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THE PEDAGOGICAL DEVELOPERS INITIATIVE
- SYSTEMATIC SHIFTS, SERENDIPITIES, AND SETBACKS

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ABSTRACT

Pedagogical projects have often, at KTH Royal Institute of Technology, as well as elsewhere, been initiated and managed by individual enthusiasts rather than dedicated teams. This generally decreases the possibility of successful implementation of more ambitious ideas, e.g., changing educational programs, implementing the CDIO syllabus, or strengthening the pedagogical development of larger parts of the faculty. To enable wider and more effective change, KTH top management therefore launched a university-encompassing three-year project in 2014, in which a group of highly motivated teachers from all schools at KTH were appointed part-time pedagogical developers (PDs). The PDs were given the task of promoting pedagogical development and facilitate cooperation and knowledge exchange among faculty members, as described in two previous papers at CDIO conferences. From 2017, the outcomes of this project are supposed to be integrated parts of the KTH line organization. The project has led to numerous actions, which would have been difficult to set in motion unless given the freedom in time to explore and to develop into a collective effort rather than a myriad of individual "stand-alone" examples. By addressing key areas for pedagogical development, our group of dedicated faculty have tried to surpass the suboptimal "lock-in" of strict individual reasoning and to deal with surfaced questions and relevant issues in a broader collective manner. A major insight confirmed by the project and its many sub-projects has indeed been the fundamental importance of collegial discussions and the creation of processes that facilitate and support teacher cooperation. We have also, through discussions with faculty at KTH, confirmed the need for clearly defined, tangible incentives for teachers, motivating them to participate in pedagogical development activities, even if this means less time left for the traditional pathway to rewards within academia, i.e. research. In this paper, we chart changes that have occurred in the educational practices at KTH by describing and discussing the project's focus on pedagogical development of faculty, actual execution of changes in the engineering educations, lessons learned along the way, and visions yet to be realised.

KEYWORDS

pedagogical developers, educational change, change agents, faculty development, CDIO standards

INTRODUCTION

As stated in CDIO Standard 10 (2010), faculty members need to get proper support and training in order to be able to successfully introduce new types of active, experiential or integrated learning activities in their courses. Reaching such a goal is a university-wide change process which involves almost all faculty members. However, change processes are hard to both manage and execute. There are several models emphasized in the change

management literature, and after learning that the majority of extensive change efforts fail, Kotter (1995) couched his model as a way of avoiding major errors in the change process. Todnem By (2005) puts attention on the contradictory advices provided from change management literature overall and that a strong reason to this is due to the lack of empirical evidence. Kotter viewed change management as several key phases to provide guidance, minimize critical mistakes in any of the phases and noted that failure to any of the phases can have devastating impact on the momentum.

Past studies have shown that a few key components to successful change processes are a combination of top-down and bottom-up strategies (Elton 2003, Graham 2012) and a close relation to the day-to-day work performed by individual teachers (Kleijnen et al. 2014). An alternative approach to systematic faculty development is through institutional programs using peer-to-peer support and training of individual teachers e.g. the Carl Wieman Science Education Initiative (Wieman et al. 2010). With a growing academic interest to document and track educational change efforts from a descriptive character (e.g. Kezar and Eckel, 2002; Kolmos and De Graaff, 2007; Reidsema et al., 2013), we attempt to share experiences to benefit both operational and strategic values.

The originating work by Kotter and Schlesinger (1979) and Kotter's (1995) model can be described as aimed at the strategic level of the change management process. In contrast to this, Jick (1991) developed a model more focused on the tactical level in order to guide the implementation of major organisational change. Jick emphasizes that implementing change is an ongoing process of discovery, and therefore thoughtful questions has to be asked throughout the entire process. Mento et al. (2002) continued to explore the importance of change implementation as a 12-step framework for change made tracking progression a way to fine tune change efforts. The first seven steps of their framework are all relevant to discuss when it comes to the change project that this paper is focusing on. The first (1) step is to identify the idea and its context, the second (2) step is to define the change initiative while the third (3) step is to evaluate the climate for change. After that comes the fourth (4) step that is focused on developing a change plan and the fifth step (5) which is aimed at finding a sponsor. Step six (6) emphasizes that you have to prepare your target audience and step seven (7) states that you have to create a cultural fit in order to make the change last.

In 2014, KTH started the pedagogical developers (PD) initiative, a 3 million Euro project to support the bottom-up part of the change process. This project started from the ground level, i.e. from student perception of their learning environment and everyday problems for teachers (Berglund et al. 2015). In the second year of the project, the PDs developed educational support material for teachers and strengthened the collegial dialogue (Berglund et al. 2016). In this paper, encompassing insights from the third consecutive year, we describe what has been achieved so far, and our change visions for the future. Finally, we draw a set of general conclusions based on the whole PD project, highlighting our approach, the implementations, and efforts to sustain the process beyond the formal project's end date. Our ambition is to inspire those that are stuck to break loose, or in other words, to find progression and build momentum towards accepting change as something much needed also in an academic environment.

SHORT SUMMARY OF THE THIRD YEAR ACTIVITIES

During the third year of the project, there has been a continued work on refining the Learning Experience Questionnaire (LEQ) process which is used to obtain information about how students perceive their learning environment (Berglund et al. 2015), and to improve the pedagogical workshops for enhancing the pedagogical skills of faculty members (Berglund et

al. 2016). The focus in the LEQ process development has been to make the process more user friendly and the results from LEQ are now automatically imported into a template for course analysis. Systematic work to improve the quality of the workshops has been performed, based on the analyses of written feedback from participating faculty members.

In early 2016, it was decided within the PD group that the main focus of the common activities during 2016 should be to find ways to incorporate the gained experiences at both university and school levels. This work was summarized in a written report to the KTH educational board, where the PDs put forward a list of proposals for future decisions, to promote pedagogical development. A selection of some important issues that the PDs worked with during the third year of the project is presented below.

The PDs:

- made a proposal for improving the process to start new courses.
- made a proposal for the structure of a common document for course information to students.
- suggested a common certificate for global competence.
- participated in the development and testing of new pedagogic courses.
- developed a course for implementing course development in existing courses which utilize many of the outcomes of the PD project.
- acted as a consultation body for input in different pedagogical development projects, e.g. the specification of a new learning management system, and the redesign of lecture halls and classrooms.

The project should be incorporated within the line organization from beginning of 2017. When writing this, we cannot fully grasp the consequences of this organisational change, but 7 out of 10 schools at KTH will at least in the short run continue with PDs in some way, and a small budget for collaborative efforts among PDs have been decided upon. We also note that KTH top management has started up an organized university-encompassing dialogue about educational strategies, and that some of the PDs have been assigned to leadership positions in the educational organization.

OUTCOMES FROM A CDIO PERSPECTIVE

It was realized at an early stage that the PD activities could be mapped to CDIO standards and syllabuses (Berglund et al, 2015). This paper takes a deeper look at what has actually been achieved at the end of the three-year project. Table 1 summarizes some of the main activities mapped to relating CDIO standards. We have indicated the outcome/impact reached by the overall project from an estimate of how well each activity is included in the present educational structure at KTH.

Table 1. The third year PD activity overview and CDIO mapping

CDIO Standard	What has been Implemented	Outcome/impact
2. Learning outcomes	Intercultural competence	Certificate of Global Competence.
	Progression in report writing	Implemented at two schools.
3. Integrated curriculum	Program oriented teacher teams	Created in some study programs.
	Sustainable development	Integrated in most study programs.

5. Design-implement experiences	Challenge-driven education	Agreements set up for one program.
8. Active learning	Clickers and similar tools	Used by many teachers (>10%).
	Toolbox for formative feedback	Available online.
	Flipped classroom	Two courses developed by PDs.
	E-learning	Testing and implementation of digital tools.
9. Enhancement of faculty competence	Equality and diversity	Common views by collegial discussions.
	Research in education	>10 scientific publications by PDs > 8 scientific publications inspired by PDs
10. Enhancement of faculty teaching competence: Workshops/Seminars	Assessment methods Designing courses for motivation Educational development with LEQ Flipped classroom Formative feedback Get started with E-learning Help your students to study in your course ILOs and the Course Syllabus Independent students	Given 4 times, 60 participants Given 6 times, 115 participants Given 3 times, 90 participants Given 4 times, 60 participants Given 6 times, 135 participants Given 2 times, 35 participants Given 2 times, 25 participants Given 5 times, 60 participants Given 2 times, 20 participants
10. Enhancement of faculty teaching competence: Other	Communities of Practice (CoP)	>15 lasting ones have been established.
	Classroom observations	Implemented in two CoPs.
	Pedagogical courses	Two new courses have been developed.
11. Learning assessment	Revision of master thesis course	Mapping to program learning outcomes.
	Learning Experience Questionnaires (LEQ)	>400 courses/year.
	Revision of examination methods	Done in one study program.
12. Program evaluation	Progression analysis of CDIO skills • Innovation management • Sustainability learning objectives	 Done in one study programs. Done in two study programs.
	First year mathematics - bridging the gap	Done in two study programs.
	Student feedback for program analysis	Implemented in one study program

We now turn to a more detailed description of the PD activities mentioned in Table 1.

CDIO Standard 2 - Learning Outcomes

Intercultural competence: A university-wide add-on program, 'Certificate of Global Competence' has been developed. While technically not part of any study program, and thus seemingly at odds with CDIO thinking, this promises to be a way of making room for learning outcomes seen as important in all programs, and supporting international student mobility, without having to alter these programs' often painfully worked out syllabi.

Progression in report writing: At two schools, PDs have developed progression schemes in report writing. Students get a first-year introduction to academic writing and improve their skills during years 1-3 with increasing demands, followed by a B.Sc. thesis report using the same format and grading as the M.Sc. thesis report (but with less strict requirements).

CDIO Standard 3 - Integrated Curriculum

Program oriented teacher teams: In a few study programs, PDs have initiated and formed teachers' teams for the whole program. This all-encompassing approach facilitates the development of an integrated curriculum. Other PDs have worked together with leaders of study programs to initiate program discussions about progression.

Sustainable development: Thanks to many different efforts at KTH: the PD project; KTH sustainability office, and different program directors, sustainable development is now implemented in most educational programs at KTH and is being assessed on a university level, since KTH nowadays is ISO certified.

CDIO Standard 5 - Design-implement experiences

Challenge-driven education: One PD has been working on setting up international agreements for challenge-driven projects, allowing students from different universities to participate in large common engineering projects.

CDIO Standard 8 - Active Learning

Clickers and similar tools: Many PDs and other teachers have tested and are now using clickers or web-based response systems in education. This development has been strengthened during the last three years and the methodology is starting to become generally accepted among faculty. As an example, one department has purchased 300 clickers to be used during lectures in large basic courses, reaching around 1200 students per year.

Toolbox for formative feedback: The PDs have developed a website that maps a variety of courses and different forms of formative feedback provided by KTH faculty. It is based on interviews and highlights pros and cons experienced, from the teachers' perspectives.

Flipped classroom: Two PDs have been involved in the development of courses using the flipped classroom pedagogical model. The new engineering program Industrial Technology and Sustainability has an explicit pedagogical foundation focused on flipped classroom with video recorded lectures, gamification and real world problems from industry partners.

E-learning: Most PDs have been involved in testing and evaluating various kinds of digital tools in education. This includes different ways of using video in education, tests of new software for E-learning, making MOOC courses etc. At one department, several second cycle courses use recorded lectures as a significant part of the students' learning activities, enabling a shift from lectures to seminars with enhanced discussions.

CDIO Standard 9 - Enhancement of Faculty Competence

Equality and diversity: One PD has worked with equality issues when teaching architecture and the small number of female role models put forward within the field. Teacher discussions have been initiated and the results have been put together into rules about equality and diversity.

Research in education: The PDs have published their findings at pedagogics conferences and in pedagogical journals and we can count to more than ten publications so far (most

PDs had no publications in the field of pedagogy before the project). Another effect is that the PDs have inspired other faculty members to submit pedagogical innovations as papers to local and international conferences and journals. Deeper studies in areas relevant for advancing engineering education has also been initiated, e.g. understanding students' study strategies, investigating student motivation driving forces, and testing new ways to introduce peer review to engineering students.

CDIO Standard 10 - Enhancement of Faculty Teaching Competence

Workshops: Nine different workshops for continued education of faculty teaching first and second cycle courses have been developed by the PD group. These workshops have been given on 34 different occasions, with a total of 600 participants. Three of the workshops were given in an international context at Trinity College Dublin, Ireland, and one at the CDIO European Regional Meeting, in January 2017.

Communities of practice: One aim of the PD project was to create new communities of practice (CoP), (Wenger, 2015), where teachers actually talk about pedagogical issues. Every PD has tested a number of different CoPs during their work and every PD have on average introduced one CoP that is foreseen to be continued in the future. The created CoPs are of many different kinds, like e.g. LEQ discussion groups, pedagogical lunch meetings, teachers in mathematics, teacher teams in various study programs, examiner meetings, group of teachers interested in active learning etc.

Classroom observation: As a means to promote reflection and peer exchange, classroom peer observation visits were organised at two school for teachers visiting each other in small groups, following a routine with meetings before and after each visit, discussing first the focus of each visit and each teacher's special interest, and after the visits reviewing observations related to these, as well as topics emerging during the visits.

Pedagogical courses: The PDs have developed two pedagogical courses on issues that are seldom covered by courses given by the teaching and learning department:

- Reflective teaching in a subject perspective - a course that is run locally at departments to promote community of practice building among teachers.

- Pedagogical development of an existing course was developed to enroll teachers that want to make changes in their courses, but need support while doing it.

CDIO Standard 11 - Learning Assessment

Master thesis course: A thorough revision of a Master thesis course was made to practically include both stakeholder and faculty perspectives and to map goals and assessment methods to program learning outcomes. For example, the course now requires students to write and follow project plans and to make opposition on master theses.

Learning Experience Questionnaire (LEQ): A method to assess the students' learning environments was developed during the project and is based on a questionnaire and a follow-up collegial analysis of courses (Berglund et al 2015). The collegial discussion is included to promote course development by sharing the experience of the participating teachers. In a few courses, students have also been involved in the course analysis process with quite interesting results (they better understand the development process and why it takes time). Although the usage of the LEQ process is not a requirement at KTH, it is spread to all KTH schools and is used by most departments at KTH. During its first year of implementation (May 2015 - April 2016) more than 400 courses were analysed using the LEQ process.

Revision of examination methods: In one study program, the PD worked with a thorough revision of all examination methods used during the first year of studies, which also included the work to set up a community of practice with all involved teachers.

CDIO Standard 12 - Program Evaluation

Program evaluation projects have been done for many programs at KTH. These projects have often been carried out in response to program evaluations made by the Swedish Higher Education Authority. However, in recent years, more specific program evaluation projects have also started, in order to enhance various aspects of programs. Below, we give a few examples where PDs have been heavily involved.

Progression analysis of CDIO skills: When working in close collaboration with study program directors, the PDs have in some cases been asked to make program analyses of specific CDIO skills. The learning objectives and progression of sustainable development skills have been systematically evaluated in one program and discussed in other programs. In another program, one PD has worked with progression of student activities related to innovation management and teamwork.

First year mathematics - bridging the gap: There is a gap between what students actually know about mathematics from high school and what they are expected to know when entering university. In two study programs, this gap was investigated by an analysis of examination results and student enquiries. Based on this analysis and thorough teacher discussions, changes were introduced in the first year curriculum design. A strategic plan for monitoring this gap in the future was also developed.

Student feedback for program analysis: In one study program, all students write about and discuss their courses with peers and faculty members, including program management, as part of a meta-course. This data is now systematically collected and analyzed, and used for feedback, both on the program and on a course level.

DISCUSSION

Change management theories available to academics and practitioners are often contradictory. From organisational change management literature, e.g. Jick (1991), Kotter (1995) and Todnem By (2005) stress that the lack of empirical evidence and critical screening of efforts made is why implementation successes tend to deviate significantly. The PD project has addressed a large number of issues related to the CDIO syllabus and also been able to create real pedagogical change for individual courses and teachers. From the mapping to the CDIO standards, we can see that a large amount of work has been devoted to faculty development, curriculum improvement and active learning (the latter often related to the introduction of digital tools). On the other hand, efforts have not been put on the CDIO context and on the introduction of engineering to students (CDIO standards 1 and 4 respectively), mainly because these standards are already quite well developed at KTH. The PDs have not focused on CDIO standard 6 about engineering workspaces, since this is an issue for other projects already active at KTH. Finally, no activities are directly mapped to CDIO standard 7, about integrated learning experiences, which is somewhat misleading since many PD activities have in fact been related to work with complementary skills. Hence, the efforts made within the project have quite well reflected the most urgent needs for KTH to develop further within the CDIO concept. It is interesting to notice that this development has emerged and self-organized from a bottom-up approach while still following the first three change steps that Mento et al. (2002) describe. Also the second step enhanced by Mento et al. (2002) that emphasizes the need for defining the change initiative from the start

was done through the analysis of the organisation and its need for change. This was performed before the PD project was initiated.

The project can retrospectively be viewed as having followed a three year development process, with the following major activities during the different years:

- Year 1: Obtain a basic understanding of how the students perceive their learning environment, and identify the faculty's needs for pedagogical development.
- Year 2: Develop support structures to facilitate and simplify the pedagogical development of the faculty to ensure that change is implemented in a time-efficient manner.
- Year 3: Develop and suggest processes to make these activities consistent with the overall university strategy for pedagogical development, and to integrate them in the line organization.

Considering results and experiences gained within the project, we can now start to analyze it from a faculty change perspective. As shown, the PDs have set in motion a number of change processes. The importance of supporting faculty with new pedagogical methods involves what scholars (e.g. Kleijnen et al., 2014, Reidsema et al., 2013, Graham, 2012) address as a way to anchor changes at the level of individual teachers. This has been a particularly strong point within the PD project, where motivated PDs from the faculty have worked together with engaged teachers to actually create local change.

When organizations meet challenges not previously considered, it is hard to move away from existing practices. From the perspective of path dependency (Wilsford, 1994), this is a situations where structural forces are dominant, and changes are considered an upset to normal traditions. Hence, a strong internal momentum is needed to go beyond the existing path of practices and create a new trajectory. From a change perspective, the PDs have broken some of the internal silos by facilitating sharing of experience between faculty concerning, e.g., new pedagogical methods. This systematic shift can be seen as both a way to prepare the target audience (step 6 in Mento et al's 2002 framework) as well as a way to create a cultural fit (make the change last), which is step 7. However, there is an obvious risk of losing momentum when - as happened in 2017 – when the financing and ownership of the PD project was moved from central university level to local school level. The anchoring process remains a key ingredient if vital insights are not to be lost in the implementation process. In consequence, this step became a critical setback that stem from a lag within the line organisation when it comes to internal dialogue and decision-making.

The PD activities at different schools have been organized and executed in different ways. Some PDs have been given a large degree of freedom, while others have been more controlled. This aspect might have influenced the motivation and enthusiasm for individual change initiatives for the PDs. Looking at the activity in the PDs' community of practice, it seems that those PDs with more freedom participated and performed to a greater extent. So, for the continuation of the project, we believe that it is important that the engaged faculty should be given enough freedom to explore their own ideas of pedagogical change. And in the same way that some of the PDs were given a large degree of freedom in what to do, this freedom also needs to be given to the teachers that in future will embark on a similar pedagogical journey that the PDs have undertaken. Allowing for a large degree of freedom is important since pedagogical change is something highly personal for a teacher.

CONCLUSIONS

The PD group have benefitted a lot from the internal discussion within the group. From this experience, it is suggested that organisational structures to support the networking of teachers are needed to implement change on a university-wide level. This way, teachers are given the opportunity to actively discuss pedagogical issues with peers and, thereby, push the pedagogical development. Strategies to work together as an entity during the change process seem to be one of the keys in creating sustainable changes. Another key is to find new and innovative ideas to be able to work efficiently and reduce the workload of individual teachers. Establishing a team work feeling is crucial for the establishment for changing existing courses, programs or similar.

Finally, we shortly recognize a few of the systematic shifts that have occurred during the PD project together. We do this by also portraying a few serendipities discovered during our change path, as well as some noticed setbacks.

Systematic shifts

Even though the project just has ended, we can see some *systematic shifts* that likely will prevail. The first is the use of the LEQ process including the collegial course analysis for sharing experience. Most of the participating teachers express a positive attitude towards sharing their experience with peers. Furthermore, the PDs have been influential in the changes implemented in pedagogical courses and workshops based on teacher needs. The PDs have created and lead faculty dialogues which have resulted in real change as well as have become a vehicle for spreading new pedagogical methods.

Serendipities

The main *serendipity* was arguably the strength found in communities of practices across school and disciplinary divides. The creation of these communities clearly tapped into an unknown need among pedagogically interested teachers. Without it, the efforts would most likely have been much weaker and the results of the project would not likely have reached as far. An additional explanation for the success of these communities was likely the high degree of freedom that was given to some of the PDs, something which in turn was not as much a planned thing as an effect of the line organisation not really knowing what to do with the centrally funded PDs. Together with the open atmosphere in the PD group, the enthusiasm and motivation gave rise to many unexpected ideas. Among these ideas were the topics of the workshops, some of which were developed out of pure interest among the PDs.

Setbacks

An important, and possibly fatal, *setback* in the project has been that we have lost some momentum during the integration of the PD project at school level. More attention should have been given to establishing the outcomes of the PD project in the line organisation already at an earlier stage. The reason for this is not completely clear to us, but one may speculate that the necessity for change had not been sufficiently articulated from the beginning. The necessity to keep the process running has been understood by the top management, who has started up a university-wide strategic dialogue on educational issues, but by the time this has landed in the organisation, no one can know what will be left of the structures and communities formed during the PD project.

FUTURE CROSSROADS AND CHALLENGES

Midway through the final year of the PD project, the final report was drafted by the PDs. The reason for filing the report before the project ended was to allow time for KTH top management to make strategic decisions based on the findings from the PD project while the PDs were still involved in the project. Two main future scenarios were identified by the PDs. Firstly, the PDs could support the line organization with issues related to pedagogical development and quality assurance of education. Secondly, the PDs could be part of an organizational structure for spreading good ideas and practice-related research within the faculty and thereby drive the collegial discussions. This means that the PD activity should change focus from developing activities that support pedagogical change to actually reach and inspire a large part of the faculty to implement change. Accordingly, it was suggested that the PD project should be reformulated into a new organizational structure with both a School specific part and a common part to support this development. In this way, KTH can build up a university encompassing pedagogical network with the ability and the competence to actually implement change. To simplify the change process, the PDs suggested to KTH top management a number of administrative interventions that needed to be in place.

Most importantly, it is suggested that a *development-oriented* university-wide pedagogical program is created with a focus to support teachers to actually perform pedagogical development. As part of such a program, it is suggested that each School at KTH should have a pedagogical council working with quality issues related to pedagogics. In addition, a decision should be taken that course evaluations and course analyses should follow the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG). It is also suggested that every course should have a course description which includes the teacher's pedagogical view on the course. Finally, at a program level, it is suggested that a method for collegial program development and assessment, similar to the one developed for collegial course development, should be developed.

Organisational decisions are, however, not sufficient to implement change - support structures for teachers are also needed. Hence, it is suggested that course analysis should be done in a collegial setting (on scheduled meetings) where experiences could be shared among teachers. To promote a pedagogical discussion across school boarders, it is suggested that a forum where interested teachers can meet and discuss pedagogical issues is created. To give appraisal to pedagogic work, it is suggested that a pedagogical academy should be established, faculty should be encouraged to document and publish pedagogical development and research work and an "Educational Environment of the Year" prize should be inaugurated. At an individual level, each teacher should have a pedagogical development plan with clear and measurable goals to enable KTH to appraise pedagogical efforts.

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