.

Acknowledgments

This practicum heavily depends on staff-members playing the role of steering committee and customers providing real life project. Therefore, we like to thank Frances Brazier, Maarten van Steen, Hans van Vliet and Roel Wieringa as members of the steering committee and RIPE and Hochem for offering projects.

References

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