SELF-EVALUATION DRIVEN RECOMMENDATIONS FOR PLANNING INTENSIVE PROJECTS

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ABSTRACT

Intensive Programs (IP) have been organized by four European partner universities. The main idea is to gather approximately 40 students and 15 teachers together for three weeks to conceive, design, implement, and operate embedded system prototypes. Self-evaluation is an integrated part of the IP. The results of the evaluations are used to improve the concept, content, and practical arrangements for the next IP. The same partner network has organized similar intensive projects with different topics, but using the same internal evaluation method. We can recognize issues which make the IP successful and are common to the intensive project concept, independent of the topic. Based on the evaluation material, we will make some recommendations that can help organize similar intensive projects in the future.

KEYWORDS

Erasmus Intensive Project, Internal Evaluation, Best Practices, Program Development, Standards 3, 4, 5, 7, 8, 9

INTRODUCTION

In 2008, Helsinki Metropolia University of Applied Sciences (Metropolia), Fachhochschule Frankfurt am Main (FH Frankfurt), Coventry University (Coventry U), and Vilnius Gediminas Technical University (VGTU) came up with an idea to enhance their co-operation by jointly organizing a short-term Intensive Project (IP). The main idea was to gather approximately 40 students and 15 teachers together for three weeks in August to conceive, design, implement, and operate embedded systems. Self-evaluation was an integrated part of the IP. The first

evaluation was completed during the first week and was promptly analyzed, enabling the possibility of making changes to the IP curriculum and practical arrangements. The second evaluation was a systematic interview of the students either individually or in small groups and interviews of all teachers. The third evaluation was an electronic questionnaire at the end of the IP, which also fulfilled the EU report minimum student evaluation criteria. The results of the evaluations were used to improve the concept, content, and practical arrangements for the next IP.

At the time the first IP was planned, Metropolia was in the process of becoming a CDIO Member institute (Karhu 2010) and it was natural to adapt CDIO Standards (CDIO 2004) as general guidelines. The Standard 3 - Integrated Curriculum supports the learning of a multidisciplinary topic, and we can say that the IP also gave students a practical introduction to Embedded Engineering (Standard 4 - Introduction to Engineering). The IP was organized as a Design Implement Experience (Standard 5 - Design-Build Experiences) utilizing Active Learning methods (Standard 8 - Active Learning). Integrated Learning (Standard 7 - Integrated Learning Experiences) was applied by dividing the students in multicultural groups which combined their individual strengths in engineering problem solving. The IP also strengthened the faculty's skills and teaching competence (Standard 9 - Enhancement of Faculty CDIO Skills and Standard 10 - Enhancement of Faculty Teaching Skills). Although Standard 12 - Program evaluation is primarily meant to be applied in a full engineering degree program evaluation, we found the continuous evaluation against some parts of the standards helpful for the continuous development of the IP.

This paper describes how we organized the IP, the IP objectives and learning outcomes, how we performed an internal evaluation, our primary results, and how CDIO learning objectives were addressed. We have recognized issues which can make the IP successful and that are common to the intensive project concept, independent of the topic. Based on the evaluation material, we provide some recommendations that can help organize similar intensive projects in the future.

ORGANIZATIONAL ASPECTS

All of the discussed IPs are joint programs of four different universities. Metropolia is responsible for the IP coordination. Other involved universities are Coventry University, Vilnius Gediminas Technical University and Fachhochschule Frankfurt am Main. To organize the IPs, we primarily used internet tools to plan meetings. All meetings were organized as workshops in which we worked on the actual planning of the IP. Each participant took part in the planning with an approximately equal share of the work load. In the beginning of each IP, we decided upon the main responsibilities of each participating institute. The depth of the partnership was enhanced during the planning stage and IP.

The teachers were selected based on their expertise, language skills, ability to supervise student groups, and their personal working schedule. Each sending institute did their screening locally and made their selection after discussions during the planning meetings. All applicants had equal opportunities to be selected.

During the IPs, organizers conducted multiple internal evaluations using group and individual interviews, and online and paper questionnaires. The results were analyzed by FH Frankfurt and later utilized by the steering group consisting of the core members from each of the universities. Tasks related to evaluations were distributed between partners.

Helsinki Metropolia University of Applied Science was the host institution for EDSP IP 2010 and also responsible of the original concept, coordination, feedback analysis and reporting. Lecturers from Metropolia had practical knowledge of digital signal processing, USB and innovation methods and gave lectures on microcontrollers, interfaces and practical implementations. Staff members also supervised the group work.

Coventry University was the host institution for EDSP IP 2011 and was responsible for teaching microcontroller technology, mechanical engineering, working and documentation practices. Teachers also provided lectures on these topics, gave exercises and supervised the group work on all other IPs. Vilnius Gediminas Technical University was the host institution for two IPs (EDSP 2012 & Active Games 2013). Responsibilities included microcontrollers, sensors and analog electronics. Staff members also supervised the group work for all other IPs. Lecturers from FH Frankfurt were responsible for teaching digital signal processing and supervising the laboratory exercises and group work.

All partner universities were responsible for the tasks which were organized and divided during the meetings prior the IP. As there were multiple IPs with the same partner universities, the transnational cooperation worked without any problems or special concerns. The effectiveness of the approach in which each partner university brings its special knowledge to the IP and actively participates in the student group work was highly effective.

Each of the partner universities selected their participating students. The opportunity was announced to students from suitable technological fields. The students wrote applications, and each of the sending institutes decided using their own internal rules on who would attend. Students were required to know the fundamentals of embedded systems, IT and electronics. During the IPs, accommodations and meals were organized by the host institute. The meal gatherings turned out to be an important factor in binding the student groups together for all IPs. During the 2013 Active Games IP, the staff and students had shared accommodations, which turned out to be a success by making the learning environment more casual.

The funding issues were constantly discussed during meetings, and all partners knew the available funds and what the eligible costs were. Participants received full subsistence costs and 75% of the real travel costs. All usage of funds was managed centrally by Metropolia to ensure that all receipts were saved according to the financial guidelines of the funding agency (CIMO 2014). Student accommodations and student/teacher meals were organized by the host institute and then billed to Metropolia. Metropolia reimbursed 75% of student travel costs directly to the students based on the real costs. Teacher hotel reservations were also made by the host institutions and paid by either the traveler themselves or directly by Metropolia. Metropolia reimbursed teacher travel and accommodation costs based on the real costs and following the financial guidelines.

INTENSIVE PROJECT OBJECTIVES AND LEARNING OUTCOMES

One of the main objectives of all IPs was to increase co-operation between the partners. Before the IPs, the only activity between partners was a bilateral Erasmus teacher exchange between Metropolia and FH Frankfurt. Currently, Metropolia and FH Frankfurt have increased the bilateral exchange by introducing a new PSoC course and new Matlab in FH Frankfurt. VGTU has a teacher exchange with Coventry U and is also starting to exchange with Metropolia in addition to a few other teacher exchange ideas, which are being discussed

and planned. In addition, there has been an increase in long-term student exchange from FH Frankfurt to Metropolia. During the process, we were able to create new learning platforms and engineering workspace concepts which were partly adopted by all partner universities (Standard 6).

Our second primary non-technical objective for all our IPs was teaching students how to work in multicultural engineering teams, which improves their interpersonal skills. Similar observations have been made by Kitsnik et al. (2004) in a study related to peer tutoring. This objective has been accomplished extremely well. From IP to IP, students have reported the best features of the IP as: a) meeting new people from different cultures and b) team work in multicultural groups. Participating teachers observed first hand during the IPs how teams with four students from different cultures blended together as a group. The language and the cultural barriers were completely broken; all students were equal regardless of their origins or language skills and teams used the differences of the team members as strengths.

For the 2013 Active Games IP (Metropolia 2013), we introduced a third, non-technical objective: how to find an engineering solution to a non-engineering problem. This goal was realized by conceiving multiple different active game concepts and prototypes of game controllers. We plan to use these prototypes during the next IP where the concepts will be refined and the selected prototypes will be developed further. The variety and scale of the innovative ideas was extraordinary. The staff hoped in advance that students could take into account different requirements in terms of disabilities or other physical requirements. The amount of different approaches, the levels of innovation and the concrete results exceeded expectations.

The most innovative part of the Active Games IP lies in the fact that the emphasis is designed to change from year to year. The aim for the first year was for the students to conceive active game and game controller concepts and design simple prototypes. The next year, different students would continue the work based on the documentation created by the students from the first year. This approach binds the IP together, teaches students that their project results and documentation will matter and hopefully yield better results in terms of usable products.

Our anticipated learning outcomes were met for all of our IPs during the period from 2010-2013 (Metropolia 2012, 2013). The student feedback showed that more than 90% of students felt they learned new things during the IP and gained more professional skills. Based on the final assessment of the IP, we can say that all students performed at least at a "good" level, with most of them at a "very good" or "excellent" level. Students and teachers felt that the IP was a great success.

IMPACT AND EVALUATION

The 2010-2011 EDSP IP student feedback shows that the students gained new skills and theoretical knowledge, better language skills, new friends, life experience, credits, experience and knowledge of different cultures, and soft skills needed to work on a professional project in a multicultural working environment. During the 2012 EDSP IP, students reported development in teamwork and communication skills, problem solving skills, presentation skills, improved knowledge of embedded systems and new software, better general understanding of the study area, concept development and implementation skills and time management skills (Metropolia 2012). During the 2013 Active Games IP students who

participated in the IP reported that the IP was an "eye-opening experience" (Metropolia 2013). This outcome was due to the multi-disciplinary topic for which students were forced out of their comfort zones and were required to collaborate with team members. The development of all of these skills reflects the needs of the market for a new type of engineer who is not only competent in his area but is also able to work in a team, develop a product and present the work performed to stakeholders (Standard 3).

Teacher interviews show that the teachers gained experience and knowledge on different cultures and practiced language skills (Standard 9). In addition they obtained experience on organizing multinational, multicultural events. Lecturers and lab assistants have also mentioned that the project has allowed them to gain more project coordination skills and to continue the development of these types of projects in the future. The 2013 Active Games IP resulted in deepening long lasting relationships and provided an opportunity where teachers could have free and open discussions on various topics.

EVALUATION AND EVALUATION METHODS

For the first two IPs, we collected student feedback in the middle of the IP and immediately after the IP (Metropolia 2012). On the subsequent IPs the feedback was collected three times – at the end of the last day of each week. The feedback was conducted and evaluated by the FH Frankfurt EvaS Team. The methods used included a paper questionnaire and an online form.

For the 2013 Active Games IP a multi-phase evaluation process was used (Metropolia 2013). Student progress was monitored not only during the weekly competitions but also during the group work in real time. Additionally, there was a peer evaluation process in which the students evaluated each other. The evaluation was conducted by all staff members, but the electronic evaluation forms were evaluated by FH Frankfurt.

In brief, the results of the student feedback are as follows:
- 2010 EDSP IP: Students were very satisfied (about a 4 on a scale of 1-5) with the IP. However, there were two items where students did have some concerns. A) "The amount of work was appropriate for the amount of time" result 2.8 is rather expected because they had only three weeks allocated to do things that they are used to working on little by little during the whole semester. B) "The scheduling of the project (deadlines, milestones, etc.)" was scored as a 2.9. This issue is one of our main concerns for improving the next IP. The highest points received was 4.4 for the question of "Would you recommend this intensive program?", which indicates that the IP was overall a big success. In addition, on the last feedback students gave good ideas on how to further improve the IP, advice for the next IP students, and reports on the main problems with the program.
- 2011 EDSP IP: Overall, the students were very satisfied (approximately 4.5 on scale of 1-5) with the IP, which shows an improvement compared to the previous IP (4 on the same scale). There were no items for which the students had serious concerns. We had clearly improved the beginning of the IP by increasing the amount of laboratory working time and instructor support. Additionally, scheduling was much better than the previous year, which is quite expected because we made some changes last year during the course based on our observations. The highest score of 4.7 (compared to 4.3 last year) were received for the question "Would you recommend this intensive program?", which indicates that the IP was a big success

overall. In addition, students gave good ideas on how to further improve the IP and valuable advice for the next IP students. We used this information during the planning of the next IP.

- 2012 EDSP IP: We received similar results compared to the two previous years, with excellent ratings around an average of 4.5. This evaluation showed a slight improvement from the previous year. The organizers obtained excellent marks from the students.
- 2013 Active Games IP: The results of evaluations were excellent. There was only a little room for improvement except regarding matters related to the facilities, equipment and tools available. On the other hand, a lack of tools can be seen as an engineering challenge and not necessarily as a shortcoming. These results were partially expected based on our track record.

Overall, the implementation of the IP projects was evaluated as outstanding. Most respondents have had difficulty specifying what aspects of the project should be improved in the future. Most importantly the project organizers have reflected on the recommendations of the internal evaluation report of the previous stage. Students were asked to comment on concerns that arose during the previous stage of the project, such as lecture content, the schedule, conflicts in teams and others; they have confirmed that they had no difficulties with these aspects of the program.

Internal quality assurance

In addition to student feedback, we conducted an internal quality assurance review. During all IPs, multiple interviews were conducted with the student teams. The results were used to improve the quality of the next IP and gain information about the factors students found important.

All of the respondents have stated that after participation in the project they are better prepared for the job market because "they have received more practical experience", "learned to apply theory to practical activities", and "have become more confident in their study area". Respondents have also stressed that participation in the project will become a prominent part of their CVs due to the program's official recognition by the home institution and the issued certificated of participation. Furthermore, all students have mentioned that one of the most important skills gained through the participation in the project is the ability to work in a team, which is also highlighted by graduate recruiters as one of the most important skills. All of the developed skills are particularly important because most respondents have stated that they did not have previous work experience in their study field.

Other improvements from the IPs

The IPs facilitated new links to other projects, and the teachers had excellent networking opportunities with other European teachers. For all IPs, we organized teacher's visits to local companies and organizations as well to other faculty in the host institution.

The academic staff have also expressed strong beliefs that participation in the project will greatly impact the employability of the participants because: "it gives the foreign students 3 weeks of intensive English language training, and the work in the international groups is always a benefit; this is why our goal was to make sure there was one student from each country on every team"; "it is very important for graduates to have international experience"; "a lot of courses have an academic type of emphasis and my experience is that they get a lot

more out of the practical hands-on experience especially with modern experience. Once they are in an interview, the employers want to know what they have performed. Additionally, it helps them realize what is expected of them in terms of what is to be performed for the final thesis, and they definitely perform better practically".

It is also worth noting that the IP offers an excellent framework to simulate a real project work environment. In addition to new skills in the area of embedded engineering and group work, the students obtained a unique opportunity to learn realistic working processes. Students had to use their prior technical knowledge, adapt new theoretical concepts, learn to use new tools and equipment, work with new people from different cultures in an environment of strict time constraints, with limited availability of equipment and parts, and a constantly changing situation.

The IP also worked as a cross evaluation forum on teaching methods. The teachers compared their teaching material, syllabi, premises, and teaching methods with each other. This process improved the mutual understanding of the local and global professional requirements for future engineers

OUTPUTS

The outputs of all EDSP IPs are quite similar. The main website is located at http://edsp.vgtu.lt and was managed by Vilnius Gediminas Technical University. For the 2013 Active Games IP the main website was located at http://activegames.eu, which was managed by Helsinki Metropolia University of Applied Sciences. Both websites consisted of public documents, some photographs from the IP, contact information, and teaching material.

During all IPs, students were encouraged to publish video clips on YouTube. Starting with the 2011 EDSP students were asked to set up a Facebook group for the IP. Students and teachers posted embedded engineering-related postings and pictures months after the IP. Even after all the IPs were completed, there are still dozens of video clips found by using the IP name and year as the keywords. The old videos have proven to be excellent promotion material for future IPs. Examples of these videos are:
- EDSP IP 2010: http://www.youtube.com/watch?v=V74BPaPJIzo
- EDSP IP 2011: http://www.youtube.com/watch?v=FNEjLG7BCS4
- EDSP IP 2012: http://www.youtube.com/watch?v=g_cTJ7pIJEY
- Active Games IP 2014: http://www.youtube.com/watch?v=PYuIuHinSOw

The electronic student work documents for the 2010 EDSP IP are available for screening at http://users.metropolia.fi/~anttikp/eDSP/student_docs. For the 2011 and 2012 EDSP IP, the work documents were collected, but they were used only for internal evaluation. The student groups' documentation for Active Games 2014, as they were created by the students on the dynamic workspace, are available at http://activegames.eu/wiki-2013/. This workspace was the primary method for documenting the work during the IP. The final reports for all EDSP IPs are located at http://users.metropolia.fi/~anttikp/eDSP. The final report for the Active Games IP is located at http://activegames.eu/report. In addition, the results of the IPs discussed were published in different forums, such as CDIO conferences, local media, and internal meetings.

For the 2013 Active Games IP, the most significant outputs of the IP were the numerous prototypes using different types of body user interfaces created by the student groups. Some

of the prototypes were expected, but there are also truly innovative game interface ideas that could have potential real life applications. The documentation and experiences gained from all prototypes will be utilized further during the next IP, where the students' projects will be based on previously created prototypes. This output was planned and is based on the experiences from EDSP IPs. There should be continuation between individual IPs.

CDIO LEARNING OBJECTS

During the IPs, students worked on the same topic for three consecutive weeks. Each of the groups was randomly selected and consisted of students from four different universities. During the whole IP, each student group had to work together to achieve the goals. It has been observed on multiple occasions that the performance of the groups was excellent regardless of the cultural differences. The students' interpersonal skills were apparently strengthened during the IP.

Technical learning outcomes of all discussed IPs were relatively similar. Typically the subjects taught at their home universities prior to the IP were related to individual technical topics mostly in electronics and computer engineering. After completing the IP, students had skills in combining multiple individual topics. This experience resulted in knowledge and skills on how to actually implement real-life systems or in system building. During the IPs, students gained skills in building prototypes, which is often a less valued topic in computer engineering curricula but is nonetheless an essential skill in the embedded engineering industry.

The created prototypes required diverse engineering skills. Students were forced to combine their knowledge and skills when selecting the technology used in the group. The students within a given group had different backgrounds, which encouraged students to teach new skills to other team members to achieve better results. The goal for each IP was always selected such that the students did not have a priori experience forcing them actually to conceive and then create their own prototypes. This type of approach promotes real engineering reasoning and critical thinking.

Regardless of the IP, one of the most important skills learned during the three week period were skills for problem solving and experimentation. As the students combined their skills and knowledge to build systems and prototypes for which they had no previous experience, they also ended up having new types of problems. As the environment, available tools and devices were unknown for most of the students, solving the problems had an additional challenge. This limitation taught students to use the tools currently at hand to think creatively.

During the 2013 Active Games IP, the students were not building the prototypes only for the current IP. They recognized how their results would actually be a product that would be refined further during the next IP. In addition to product development skills, the students had to take into account the personal characteristics of the potential users of the prototypes in terms of disabilities and the effects of aging. This issue often poses unique challenges to students of technical subjects.

CONCLUSIONS

Self-evaluation methods were effectively employed to improve the quality of annually organized intensive project weeks. CDIO standards provided valuable guidelines on planning

the IP. Our main recommendations for organizing similar intensive projects on multidisciplinary topics are as follows:

- Plan the self-evaluation as an integrated part of the IP.
- Use multiple evaluation methods, such as individual and group interviews, e-questionnaires, and paper questionnaires.
- Use a multi-phase evaluation to maintain the feedback loop.
- Analyze the evaluation results systematically and use them to improve the current IP and the following IP.
- Use CDIO standards as guidelines for your IP.
- Arrange informal gatherings such as meals together, group accommodations, and group visits.
- Spend some extra effort balancing the work load and budget between the partners.

We are planning to continue the project partnership beyond the period of support from the ERASMUS-program. We expect funding to be more challenging in future, and therefore we will extend the co-operation by asking more institutes to join the coalition and add real industrial connections to the project. In addition to joint IPs, we hope to extend the partner network to other forms of co-operation such as research, double degree programs, and long-term teacher exchange.

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