DEVELOPING SENSOR TECHNOLOGY INNOVATIONS WITH BUSINESS POTENTIAL TOGETHER WITH STUDENTS: LET'S RETURN TO THE MASTER-APPRENTICE APPROACH

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ABSTRACT

ID3AS is a programme in the field of sensor technology to stimulate innovation and network creation in the Eems Dollard Region (EDR), the most northern region along the Dutch-German border. The ID3AS-programme provided an opportunity for over 80 students with different backgrounds to participate on a scala of real world challenges. Real world learning environments like these are becoming increasingly popular in education, so it is important that we know how to organise the participation of students and tutors effectively.
However, in ID3AS it proved challenging to realise a fruitful learning experience for the students, while simultaneously adding real value to the projects. The difficulty stems from the fact that both students and tutors struggle with the inherent unclarity of innovation projects, while at the same time industry partners need actual results. We think that the currently prevailing approach of the student learning by discovery, with the tutor in the role of process supervisor, is suboptimal in these conditions. Based on our experiences we propose to have students join a consortium as an 'apprentice' to a 'master'. The master, being a tutor from either university or company, should be comfortable with leading by example in an uncertain environment where both learning outcomes and concrete results are expected. We present several examples where this approach worked and give the outline of an experiment we plan to conduct on this topic.

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1 INTRODUCTION

ID3AS[2] is a multi-year research and development programme in the field of sensor technology. The aim of the programme is to create a network of companies and knowledge institutions in the EDR, developing viable innovations ultimately resulting in economic activity and employment opportunities.
From various application domains, such as Care, Agro and Logistics, the project team attracted companies with promising ideas in the field of sensor technology. These companies were then supported to form a consortium with other relevant parties such as potential customers, content experts or a party that could bring the idea to the market. German-Dutch cross-border cooperation was a mandatory requirement of the funder. All in all, our work has led to more than 25 consortia and projects between German leadpartner Hochschule Osnabrück/Lingen and the Dutch Hanze University of Applied Sciences Groningen (HUAS). The data in this paper are based on the 10 projects on the Dutch side of the border managed by HUAS.

Although our main obligation to the funders of the programme was to create succesful innovations together with companies, our mission as a UAS motivated us to have as many students and lecturer-researchers participate in the projects as possible. In that sense ID3AS acted as a living lab/Innovation Workplace (IWP). In an IWP, partners from research, education and professional practice collaborate on complex issues whose solution requires the co-creation of knowledge in a way that transcends traditional boundaries of structures, sectors, disciplines and forms of learning [1]. The concept of IWPs is becoming increasingly popular with Dutch UASs as a way to prepare students for the complex interdisciplinary challenges of the future. HUAS, for example, has the ambition that all students participate in an IWP at least once during their studies.

To ensure long term viability of the IWP concept, it is crucial that all parties involved benefit from participating in an IWP. For this paper we will look specifically at the way students and their tutors are involved. We believe that the current way of involving students in our consortia can be improved. Our goal is to maximize the students' contribution to the project, provided that the students have a good learning experience. This learning experience encompasses both subject-specific competences and general competences such as being able to deal with uncertainties and complexity in collaboration with others. The way in which student work and supervision are organised plays an important role in this.

[2] www.ID3AS.org

2 EVALUATION OF STUDENT AND TUTOR INVOLVEMENT IN ID3AS

During its duration, ID3AS facilitated many student assignments, internships and graduations (see Table 1). Students have worked on sensor selection, testing, designing sensor circuits, data analysis, user interface design, business models, legal issues, gamification of a webapplication, building an activity tracker, measuring stress, applying artificial intelligence, etc.
Tutoring of students was typically assigned to a lecturer-researcher. This supervision focused on progress of the project, the groups working process or achieving learning outcomes.

Table 1: Parties involved in ID3AS

Parties involved	Nr
Student groups	>20
Individual graduates	5
Total number of students (Engineering, Business, Law, IT, Communication and Lifesciences)	>80
Lecturer/researcher in the role of tutor	13
Companies	18
Knowledge institutions	6

We have experienced that the current way of working and learning by students and tutors did not function optimally in the ID3AS projects. Characteristic of these projects is the complexity of working across disciplines, multiple interests, intercultural communications, and flexibility based on business potential of the innovations. These are exactly the kind of things we want our students to learn in IWPs, but it proved to be challenging.
Engineering students as well as business students showed frustrations due to preceived vagueness of what is asked of them, evolving requirements and the feeling of having to discover everything on their own. They found it difficult to acquire the extra knowledge required for the problems at hand. They felt overwhelmed and this resulted in lack of commitment and mediocre results.
Unfortunately, the tutors, who can be lecturers and/or researchers, were of limited help to the students. The tutors struggled as well with having to adapt their tasks, working in a interdisciplinary instead of a monodisciplinary setting, the executive role that was required for achieving project results and guiding students in working on flexible and evolving content. Initially lecturer-researchers were hesistant to join the project. When they did join, they stuck to the coaching role instead of providing the students with some much needed ‘scaffolding’ [2].
These difficulties had an effect on the external partners. They were regularly frustrated with students because of lack of progress, low quality results, lack of commitment, not considering alternatives, and not being allowed to change the assignment over time.

As the project progressed, we carried out several ad-hoc ad-hoc interventions to address these challenges and improve the results of students' work (Table 2).

Table 2: Interventions on student/tutor involvement

Nr	Interventions
1.	The approach of trying to create an assignment was changed into asking lecturers and students what they thought they could contribute (self-efficacy).
2.	Company staff and students started working in a shared office at HUAS for two days a week (shared workspace). The climate in the office used was to be controlled by the system under development. (Smart Indoor Climate project).
3.	Company actively organized lectures and expert training to bring students up to speed when knowledge was lacking (Smart Ship Management).
4.	Lecturers actively joining the student work as foreman (Smart Marine Aquaponics, Voicemint).
5.	Organising a project startup of two days for company and students under the guidance of AI-experts from HUAS (Smart Indoor Climate).
6.	Providing expert guidance to business students on how to do real world business modeling to guide the decisions of consortia, instead of the one 'trick' they had learned so far.
7.	Involving the tutoring lecturers and students as much as possible in the different project meetings so they can see the big picture.

These interventions had a positive effect on the earlier mentioned challenges. Students learned formally and informally from their more experienced colleagues and project members from their or another field of expertise. Students started to display more ownership for the project result and developed more courage to question assumptions or an approach. This lead to a more valuable contribution of students to the project as well as a more valuable learning experience; students were more succesful in applying their knowledge and skills in an interdisciplinary environment.

Something similar applies to the lecturer. Lecturer-researchers were more actively involved in the project team, working with students and professionals in the field. They took more responsibility for the project result, invested time in keeping their knowledge up to date, and experienced the value of their expertise within the breadth of competencies needed for successful innovations. This is reciprocal teaching and reciprocal learning, which contributes to a more valuable educational guidance of students, now and in the future.

This leads us to the following assumption: in the complex projects typically found in IWPs, a more hands-on involvement of lecturer-researchers and a different way of guiding students (master-apprentice, agile) will give students a better learning experience while also bringing about better project results.

3 DISCUSSION

Basically these findings match with what is already known from theory, for instance Dochy's model of High Impact Learning [3], principles of agile development [4], and scaffolding of interdisciplinairy learning [2]. Still, we expect many UASs to struggle with similar issues and if we are to make the concept of IWPs succesful we shall need to improve.

The main issue with the master-apprentice approach is scalability. It is unlikely that this approach can be adopted for every project in the short term. Still, not all is lost. First of all, we noticed an improvement with the lecturers over the years. By gaining experience in the projects, lectures gain confidence. The lecturers who enjoy this kind of work can take on more and reach economy of scale. Secondly, when the companies experience improved results, they are likely to be more willing to make the financial contribution necessary to make this approach more affordable. And in the end, we feel that if we are running these kinds of projects anyway, we'd better do it in the best possible way.

4 FURTHER RESEARCH

In further research, colleagues at HUAS plan to test our assumptions in a controlled setting of one research group. Lecturer and researchers and students will form four small teams to work on a research question from an external customer. The lecturer/researcher will not just be supervising the students but will work side by side with the students. Students are to be made owner of a part of this project and have contact to the customer. Expectations and experiences from all parties will be gathered before, during and after the project. The results will provide more insight into the effects of this way of collaborating.

Our ambition is to further develop this experiment into a vibrant research environment where students and lecturers collaborate with the professional field on complex problems. The first experiment along these lines started in Februari 2020. Due to the corona pandemic, the experiment was severly limited. It is hoped that the experiment can restart in September.

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