# Enhancing and integrating employability of students for IT

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**Abstract**

The Master of 'informatics as a second competence' (ISC) has been created at the University of Grenoble Alpes in 1985 to teach informatics to students who have already passed a bachelor's degree in another discipline. The challenge of such a Master's programme is to train versatile people who will combine the skills acquired in their first discipline (acquired during their bachelor studies) with theoretical and technical skills in computer science, enabling them to create, develop and implement tomorrow's software tools. The purpose of the PROfessional network of Master's degrees ISC European Tempus project is to disseminate the experience of the Master programme at Grenoble and to create a network of ISC Master's programmes in Central Asia. In this contribution, we will explain the rationale of the project and describe measures that enhance the employability of students by integrating practice in the teaching.

Keywords: Informatics as a second competence, tempus project, employability, active learning, peer instruction, reverse teaching.

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## 1. Introduction

A number of students do not study a field with good prospects for employment. Also, one observes that almost any field in our society depends on information technology (IT) in a more or less essential way. Hence, there is a need for software developers to understand the needs and expectations of the users who will use the software developed by them. The Master of 'informatics as a second competence' (ISC) tackles this challenge. This Master programme has been created at the University of Grenoble Alpes already in 1985 to teach IT to students who have already passed a bachelor's degree in another discipline. The 'Master's programme objective is strictly vocational, as it aims to train versatile people who will combine skills acquired in their first discipline (the ones they acquired during their bachelor studies) with theoretical and technical skills in computer science, enabling them to create, develop and implement tomorrow's software tools in a better way' (Bardou et al., 2015). This Master programme has proven to be successful for the employability of the students.

## 2. Purpose of project

The PROfessional network of Master's degrees ISC (PROMIS) project is a European Tempus project funded by the Education, Audiovisual and Culture Executive Agency. PROMIS primarily aims at extending in Central Asia (CA) an existing Master's degrees network for training 'ISC' that was created in a former Tempus project called ERAMIS (Adam, Merceron, Lujan-Mora, Milosz & Toppinen, 2012). The project also aims at improving the vocational features of the Master's degree network by strengthening the relationships between the universities and the local companies and adapting the teaching process to the social needs of the students (Adam & Bardou, 2014).

PROMIS project encourages a close cooperation of local IT companies in the teaching process and the studies' organisation (participation in steering committees, development of internships and the setting up of courses taught by companies' fellows). This gives the companies the opportunity to express their real needs in terms of required skills for their future recruitments; and thus, improve the employability of graduate students.

PROMIS also proposes to improve the efficiency of the teaching process by setting up reverse teaching, which is also called 'flipped classroom' (Abeysekera & Dawson, 2015). In such a pedagogical approach, the teacher does not explain new concepts in front of a silent classroom that is only listening. On the contrary, students first study the topics by themselves, typically by watching videos prepared by the teacher. In the class, students discuss difficult aspects and apply the knowledge to solving problems. Time is allocated differently than in the traditional teaching. Almost no time is spent in class in explaining new concepts. Rather, time is spent to deepen critical aspects and put the knowledge into practice. A challenge in adopting the reverse classroom or peer interaction is the availability of good teaching material for self-study. In particular, the teaching material needs to include simple exercises to support active reading or active watching of the students. The teaching materials and the pedagogical approach need to enhance the employability of the students as well by integrating practice into the teaching. Indeed, the former ERAMIS project has shown that teaching in CA tends to be too academic for this kind of studies (Adam & Bardou, 2014).

The PROMIS project involves a large consortium of 18 partners and an external expert in the implementation of the Bologna process in CA. The project was running from December 2013 to June 2017. The European (EU) consortium is composed of five universities: the University of Grenoble Alpes (Leader—Grenoble, France), the Beuth University of Applied Sciences Berlin (Berlin, Germany), Savonia University of Applied Sciences (Kuopio, Finland), Kaunas University of Technology (Kaunas, Lithuania) and Politechnika Lubelska (Lublin, Poland), and three private companies: Symetrix (Grenoble, France), eLeDia (Berlin, Germany) and Ilmi Solutions Oy (Kuopio, Finland).

The beneficiaries universities are: the Kyrgyz State Technical University named after I. Razzakov (Bishkek, Kyrgyzstan), Osh Technological University (Osh, Kyrgyzstan), Al-Farabi Kazakh National University (Almaty, Kazakhstan), Eurasian National University (Astana, Kazakhstan), National University of Uzbekistan (Tashkent, Uzbekistan), Bukhara State University (Bukhara, Uzbekistan), Technological University of Tajikistan (Dushanbe, Tajikistan), Khujand State University named after B. Gafurov (Khujand, Tajikistan), Turkmen State Institute of Transport and Communication (Ashgabat, Turkmenistan) and Turkmen State Institute of Economics and Management (Ashgabat, Turkmenistan). The first and the third universities on this list were also former ERAMIS partners and have already created an ISC Master's degree. They are part of the PROMIS project to set an example and help the other beneficiary partners.

## 3. Method

Three main measures have been put in place to unify the pedagogical approach of all partners of the project. First, one-week workshops between lecturers of all involved partners have been organised in EU universities to define a common curriculum of 10 core courses and to develop common and practice-oriented digital learning material. Second, seminars have been held by EU partners in the universities of CA. These seminars are open to students as well as academic staff, and allow for an intercultural exchange of teaching practices. Finally, two-week project-oriented students' mobilities (academic visits) have been organised in the universities of Grenoble Alpes and Beuth.

### 3.1. Workshops in European universities

Taking the existing curriculum of the ISC Master at the University of Grenoble Alpes as a basis, 10 core courses have been defined. These core courses are mandatory. Further, it has been decided that all universities should adopt the same content for these 10 courses. Therefore, workshops have been organised around these 10 courses by the EU partners, see Table 1. The first aim of the workshops is to agree on this content and to develop digital learning material that can be used by all academics of the different universities. As some of these courses are new for some partners, the second aim of these workshops is to use the help of experienced teachers to introduce colleagues to these new areas that they are going to teach.

Table 1. Workshops' organisation

| Courses | Organiser (Time) |
|---|---|
| Algorithms and data structures and programming | Beuth University of Applied Sciences, Berlin, Germany (16/02/2015–20/02/2015) |
| Operating systems and networks and web development | Savonia University of Applied Sciences, Kuopio, Finland (11/05/2015–15/05/2015) |
| Human machine interaction and mathematics for computer science | University of Grenoble Alpes, Grenoble, France (01/06/2015–05/06/2015) |
| Databases, data mining and data warehouses | Kaunas University of Technology, Kaunas, Lithuania (15/06/2015–19/06/2015) |
| Project management and software engineering | Lublin University of Technology, Lublin, Poland (22/06/2015–26/06/2015) |

The former ERAMIS project has shown the importance of a practice-oriented pedagogy to increase the employability of students at the end of their studies. Therefore, it has been decided to adopt a pedagogy inspired by peer instruction or reverse teaching. As already mentioned, with reverse teaching, students read theoretical concepts in advance; during class there is more time to deepen these concepts and put them into practice. Deepening concepts or solving exercises to put these concepts into practice is often done in group work, so that the students explain to each other what

they understand, which is called peer instruction. Work of Masur et al. (2008) and in particular experiences of Beth Simon (2013) in computer science show that this peer instruction is beneficial to learning. A final aim of these workshops is to produce exercises and activities to support this active learning pedagogical approach: exercises to check what students have grasped during their own preparation at home, and activities to deepen concepts and put them into practice during class.

All digital materials produced during the workshops; and also, the materials that some colleagues have already produced and used for teaching outside this Master are stored centrally in the Moodle learning management system installed at Universite Grenoble Alpes, and are accessible to each partner of the project. This content sharing is enrichment for everyone. In particular, colleagues from the Universite Grenoble Alpes have produced multiple-choice questions (MCQ) in the area of Java programming and algorithms that not only check knowledge of specific facts, but also comprehension and application of non-trivial concepts.

A difficulty in conducting these workshops is the language barrier, as not every colleague of CA is fluent in English, the language of the project.

### 3.2. Seminars in universities of Central Asia

The second measure concerns the organisation of seminars at the Central Asian universities. These one week, highly intensive seminars were held by lecturers from the EU universities. In this measure, the students and several lecturers from CA have been actively involved.

Contrary to the pedagogical workshops, which were described in the previous section, that were focused on the core courses of the Master's programme, the topic of the seminars could be chosen quite freely. It could be a topic outside the schedule of the Master's programme but related to informatics; the topic acts as an opening and broadening of the knowledge acquired in the programme. It could also be a topic related to the course taught in the master programme. In that case, the attendees and lecturers shared different views to introduce and understand the topic.

The organisational procedure has been as follows: each EU partner proposed a list of topics, lecturers and dates when the lecture can take place. Partners from CA could choose from these lists that what is more convenient for them. Some balance had to be kept, as the number of lectures given in each university had to be nearly the same.

Once the matchmaking had taken place, each partner from CA had been responsible for the local arrangement. This included not only very practical issues like writing invitations for visas and reserving a classroom, but also giving a time for their own academic staff interested in attending the lecture, and giving a time for their own students, especially for the PROMIS students enrolled in the Master's programme, so that they could attend the seminar. Often this meant the reorganisation of the daily schedule for 1 week. Another important task of the local authorities concerned the organisation of the translation. Experience had shown that the attending students (and sometimes local lecturers too) did not have sufficient knowledge of the English language to follow the seminars. To this extent, translators were required, who translated from English into Russian or into the local language of the country (for example Kyrgyz, Tajik or Uzbek). Experience also showed that professional translators are only partially suitable because they did not know the subject matter of computer science sufficiently well. The best solution for the translation was to select participants of the workshop who could understand English well enough and could understand the subject as well. According to our experience, these participants' best translated the contents of the workshop for the others.

The seminars were held from May 2016 to May 2017; each of them lasted 10 hours delivered over 3 to 5 days. The number of participants in the seminars varied. On average, about 15 people attended the courses. Seminars covered 20 topics from different areas of computer science (Adam & Bardou, 2017), as for example:

- Internet of things,
- Data mining,
- Data structure and algorithms,
- Semantic Web technologies,
- Aspect-oriented programming with AspectJ.

In these seminars of only 10 hours, it was impossible to cover full courses. To enable students to put into practice what they learn, it was important to select carefully the themes that should be taught. As measures for dealing with this problem, some of the following were selected: development of quick start examples to give an overview of the concepts, usage of simple and easy-to-use open source or web tools, a combination of seminars and exercises, additional introductions and diverse tasks for the students to prepare for the course.

In addition to the provision of up-to-date IT, the main focus of the seminars has been the sharing of some pedagogical principles like different types of conducting lectures as well as the laboratory seminars and exercises. After the lecture, students should be able to apply the theoretical concepts to practical exercises. For the preparation of exercises, they should install some tools, which are free of charge or open source. It was also possible to work with tools on the Internet. Another important idea of the exercises was to prepare the students for the independent continuation of self-study exercises later and to know about tools and web resources. They should be taught how to use knowledge resources in their later professional life.

### 3.3. Student mobilities

As a third measure, mobilities with selected students of CA were organised. Two mobilities took place at the Beuth University of Applied Science (Germany) and the University of Grenoble Alpes (France). They covered a two-week training in the area of software development. In addition to learning professional, application-oriented contents, the students should get an impression of project-oriented courses at EU universities. The training was carried out by several teachers of the host university, and each of them was responsible for a different specific field. In total, eight students from four different universities and three different countries from CA took part in the training in Berlin and eight other students from other universities in Grenoble. Each of those universities sent a group of two students. At least one of the two students from the same university should have good skills in programming and the other one could speak English well. In particular, the last condition was made on the basis of the experience of the seminars in CA.

The training should enable the students to program a small web application. For this purpose, different areas of computer science had to be brought together such as programming, databases or graphical user interfaces. During the first training week, the students were taught principles in those areas and they acquired experience in using standard software development tools. In the second week, the students should implement what they have learned in the first week. In small teams, they had to develop a small web application for rating hotels. Already in the first week, it turned out that the students had very different prior knowledge, e.g., they learned different programming languages and it was a challenge to raise them to a common basic level. Based on these experiences, the project planned for the second week had to be modified and simplified. In order to help everyone from the group to succeed, the task was adapted depending on the knowledge of the teams. At the end of the project, each team presented the results obtained. Especially the teamwork and the linking of different areas of computer science as well as the presentation of the results were new experiences for the Central Asian students. However, the students were not the only ones who learned a lot during the two weeks of training. The lecturers were also able to develop, try out and evaluate a concept for carrying out a project for a very heterogeneous group, a concept which could be re-used for some kind of summer school.

Furthermore, a second kind of mobility was carried out. Three students from Kazakhstan came for a short internship to Berlin. They took part in some regular lectures. One lecture dealt with current trends in media informatics. In this lecture, various lecturers from the industry talk about their experiences in their work. Moreover, the students visited the Fraunhofer Institute, a large German IT application- and research-oriented organisation, and got some insights into current projects. At the end of the internship, they took part in the 'WhereCamp Berlin' conference hosted by Beuth University and focused on the latest trends in geographical databases. During this mobility, the students got some insights about the way lectures are given in Europe and about the strong relationship between the universities and the industry.

## 4. Results

In all the partner universities, an ISC Master's programme is created and prepares students for a professional life providing them with knowledge and skills in computer science. Their ability to combine the first competence acquired during the bachelor programme with the IT skills is an asset to find a job.

This creation of Master's programmes was a challenge and not so easy to create everywhere. The notion of professional Master's programme is not easily understood in all Central Asian countries. For some Ministry of Education like in Uzbekistan, Masters' programmes are only a preparation to research activities. The notion of a professional Master's programme for advanced engineers' preparation, like existing programmes in EU Universities, is difficult to be approved. Ministries in Kirghizstan, Tajikistan and Kazakhstan have now approved this type of training.

The training of the colleagues of the partner universities in EU universities was helpful and was completed by many seminars at the partner Universities. The University of Grenoble Alpes supports a Moodle platform for the project. All project teachers have access to the platform to upload or download documents. The platform is used as a virtual place for gathering and sharing all the educational materials produced in English and Russian by all the teachers involved in the workshops. The EU partners actively participate, as it is an opportunity for them to develop or improve documents for core courses in English as well. The existence of these documents will promote the internationalisation of the Master's programmes and foster the creation of double diploma between the partners. Each teaching material produced will be available on the online platform for sharing purposes.

At the beginning of the project, very few teachers (EU or Central Asian) had experience with reverse teaching. The availability of comprehensive teaching materials provided some help in setting up the teaching activities even though a full reverse teaching approach could not be implemented in every case. Reverse teaching was nevertheless strongly encouraged during the project and was experimented in every CA partner university.

For each common course, we have developed tests composed of MCQ. These questions are written in English and translated into the Russian language. The tests have been set up on the Moodle platform of the project. A login on this platform is created for each student of the created master's programmes. The realisation of the tests by the students is in progress. The collected data about their results will be analysed in the next months.

First graduates, altogether about 50, came forth in summer 2017. About one-fourth of them are lifelong learners, which shows that this Master is attractive for students who want to evolve in their workplace. An independent expert on the project reported that companies are satisfied with their new relations with the universities.

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## 5. Conclusions and recommendations

The aim of the ISC Master is to allow for the employability of students with restricted perspective in their bachelor studies in the highly demanded IT area. In this paper, we have presented three main measures of the PROMIS project to integrate employability in the studies. It should be stressed that these three measures have taken place in all locations of the partners. This is important for all participants to become open and understand better the cultural background of other partners. These three measures are completed with the establishment of close links with companies, involving them in internships of students and in talks for specific courses of the programme of the partner universities. It is recommended that universities continue their efforts in developing close links with industry as well as teaching methods oriented towards practice for this Master to be sustainable and successful in the future.

### Acknowledgements

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