EXPERIENCE OF INTERVIEWING STAKEHOLDERS

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ABSTRACT

Cooperation and communication with stakeholders is important for engineering educators as is emphasized in the CDIO standards. The School of Science and Engineering at Reykjavik University is implementing the CDIO standards and when reviewing and revising learning outcomes, i.e. CDIO standards 2 and 3, it was decided to contact stakeholders and obtain their views and recommendations regarding priorities in the program content. This work is on-going and will be carried out until the fall of 2014. This paper will discuss the methodology used by the four different departments at the School of Science and Engineering at Reykjavik University: Biomedical Engineering, Civil Engineering, Engineering Management and Financial Engineering, and Mechanical and Electrical Engineering. Although all the departments used interviews to some extent, they used different approaches and some also used focus groups and surveys. The experience of each department will be presented and discussed.

This paper compares the different procedures used by the four departments in selecting and approaching stakeholders and extracting their views. Conclusions are drawn with regard to future methods for involving stakeholders in developing and validating learning outcomes for engineering programs at Reykjavík University.

KEYWORDS

Stakeholders, Interview procedures, Delphi survey, CDIO implementation, Standard 2.

INTRODUCTION

The Conceive-Design-Implement-Operate (CDIO) standard 2 deals with learning outcomes (LO) which include knowledge, skills and attitudes of graduating engineers. Specific, detailed learning outcomes for personal, interpersonal, and product and system building skills should be defined for each program. The standard states explicitly that the learning outcomes should be reviewed and validated for content, consistency with program goals and relevance to engineering practice by key stakeholders, groups who share an interest in the graduates of engineering programs (i.e. faculty, students, alumni, and industry representatives). In addition, stakeholders should help to determine the expected level of proficiency or standard of achievement, for each LO.

To be able to implement the CDIO approach to engineering education generally, and CDIO standard 2 particularly, and thereby reach the goal of offering education that has truly been designed in cooperation with stakeholders and meets their needs, it is necessary to learn about their ideas and opinions.

It is important to define and select the stakeholders carefully for the benefit of the relevant project, they have to be representative for a broad group. Stakeholders in engineering education can be classified into four groups: students, industry, university faculty, and society. It should be noted that a stakeholder can be a part of more than one group (Arboleda, Pachón, Paz, & Ulloa, 2013). Arborleda et al. (2013) discuss the sensible variances between stakeholder groups regarding their ability to have impact on different factors that are important in a CDIO syllabus. These authors emphazise the importance of selecting stakeholders carefully with the aim of the survey in mind. On the other hand, González, Marciales, del Mar Ruiz and Viverons (2013) define two groups of stakeholders, internal and external, the internal group being from the university and the external group from alumni, industry and high schools. They started working with the internal group in workshops and teamwork to prepare a concrete proposal of changes and then involved the external stakeholders in the validation of the proposal using interviews and focus groups.

In the research presented here engineers from industry, representatives from associations, faculty of other universities, alumni and students, as well as people employing or working with engineers were approached for consultation. In a small country like Iceland there is considerable overlap between these groups, i.e. representatives of engineering associations and alumni are generally practicing engineers.

This paper will describe and compare the different procedures and methods used to collect stakeholder input for the syllabus of engineering programs in four departments at the School of Science and Engineering at Reykjavik University (RU). The aim of the study was to develop and implement appropriate and suitable methods for collecting and analysing data from stakeholders. The results will be considered when revising the learning objectives for RU´s engineering programs. This subject matter is both interesting and important for curriculum development in the School of Science and Engineering.

METHODS

Planning an investigation and choosing suitable procedures to carry it out is a process that needs to be well thought out and implemented within the context of the research. Various methods of gathering information on attitudes and ideas are known in the literature; surveys, interviews and focus groups are among well-established research methods (e.g. 998; Creswell, Vicki, & Clark, 2006; Cohen, Manion, & Morrison, 2007, Marshall & Cox, 2008; Merriam, 2009; Creswell, 2014).

As the aim in this case was to understand the ideas, beliefs and values of stakeholders, interviews were considered to be a good method for gaining information and understanding of their attitude towards engineering education. There are many things to consider when designing and planning a qualitative inquiry. Tracy (2010) suggested criteria for excellent qualitative research that guided our work: worthy topic, rich rigor, sincerity, credibility, resonance, significant contribution, ethical and meaningful coherence. Interviews support face to face discussion that can reveal answers about fixed facts if closed questions are used, but can also give a good idea of the interviewees´ diversity of ideas and approaches if open questions are used.

To conduct an interview is a complex process. Good preparation is necessary, as well as good skills and training in interviewing. Choosing the questions carefully and avoiding leading questions is important to ensure relevant and useful information from the interviewee.

During the course of the interview the interviewer can control the line of questioning but at the same time let the informant lead and answer in his/her own terms. However, there are limitations and the researcher's presence can bias both questioning and responses, all involved are not equally perceptive and articulate. The interviewees can also provide information that is filtered through their views and does not have much relevance (Creswell, 2014).

To develop our LO and implement CDIO standard 2 it was assumed that using more than one research method was likely to give better results in obtaining different views and opinions from the stakeholders. In addition to interviews it was decided to use a survey, in this case the Delphi method (Hsu & Sanford, 2007), which is a convenient method to reach a group of people and allegedly less time-consuming than interviewing. The Delphi method is a commonly used and recognized method for gathering data from individuals within their domain of expertise (Hsu & Sanford, 2007). The definition by Linston and Turoff (2002) will be used here: "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (p. 5). The Delphi method uses a panel of experts that are contacted at least two times, i.e. in two rounds, with questionnaires. After each round, a summary of the answers is used to get the participants in the next round to connect their former answers to other participants´ answers. This is believed to get the participants to group themselves towards more similar answers until a consensus is reached. In the end the mean score of the final round is used as the final conclusion. The method starts as a qualitative approach but in the end a quantitative appraisal of preferences is presented.

When successfully applied the Delphi method prevents well known problems such as "groupthink" and group biases where individuals in the same room impact each other directly, in extreme cases with a single "leader" dominating the discussion. The Delphi method is categorized as a "structured group process" (Lineston & Turoff, 2002). With the before mentioned iteration the manager of the analysis can come as close to the goal as possible, a shared conclusion that reflects the most important focus points.

When people meet they share information and collective thinking. When people participate in a Delphi analysis they are anonymous and the only feedback is statistical summaries and relatively simple textual statements. The main drawback of the Delphi method is that the creative process is small in comparison with meetings and workshops where people have a dialog to feed from each other's ideas. Also, the method obviously does not lead to network building to the same extent as interviews may do.

Group interviews are often used to generate data and useful information from a number of people at the same time. Focus groups are a form of group interview where the group interacts not only with the researcher but with the other group members; they discuss and ask questions to get each others opinions. The method is considered beneficial when the participants experience and knowledge is valuable for better understanding of the topic (Kitzinger, 1995).

Following is a description and comparison of the different procedures used in the four departments at the School of Science and Engineering at Reykjavik University (RU): Engineering Management and Financial Engineering (E), Biomedical Engineering (B), Civil Engineering (C), Mechanical and Electrical Engineering (M).

Engineering Management and Financial Engineering

The Department of Engineering Management and Financial Engineering was the first to start working with the stakeholders. Two research methods were used to gather data, semi-structured interviews and focus group interviews. It was decided to interview individually ten persons from the industry, including three alumni. Two young graduates of industrial engineering conducted the interviews. To prepare the interviews, information about the engineering management program at RU and questions were sent ahead. The questions were related what knowledge, skills and competences the industry expected of graduates, but there were also more specific questions regarding e.g. innovation, environment, leadership, language, group work and ethics. Each interview was about one hour, starting off with the questions and followed by discussion. The focus group was organized in a similar way, with five master´s students and a senior faculty member who lead the discussion.

While the stakeholders were chosen with focus on a specific discipline, in this case engineering management, the stakeholders´ answers and discussion focused in most cases more on engineering education in general and the proficiency of engineers. The stakeholders considered RU students to have adequate knowledge of both fundamental engineering subjects and basic subjects within their discipline. They voiced their opinions that both personal and interpersonal skills should weigh more strongly in engineering education.

Lessons learned from this first attempt to reach stakeholders with interviews was that this method gave valuable input for the development of the program, and in fact important improvements followed almost immediately. However, interviewees need to be more carefully selected where quality rather than quantity should guide the selection. Also, the interviewers need to be better trained and more involved in the aim of the interview and the organisation of the department to be able to seek more in-depth information. These interviews with stakeholders resulted in a complete rewriting of the LO of the engineering management program, followed by a thorough analysis of where each LO is addressed in a course, or not. This has already led to two new courses; one on Environmental Sustainability and Social Responsibility, and one on Quality Management. Furthermore, some existing courses have been restructured with the aim of training students better in “some basic survival skills of the workplace”, such as proficiency in using Excel and writing well-structured and concise reports.

The interviewees received feedback from the department head, stating specifically which points in their views and suggestions had influenced the revision of the program´s LO. This is thought to be important in showing the stakeholders that their views are respected, a key factor for promoting goodwill and being able to engage them again in the future.

Next steps include alignment of the program´s LO and the LO for each course, in particular in the personal and interpersonal skills categories, through the whole 5 years MSc program in engineering management. When interviews are arranged again, faculty members will most likely conduct them. This will hopefully result in a more direct interaction and communication with industry, strengthening ties and leading to continuing contact.

Biomedical Engineering

The Department of Biomedical Engineering built on the experience gained from the interview methods used for the engineering management program. They decided to carefully choose stakeholders who were likely to be interested in education and/or motivated to take part.

They therefore arranged fewer interviews. They also decided that senior faculty should conduct the interviews and use the opportunity to establish contact with key stakeholders, and underline the importance of their cooperation.

Six individuals were formally interviewed; three senior engineers in the biomedical industry, one senior medical doctor working closely with biomedical engineers, and two alumni, both of whom had completed their BSc degree at RU and had recently completed their MSc degree abroad. Structured interviews were conducted at the workplace of the stakeholders. About one week before the interviews, the stakeholders received general information about CDIO and specific information about the structure of the biomedical engineering program, also explaining why they were asked to participate in the interviews. They also received three general and open questions, as seeds for thought.

All the stakeholders turned out to be prepared for the interviews, and there was usually little need to initiate answers by suggestion. The faculty were very much aware of potential bias on their behalf in the process, both in questioning and in taking notes, but they felt that they succeeded in minimizing this factor. This is supported by the fact that they rarely had to initiate answers. The first question was „What knowledge do you expect biomedical engineers to have when they graduate?“, and in most cases the faculty received a list of topics and abilities, along with discussion on emphasis in different fields. Then the faculty asked about the expected skills; personal, interpersonal and professional; and in the end about the graduates´ competence. At the end of the formal interviews there was time for any other comment, but most often the stakeholders had little to add and felt they had communicated basically all they wanted to say. The interviews with the recently graduated alumni focused more on how RU´s undergraduate program had prepared them for graduate studies, and how they felt they compared with fellow students in their graduate studies abroad. The interviews with the senior people lasted just over an hour, the interviews with the young alumni about half of that time.

The interviews gave valuable information about what the industry expects from graduates in biomedical engineering. The faculty were overall satisfied with both the quantity and quality of the stakeholders´ contribution. Although „only“ six persons were interviewed, the faculty felt they received information that would be useful in developing the program further. The interviewing faculty felt strongly that quality may be more important than quantity when selecting stakeholders for this particular task, as deduced from the information obtained in the interviews.

There was a general consensus among the senior engineers that graduates should have good knowledge in mathematics, physics, chemistry, programming, circuits and electronics, measurements and signals, physiology, pathology, regulations and standards, and project management. Other subjects were also mentioned.

Based on these interviews, the department will consider adding and/or revising courses in standards and regulations, pathology and the health system, and putting more emphasis on project management.

Regarding skills and competences, the program should prepare and train the student better in tackling large complex problems in a systematic manner, problems similar to what they may be confronted with in the industry, and make students aware that they need to complete projects and see them through. In terms of attitudes, the program should continuously encourage the students to be innovative, open-minded, and they should be able to work

independently as well as in groups. One impression from the interviews is that the education should in some ways be more interdisciplinary, i.e. graduates should be able to discuss the future of the health system in general, not only technological aspects of it.

Based on the interviews, the biomedical engineering program is on the right track but needs to place more emphasis on the skills and competences mentioned above. It is currently being planned how to amend the program and incorporate these changes.

Lessons learned are that the interview protocol used was very informative. It appears that selecting interviewees who are interested and ready to give the matter some thought is more important than the number of persons interviewed; quality rather than quantity. The plan is to follow the same protocol for the next interviews. The department was also able to strengthen its ties with the stakeholders by this direct contact. Regarding the program in general, one conclusion was to place more emphasis on training the students in „real engineering“, in terms of skills and competence as discussed above.

Civil Engineering

The Department of Civil Engineering started their stakeholder enquiries with a Delphi survey. The stakeholders chosen for the survey were from various fields of the civil engineering profession. Representatives from both the private and public sector were included, comprising the many fields of civil engineering, as well as representatives from the Associations of Chartered Engineers (ACE) and the Chartered Technical Professionals (CTP) in Iceland.

The Delphi survey was planned to include two rounds, with general questions in the first round and more focused questions in the second round, after having analyzed the answers from the first round. A total of 17 stakeholders were contacted by telephone and asked to participate in the Delphi survey. All of them agreed to take part. The potential participants were provided with general information about the CDIO ideology and information about the structure of the civil engineering program. The survey contained three open questions; they were basically asked to state what knowledge, skills, and competences a civil engineer should have when he graduates. As things turned out only six participants answered the first round of the survey, in spite of several reminders. One excused himself from participation, but the other ten did not reply. One possible explanation could be bad timing; the time of year ran into summer vacations. Another explanation could be that answering the open questions required quite a bit of effort; the questions were not “user-friendly”. However, the views of those who did answer provided valuable insight on the desired accomplishments of civil engineering graduates. The level of detail in the replies received varied considerably but three out of six had clearly given considerable thought to the questions and the topic in general, and sent very comprehensive comments.

Following the disappointingly low participation in the first round of the Delphi survey, it was decided to change the strategy. Instead of continuing with the second round of the Delphi survey, formal interviews were organized with selected leading engineers from the construction sector, the consultancy sector, the ACE and CTP. Two faculty members interviewed a total of five stakeholders, thereof four who had been asked to participate in the Delphi survey but had not replied. For these semi-structured interviews, the faculty members prepared 13 rather detailed questions, along the lines of those prepared for the biomedical engineering program. The responses from the Delphi survey and the interviews were then

pooled for further evaluation. The replies to the Delphi questionnaire were therefore taken as implicit answers to the same questions as in the interviews.

It can be concluded that the stakeholders generally did not have a very clear or strong view on the issues discussed; rather they tended to focus on the needs and requirements of their own relatively narrow field of work. It was found that interviews are valuable for gaining insight into the stakeholders´ views and ideas. They also provide a good venue to establish contacts within the engineering community. However, the interviews may to some degree be influenced by the interviewer both through the discussion and dictation of the meeting. On the other hand, the Delphi survey has the advantage that people write down their own thoughts. Overall, many interesting and useful points were noted that will help the department to develop further the LO for the both programs and courses. The next steps will be to interview five current students and recently graduated alumni, to enquire about their study experience and the learning environment at RU.

Mechanical and Electrical Engineering

The last department to approach its stakeholders was the Department of Mechanical and Electrical Engineering. They used the same methodology as the Department of Biomedical Engineering; telephone calls to six stakeholders in the industry asking them to participate, followed by sending them an information package and asking them to consider four main questions in preparation for an interview. Two persons conducted each interview, the department head and the faculty member whose area of expertise was closest to that of the stakeholder being interviewed. Selected alumina will also be interviewed using a similar process but current students will attend a focus group to reflect on the curriculum.

The industry stakeholders received a description of the relevant study program beforehand and they were asked to consider what knowledge, skills and competences (theoretical/technical/applied) mechanical/electrical engineers should have. These points served as a starting point of the interviews. Most of the stakeholders came prepared and had concrete ideas. In two out of six interviews the stakeholder had no strong opinions and then the interviewer tried to start the discussion with more specific questions.

Although stakeholders had diverse ideas on what engineers should know and be able to do, three points stood out: 1) Students should be exposed to the relevant standards in the design process, 2) The study programs focus on design which is fine, but more emphasis should be put on maintenance and operation, and 3) Personal and interpersonal communication skills should be put in focus. These three points have already been incorporated into the on-going work of writing LO for the study programs in applied mechanical engineering and applied electrical engineering. There are four more programs within the department and stakeholder involvement in these programs, as well as revising the LO for these programs, has yet to be addressed.

RESULTS

Table 1 summarizes the experience of the four departments within RU´s School of Science and Engineering on their work with stakeholders, listing the pros and cons of the methods used i.e. individual interviews, focus groups and surveys. The departments are Engineering Management & Financial Engineering (E), Biomedical Engineering (B), Civil Engineering (C), Mechanical & Electrical Engineering (M). The emphasis in Table 1 is on lessons learned

regarding the methods used for selecting and approaching stakeholders, involving them and extracting their views. Table 1 does not cover evaluation of the stakeholders´ input nor their recommendations regarding syllabus, the revision of learning outcomes, and the development of RU´s study programs in engineering.

Table 1. Summary of experience of extracting stakeholders´ views on RU´s study programs in engineering

General method	What was done	Positive experience	Negative experience	Recommendations
Individual interview	Information on program structure sent ahead (E, B, C, M)	Necessary to provide some information; saves time in the interview.	May be too leading.	What and how much information should be provided; expert advice would be beneficial.
	Information on CDIO sent ahead (E, B, C, M)	Saves time in the interview.	May be too leading; the starting point should not be a defined mind-set.	Needs to be short and to the point; expert advice would be beneficial.
	Questionnaire sent ahead (E, C)	Provides necessary frame for interview.	Questions may be too leading.	Questions need to be both open and closed; expert advice would be beneficial.
	Two young MSc graduates conducted interviews (E)	An easy solution for overworked faculty. Gave good input into the implementation of CDIO.	Faculty misses the chance to meet and establish valuable contacts with stakeholders.	Interviewers should be trained, more involved in the aims of the interview and involved in the organization of the program.
	Ten interviewees (E)	Valuable input from some participants, among them two professors from another university.	Some had little to say; some had a very narrow focus on their own specialized field of work; some had not put any effort into preparation.	Select interviewees carefully, choose people who are interested in education and likely to commit time and effort to the task.
	All interviewees received feedback (E)	Promotes goodwill and future contact with industry.		Stakeholders should get confirmation of how useful their input is.
	Two senior faculty members conducted interviews (B, C, M)	Faculty establishes valuable contact with stakeholders	Time consuming. Faculty members have to be careful not to be too leading.	Faculty´s time is well spent in conducting interviews with well chosen stakeholders.
Survey	Delphi survey, first round (C)	Very valuable input from the few who participated, presumably free from "groupthink" and bias which are well-known pitfalls of other common methods.	Disappointingly few responses	Seek expert advice on how to structure questions in a "user-friendly" way, to promote more response. Delphi could be a good way to obtain students´ viewpoint, students being an interested party.
	Delphi survey, second round (none)		Not undertaken, due to lack of response to the first round.	
	Two senior faculty members conducted interviews after the Delphi survey, e.g. with those who had not answered the survey (C)	Interviews are a good venue for gaining contacts within the engineering sector. Provided insight into the interests of the profession.	Most interviewees did not have a clear view or strong opinion on education in general; they tended to focus on the requirements and needs of their own field of work.	Select interviewees carefully, people who are interested in education and likely to commit time and effort to the task.
Focus group	Discussion in a group of 5 students was lead by senior faculty (E)	An easy way to come into contact with stakeholders and get insight into their ideas and beliefs.	Can lead to "groupthink" where few dominate the discussion.	The researchers must be familiar with the focus group methodology to be able to lead the discussion away from "groupthink".

DISCUSSION

Four university programs in engineering have contacted stakeholders through questionnaires and interviews. Their input has been obtained and analysed to benefit the development of the programs. To collect stakeholders´ input can be time-consuming but is expected to improve the educational value of a program. The stakeholders come from various areas in engineering and therefore have different views, interests and values. Some may emphasize their own field, while others look more at the broad foundation that an undergraduate education should provide. Some may have strong opinions on what to teach while others are less interested, or unsure. At RU, an attempt was made to reach a relatively broad group of stakeholders to obtain a broad spectrum of ideas and opinions, and to use different methods in order to catch the diverse stakeholder views.

The stakeholders were approached with a dual goal in mind: 1) Extracting views that would be useful for the development of LO and syllabus for the engineering programs at RU, and 2) Establishing contact, with the idea of strengthening ties with the industry and building a network of contacts with the individuals approached. Probably a well-structured Delphi survey could fulfil the first goal better than interviews can do, but nothing can replace personal contact for strengthening ties and network-building. The selection of the interviewees was to some extent influenced by the fact that we were trying to fulfil both of these goals at the same time, i.e. a few of the individuals interviewed were “high-level” people who we wanted to make contact with, CEO´s who were perhaps not likely to put much time into preparing for the interviews. In some cases, an interview with “lower-level” people would probably have given better founded views and more relevant input towards the first goal.

Those who conducted the interviews with stakeholders at RU were not experienced in preparing or conducting interviews. One of the lessons learned is that the interviewers should preferably have some training in research interviewing. To some extent, this study can be seen as an exercise for the faculty involved in gaining experience that will prepare them for the next round.

One of the advantages of having faculty take interviews is that they thereby introduce themselves to the stakeholders, paving the way for future contacts and cooperation. Also, it is important that the interviewers have a comprehensive knowledge and overview of the subject being investigated. A possible disadvantage is that faculty members may have firm ideas on how the education should be structured and could therefore unintentionally lead the stakeholders towards validating their vision. The use of a relatively open questionnaire could minimize the risk of the interviewer taking excessive control.

If an interviewer, through a fixed set of questions or firm ideology, guides the discussion with the interviewee then the chance to get a more unorganized flow of information, which can lead to new ideas, may be lost. On the other hand, an unorganized open discussion often exceeds the set time limits and a flow of information can be difficult to interpret and analyse. Therefore interviews need a pre-set structure and firm management.

The response rate in the Delphi survey was disappointingly low, and indicates that the method may be impractical for this group of stakeholders. Those who answered the survey seemed to be those who had strong opinions on education. They described their views on engineering education in detail as well as answering the three key questions regarding what knowledge, skills, and competences an engineer should have. These comments, given

without any faculty influence, gave valuable information, perhaps better than some of the interviews. However, they were a bit unsystematic and therefore more difficult to follow up in further work.

Delphi is a recognized method for gathering information from individuals “within their domain of expertise” and/or interest. Delphi could be a good way to obtain students´ opinions, since students are presumably interested in their own education. One reason for low response rates in the Delphi survey could be the time and effort needed to answer the survey. Those who received the survey were basically asked to respond to very open questions by writing short essays. This could presumably be amended by getting expert advice on how to structure more “user-friendly” questions.

Work in systematically approaching RU´s stakeholders in engineering education is on-going. First results regarding their input for the programs are that we have obtained a clearer idea of what to teach and some useful thoughts on how to teach it. Next steps will focus on getting clearer stakeholder input for defining our graduates’ level of proficiency regarding knowledge, skills and competences in the various fields.

Both interviews and the Delphi method gave valuable and useful information. In both cases, the most valuable input came from those who are interested in, or in some way connected to, education. Choosing the “right” stakeholders to approach is crucial; they must have the relevant background and experience in the engineering sector but also, they must be ready to commit time and effort to the task. The stakeholders´ recommendations have already influenced the structure and content of some of the engineering programs, thereby helping the School of Science and Engineering to implement the CDIO standards 1 and 2.

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