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# TEACHING CONSTRUCTION PROJECT MANAGEMENT WITHIN AN INTERNATIONAL AND TRANS-DISCIPLINARY LEARNING PLATFORM

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## ABSTRACT

Engineers in the field of Architecture, Engineering and Construction (A/E/C) in combination with applied social sciences and communication design people co-operate more and more across borders and in trans-disciplinary project teams. They will soon after graduation be faced with different challenges in their professional life. As a consequence and to prepare students for these challenges, in the construction business the international and trans-disciplinary learning platform elop\* was introduced by universities around the world. elop\* stands for environment-focused learning and operative platform and is formed in an alliance hosted and led by the Bern University of Applied Sciences, Switzerland. Especially modern IT-tools for communication and collaboration are in the focus of research and will be evaluated each semester. In the last years, five real design and construction projects have been realized. This paper gives a general overview about international and trans-disciplinary teaching projects and explains the learning methodology of elop\*. The scope in this paper is focused on, but not limited to the experiences of the construction project managers in the projects. A discussion of the lessons learned during the five years will be provided.

**Keywords:** Information and Collaboration Technology (ICT), project management, education, trans-disciplinarity

## 1. INTRODUCTION

The ability to work in international a trans-disciplinary project teams gains more and more importance. Globalization has entered the AEC industry as well and engineers work in projects in teams, located across borders. Hence, communication and coordination tools get increasingly important role for successful construction projects (O'Brien et al. 2003). Challenges regarding the cultural background, geographical distribution and modern communication tools have to be faced by the project engineers. Furthermore, the construction business is often characterized by a poor communication and collaboration among the project participants.

The education of engineers and architects is traditionally dominated by disciplinary classes and projects during the study (Halpin et al. 1987). Elop\* (environment-focused learning and operative platform) is strengthening the disciplinary skills and additionally the students are taught to apply this in trans-disciplinary

processes. The developed teaching and academic learning methodology is a collaboration of faculty members, external mentors, stakeholders and the students in trans-disciplinary project teams to teach professionals of the future. Since 2005, five courses have been held with universities from Europe, North and Middle America and Asia. The composed trans-disciplinary project teams had to develop sustainable solutions for sport facilities, hospitals or university buildings. The objectives in the courses are both to work on real AEC projects and learn the trans-disciplinary collaboration. All of the five projects had real clients and were evaluated by an international jury panel.

## 2. MOTIVATION

Construction projects often involve many disciplinary participants organized in collocated or internationally distributed planning teams. Hence, communication and coordination tools become an important role for successful construction projects. All advantages which result from internet developments such as fast data transfer and permanent accessibility of participants lead to new opportunities but also new challenges. Team members often suffer from overcrowded inboxes, duplication of information and searching for information in unstructured data bases.

As a consequence and to prepare students for these challenges, the elop\* projects qualify students to become familiar with different collaboration tools. A series of information and communication technologies (ICT) have been employed to collaborative work in the past. Recently, internet-based communication and collaboration technologies become almost routine deployments in AEC projects.

The curricula in the engineering disciplines are strongly focused on the specific core disciplines in their subject-specific knowledge. Survey shows that only 3,7 % of construction management education deals with teamwork (Berner and Hahr 2006). Course topics are aimed to teach social skills are just optional and have an ad-on character in the curriculum of engineers' education. It is important to strengthen the awareness that communication and social skills have to be a mandatory part of education. Especially in engineering this part of education is lacking (Figure 1).

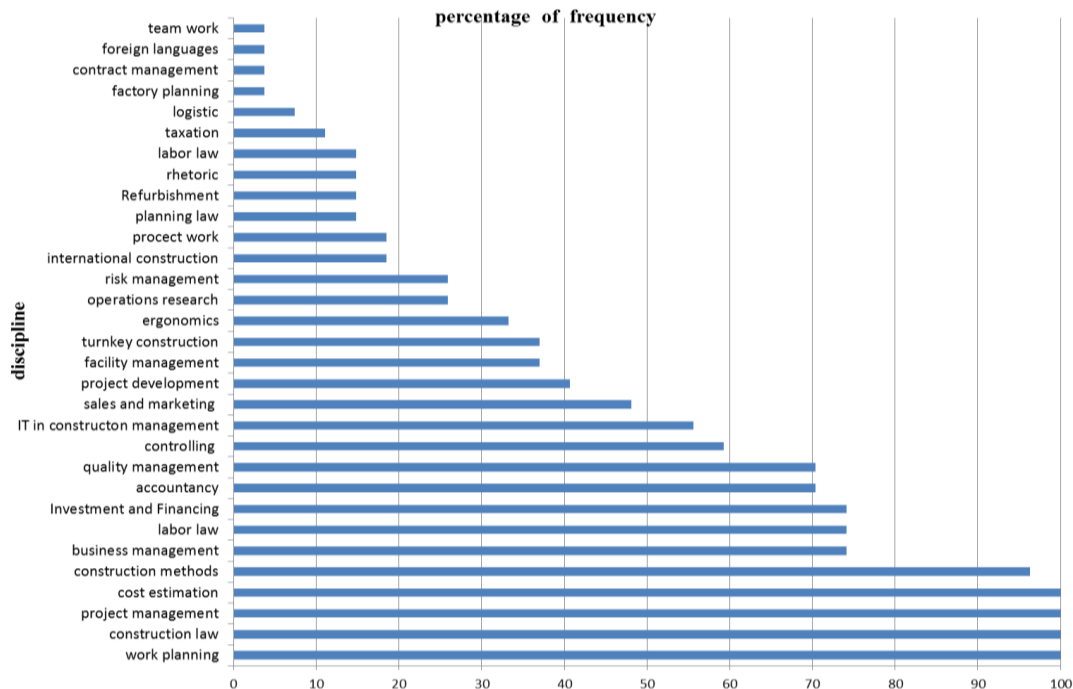


Figure 1: Frequency of subjects at German-speaking universities and institutes of technology

(Berner and Hahr 2006).

Studying construction management in a traditional way means to pass through basic subjects of financing, law, economics and project management, followed by additional courses to specialize certain topics such as refurbishment and simulation in construction. Students in construction engineering and management are also taught basic theoretical knowledge how to structure the organization and work flow of construction projects.

The increasing complexity of construction projects and the increasing awareness due to a sustainably built and social environment lead to rethinking the teaching project work. The different professionals have to work trans-disciplinarily and not sequentially one after another. Further, to face these challenges of complex tasks an integrated project work of different professions is required. The elop\*-projects teach students to fill this obvious gap in their education.

### **3. BACKGROUND**

Working in trans-disciplinary and geographically distributed project teams will be the key factor for successful AEC projects in the future. However, at the moment these factors are not supported by today's teaching concepts in a sufficient way. In this research trans-disciplinary research is defined as the "integration of academic researchers from different unrelated disciplines and non-academic participants," such as stakeholders to create new theories and knowledge (Cronin 2008). The Problem-, Project-, Product-, Process-, People-Based Learning (P5BL) laboratory and education program at Stanford University was established in 1993. It provides a platform for cross-disciplinary, collaborative and geographically distributed learning environment. Fruchter developed that environment including six universities from Europe, the United States and Japan and a toolkit to capture and share project knowledge. Her A/E/C global teamwork program is based on a P5BL pedagogical approach (Fruchter 1999).

In 2000, the University of Applied Sciences North Western Switzerland started with two POLE pilot projects to foster the modern information and collaboration technologies in cooperation with the Center of Facility Engineering and Stanford Learning Lab (Kündig et al. 2004). POLE relied on the existing platform of P5BL-Stanford PBL Laboratory (Holliger and Breit 2001). Since 2000, fourteen POLE projects were carried out with a focus on interdisciplinary product design (POLE 2013, Holliger et al. 2013). The successful experience of previous POLE courses led to the initiation of the elop\* project five years ago as a response to the need of trans-disciplinary education the AEC industry.

### **4. THE ELOP\* METHODOLOGY**

The education of students is in the focus of the elop\* methodology. The trans-disciplinary teams consist of one or two Students coming from each profession (Figure 2). Elop\* is project-based and integrates practical work processes. Thus, all projects are real building projects with real clients and stakeholders. The elop\*-projects challenge the students in four different ways. (1) The participating students are mostly master students and have a founded disciplinary and theoretical knowledge. The elop\*-projects are highly complex and large construction projects with many stakeholders and, thus, challenge the students' professional knowledge. (2) The task of elop\*-projects always aims at a comprehensive and sustainable built and social environment. Therefore, it is important that the involved disciplines collaborate even in the early planning phases in a trans-disciplinary way. Furthermore, the students are in conflict of applying their disciplinary knowledge and attitudes in the same time respecting the needs of the other disciplines. (3) The project team in elop\* are composed of students from different countries with different social and cultural backgrounds. Differences in the educational system of the participating universities, such as syllabus, term periods and different weights of the courses are aggravating circumstances. Basis to collaborate virtual or physical is to define a common language across the disciplines. (4) Due to the spatial separation during the project work, the students are forced to communicate and collaborate virtually. It is the combination of all these factors that are replica of reality but seldom taught in normal educational settings.

## 4.1 Participants

The universities of the elop\*alliance commit to a common agreement of a trans-disciplinary learning environment. The Bern University of Applied Sciences takes the responsibility for the coordination of the projects. The alliance partners for the current project are Bauhaus-University Weimar (Germany), Bern University of Applied Sciences Architecture Wood & Civil Engineering, Burgdorf (Switzerland), Cologne University of Applied Sciences (Germany), Haute Ecole du Paysage, d'Ingénierie et d'Architecture (HEPIA), Geneva (Switzerland), Polytech Marseille (France), Politecnico di Milano (Italy), Stanford University, Stanford (USA), Tecnológico de Monterrey (ITESM), Campus Querétaro (Mexico).



Figure 2: elop\* project team composition.

## 4.2 Course structure

The elop\* projects are structured in four main parts and designed for one semester (Figure 3). (A) The phase A launches with the virtual-kick-off session via the video-conference system. This first meeting is for introducing the topic and the participants. In this phase, the students will work locally in their disciplinary groups to get a deeper understanding of the topic related to their discipline.

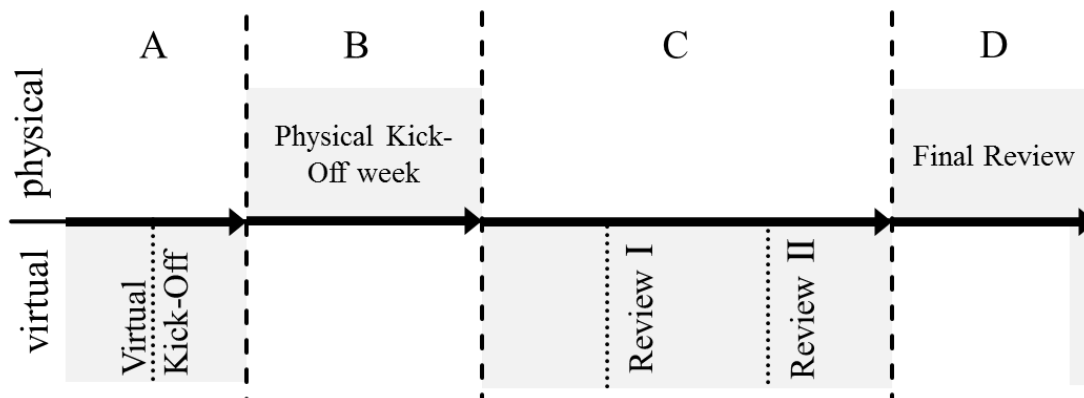


Figure 3: Structure of the course

(B) During the second phase, the physical kick-off week (Figure 4), the students get involved in several workshops for team- and trust building, get familiar with communication and collaboration tools and project planning. (C) After the physical kick-off starts phase C back at the home universities. The students work intense on innovative solutions according to the task definition via virtual communication and collaboration tools. In two intermediate review sessions the students get a comprehensive feedback by the jury panel to improve their processes in the teams and the final output. (C) The final review at the end of the project is conducted physically again. The students present their final results by using poster, video, visualization and models.



Figure 4: Team building process (left), project work at physical kick-off (right)

### 4.3 Assessment

An internationally jury composed of at least one jury member of each discipline, representatives of the stakeholder, the elop\* lead-team and external experts assess the performance of the outputs in the final review and as well the documentation. A strong focus is also set on the assessment of processes during the semester, such as decision making and team management.

## 5. COMMUNICATION TECHNOLOGY

The ability to communicate with all project participants in an effective and efficient way is the key factor for project success. At the moment, the official communication tool of elop\* is the SCOPIA desktop video conference system hosted by the ETH Zürich. SCOPIA enables face-to-face conferences with voice, video and data collaboration (Figure 5). SCOPIA Desktop is a web browser plug-in that allows every participant to share presentations, videos or other desktop applications. During a presentation, the presenter can mark and draw on the slides to emphasis certain points of the presentation. Furthermore, SCOPIA provides a chat function and recording function to take a video file of the conference session.

Video-conferenced elop\* (review) sessions via SCOPIA usually involve about 10-15 conference rooms with about 50 people altogether. It must be noted that for SCOPIA sessions a fast internet connection is necessary. For the internal group meetings each team has an individual and protected virtual conference room.

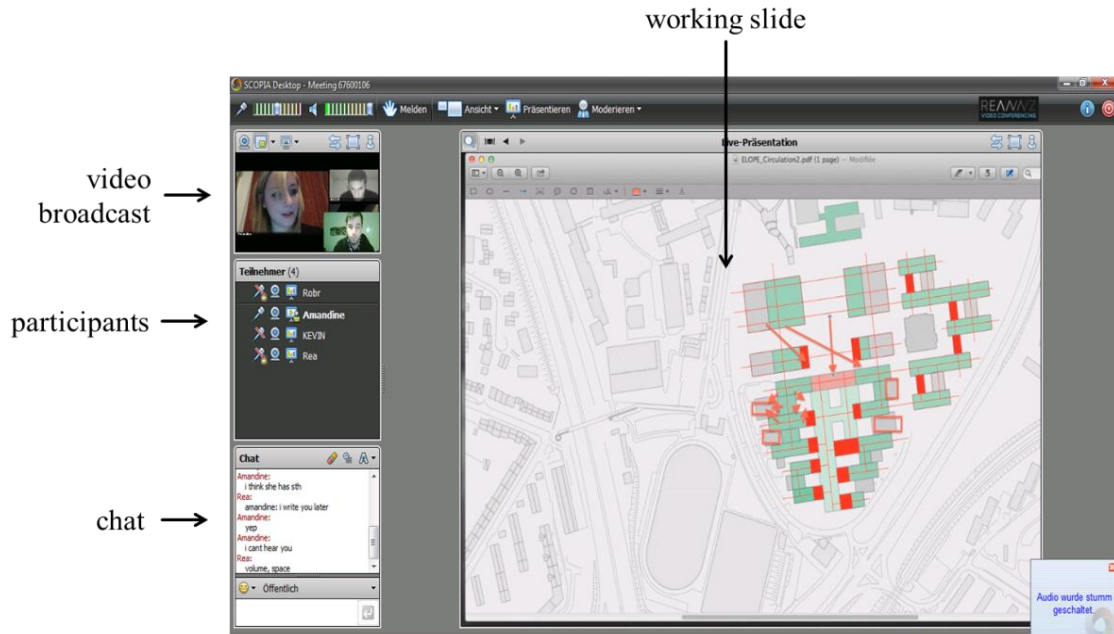


Figure 5: Scopia Conference

For many elop\* project teams Skype is a very popular communication tool. It allows for voice-over-IP applications. Skype allows face-to-face communication for the students, too, which is very important, because one can recognize the facial expression during the discussions. Group video conferences are possible up to 25 participants but not free of charge. The strongest advantage of using Skype is that the application is well known to almost every student und easy to use for spontaneous meetings.

For elop\*5 a new communication (as well as collaboration) tool was introduced, namely the elop\* blog (<http://elope.10mm.ch/e5/>). For each elop\*5 team a blog was installed. It provides the functionality to publish the students ´ideas and outputs in text format, pictures or videos. Other students, the coaches and guests can write and publish their comments. The students that are involved will be informed via Email about an incoming message in their blog.

Even e-mail is still an effective communication tool and is often used for easy data sharing in the teams. The flexible character of e-mail allows the team members to send mail and files asynchronously. Hence, multiple versions of the same content are used, edited and stored decentralized on each PC which is one of the mayor criticisms for this technology.

Last but not least, also Facebook is omnipresent in education. Most every student has an account and, thus, permanently connected. A short survey among current students shows that communication about the project-related issues via Facebook is very popular. The students proclaim the short time of response as the most advantage using Facebook for communication. Even pictures from the elop\*5 Kick Off are available on <https://www.facebook.com/elope5>.

## 6. COLLABORATION TECHNOLOGY

“Collaboration is a creative process undertaken by two or more interested individuals, sharing their collective skills, expertise, understanding and knowledge in an atmosphere of openness, honest, trust and mutual respect, to jointly deliver the best solution that meets their common goal.” (Wilkinson, 2005)

Working in an efficient way with a huge amount of data such as in construction projects demands a flexible and structured file-sharing system. The elop\* project teams are equipped with a well-sized Dropbox account. Dropbox is a file hosting service that offers cloud storage and file synchronization. Dropbox allows for a flexible

creation of folder structures. After adding or editing of files or folders on each of their computers, Dropbox synchronizes the content with all invited team members.

Google Drive (formerly "Google Docs") is a service that provides a network file system for the synchronization of files between different computers and Google users. At the same time it allows for online data backup. In addition, it provides functionality for word processing, spread sheets, creating slide shows, forms, and drawings. Google Drive allows the students to edit their documents virtually together and displays changes in real-time to everyone involved. Google Drive is also an easy tool for decision making. Opinion polls can be created easily to allow all team members to vote in a democratic way and promote the decision making process in the teams.

## 7. VALIDATION AND CONTINUOUS IMPROVEMENT

For accurate validation of the elop\* methodology, a comprehensive survey was conducted among all former elop\* students. A total of 168 students participated in the previous five elop\* projects, meaning that the survey was answered by 43 % of the students (Figures 6 and 7). It was divided into four parts: general questions, communication behaviour, data sharing and educational practices. The questionnaire comprised both open and closed questions.

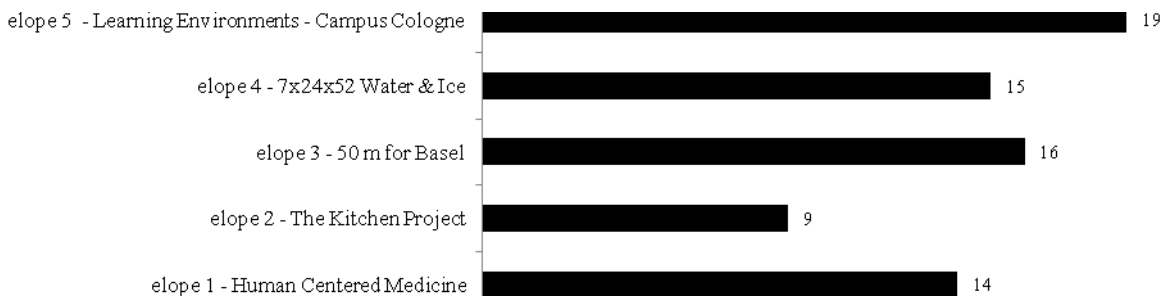


Figure 6: Project-specific distribution of survey participants

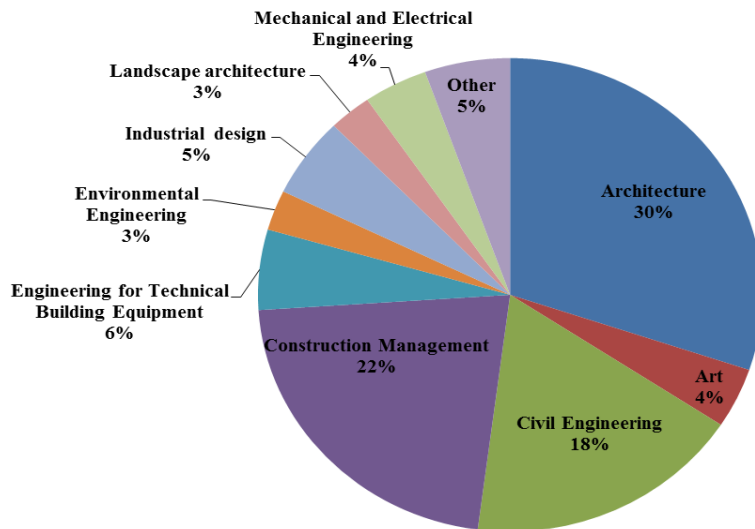


Figure 7: Discipline-specific distribution of survey participants

The research was focused on virtual communication and collaboration. During the elop\* projects, the participating students were provided with tools to perform efficiently in a virtual set-up. 85% of these students agreed that the tools and methods provided were highly effective for trans-disciplinary work.

Figures 8 and 9 illustrate the most important findings. Before attending the project, only a third of the students felt that they had good or excellent knowledge of virtual communication tools, but the post-project evaluation showed that more than 77 % of the students felt they were either good or excellent at using the tools. The same tendency is reported in the use of virtual data-sharing tools before and after participating in elop\* (Figure 9).

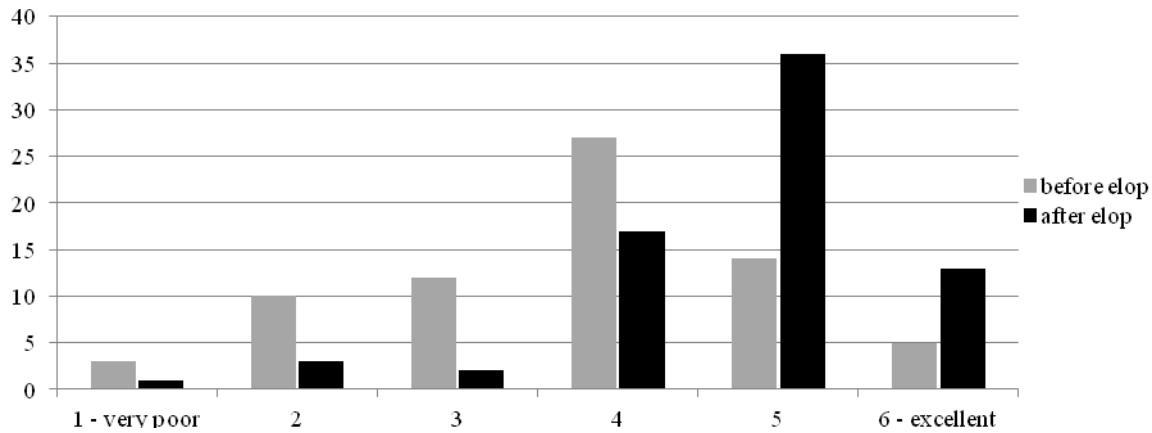


Figure 8: Experiences of students in using virtual communication tools before and after participating in elop\*

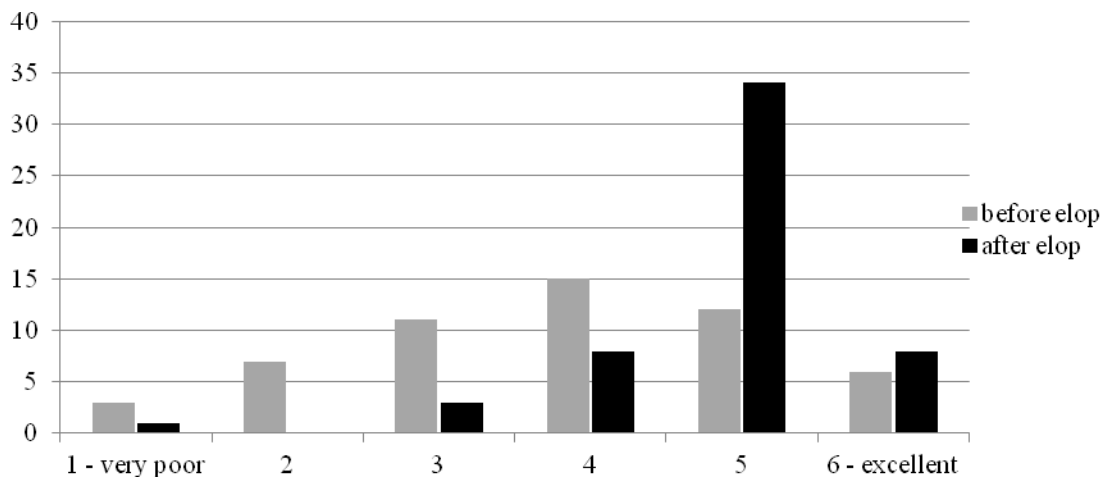


Figure 9: Experiences of students in using virtual data-sharing tools before and after participating in elop\*

The survey shows additionally that the limited period of meeting physically during the kick-off week requires very precise planning. It also shows that the input lectures and workshops to introduce virtual collaboration and the trans-disciplinary methodology are essential for the project's success.

## 8. CONCLUSION

The elop\* project described in this paper is a teaching and learning platform for trans-disciplinary AEC projects integrated with social sciences and design. The interaction between academic procedures and practice of using virtual communication tools and methods is an integral component of the elop\* methodology. During the last five



years, valuable improvements have been made towards a learning framework for construction management professionals. The methodology was evaluated with a questionnaire among all previous elop\* participants. The results showing the effectiveness of the elope methodology.

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