

Research Methodology and Ethics – Researcher Education for Undergraduate Students in the Process and Environmental Engineering Study Programmes

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ABSTRACT

In this article, we describe the design, development and implementation of research methodology education carried out in the Department of Process and Environmental Engineering at the University of Oulu. This qualitative case study aims, using questionnaires, to clarify how to foster students' awareness of ethical issues in research. A total of 25 students participated in the research methodology education in spring 2004, 4 students in the group of distance learning and 21 students of contact education. The first research question concerns the meaning of ethical education when helping students to construct knowledge of ethical issues in research and science. The second question is whether students learn as well through distance learning environment, as when participating in contact lessons? Statistically, there were no significant differences between the answers of the distance learning and contact education groups. Both groups expressed that ethical education is useful because it helps them to achieve aims, to gather information, and to foster interest in research. The students also wrote that they would be able to use the information and skills gained during the course, in other contexts. The results show that all the students

developed their knowledge of research and ethical ideas of research work during the study period. Consequently, their awareness of the importance of ethical principles increased. However, it is impossible to draw any long-run conclusions, due to the results being based on a small number of students, and the short length of the study period, which was only two credits (a credit being equivalent to 40 hours of work). To confirm whether there were real changes in their conceptions, further research is needed.

Keywords: Ethical Education, Ethical Awareness, Contact Lessons, Research Studies and Distance Learning.

1. INTRODUCTION

This qualitative case study aims to clarify, how to foster students' awareness of ethical issues in research through research methodology education in engineering education. First, we wanted to know the meaning of ethical education in helping students to construct knowledge of ethical issues in research and science. Traditional instructional approaches typically organize and present information consistently with

what experts judge as correct or accurate; students, in turn, are expected to adopt this standard as their own. However, recent evidence suggests that students find expert conceptions difficult to comprehend. Constructivist teaching and learning approaches, featuring open, student-centred inquiry may offer advantages over contact education in classrooms. In student-centred environments, individuals search, interpret and synthesize information in order to generate knowledge [1]. Therefore, it was also interesting to know, how well students learn through a distance learning environment, when compared to participating in contact lessons in classrooms.

Design, development and implementation of the research methodology education project were carried out in the Department of Process and Environmental Engineering at the University of Oulu. This is an ongoing project that started in 1995 [2,3]. The aim of the research methodology course was to give an opportunity for the students to get familiar with research methodology and ethics already during their undergraduate studies, to encourage them to postgraduate studies, and to create a universal course on research methodology for the fields of environmental and process engineering. During the course, the students were given a general view to research from defining the goals and planning the experiments, to evaluation and reporting of the results. The main idea was to give the students as much heuristic knowledge as possible via the experiences of junior and senior researchers. Based on positive results in the evaluation of the project, a new course was derived jointly with the students and the research staff of the Department.

2. COURSE CONTENT AND FUTURE IMPROVEMENTS

The education was carried out using different methods of implementation. The main teaching methods were lessons, seminars, student presentations, discussions and tutoring, and controlled work independently or in small groups. During the course, research methodology and the different stages of research were discussed, starting from literature survey and design of test equipment, to evaluation and reporting of the results [4]. The course was closely linked to the other activities of the Department, e.g. research projects and courses. It was carried out in the field of scientific writing, experimental planning and working, construction of laboratory equipment, modelling and simulation, evaluation and analysis of results and reporting. Students also visited industry and research institutes. In addition, ethics in research and science was considered. In the academic year 2003–2004, a deeper focus on the approach of ‘Ethical conceptions

of undergraduate students on research and acting as a researcher’ was taken. Several ethical themes, e.g. the purpose and need for ethics in research and engineering, concepts of ethics and morality, justification of moral and ethical education in engineering education, rules of researcher’s ethics, misconducts of ethical rules, and ethics and good life were introduced and studied, either live in a lecture room, or through a distance learning environment.

3. EVALUATION AND ENCOURAGEMENT

The evaluation was systematic during and after each course. Feedback regarding the course given by the students and the research staff of the Department, was positive and encouraging. According to the feedback, there was a clear need for this kind of education. Both theoretical and practical knowledge and research skills of the students increased. These skills would be valuable in the future, not only in academic research, but also when working in industry. The best achievements were in the design of a new course together with the students, and in bridging the gap between undergraduate and postgraduate studies by giving an opportunity for the students to get familiar with research and research staff already during the undergraduate studies. From the students’ point of view, the obtained knowledge and skills were useful in finishing their M. Sc. theses. Collaboration between Laboratories inside the Department and between the two Study Programmes – Environmental Engineering and Process Engineering – also developed further.

The main problems during the course were in finding a time for the lessons and discussions that was suitable for all participants, and in holding the project together during the long time period. The course demanded a lot of time from the teachers and research staff. However, it would be worth the effort if the students stayed as postgraduate students in research groups.

The evaluation of the newly established course and the new approach that utilizes distance learning was done during spring 2004. The new approach was planned to overcome the main problems of the earlier research methodology course.

4. METHOD

The study is a qualitative case study. A total of 25 undergraduate students participated in the research methodology course in spring 2004, four in a distance learning and 21 in a contact education group in the Department of Process and Environmental

Engineering at the University of Oulu. Participant selection was purposive. It presented a group of students being introduced to the ethical issues and research methodology under study for the first time. The students had the possibility to choose whether they wanted to participate in distance learning or contact education. The distance learning environment used was Discendum Optima developed by Discendum Oy in Oulu, Finland. The company is an expert in electronic learning and a provider of learning environment services [5]. Discendum was selected because of its significant development history, and demonstrated applicability for educational sciences at the university level. It enables students to build their own knowledge, to revise and to reformulate their ideas. The students were also familiar with Discendum and evaluated that it is easy to use [6]. The only problem mentioned by the students before the course was, that one of the students did not have a computer and Internet access at home.

Both groups studied the same topics:

- Why do we need Ethics in research?
- Why do we need Ethics in engineering education and in the engineer profession?
- What do we mean with research?
- How do researchers work and what are the pros and cons when working alone, when compared to working in a group?
- What kinds of ethical rules are there in research?
- Why do we need ethical education and what are the basic ideas in it?
- How are Ethics and good life connected with each other?

The contact group had lectures and other presentations given by a professor and young researchers. While engaging in ethical exploration, the distance learning group reviewed available resources on the World Wide Web, journals and books and identified, analysed and selected information guided by continuous scaffolding, peers and the teachers. The task of the students was not to find the correct answers among the available resources, but to generate and revise their conceptions using the resources as reference material. When the students had written their answers, scaffolding notifications were placed by teachers and peer students in the note-taking window to give feedback and help students to reflect the key issues in more detail (e.g. "You found the core concepts very well and their definitions were good" or "...it is useful to familiarize with different sources... to get a many-sided view of the topic").

There are several methods and instruments that can be utilized to depict student conceptions, e.g. interviews

of the students prior and following the course, or concept maps of understanding [7]. In this study, data was collected using questionnaires covering core elements of the study programme. The questionnaires included both closed and open questions. The closed questions consisted of the evaluation of the course and were planned using a Likert scale from 1 to 4. Via the open questions, we gathered information on conceptions of research, work of researchers, the students' own study activity, and ideas for development of the course. The students answered the questions at home at the end of the course. Three students from the distance group and six students from the contact group sent their answers to the researchers. The data was analysed quantitatively and qualitatively by using content analysis methods, taking research questions into account. The interpretation is focused on the most typical and the most exceptional conceptions of the students. The results based on the most typical conceptions were tested using a Median test [8]. The results based on the most exceptional conceptions could not be established statistically, but their veracity was confirmed using deep analysis, reading the findings over and over again, and going back to the raw data for comparative checking [9].

5. FINDINGS

Statistically, there were no significant differences in the answers of the groups. All the students from the distance learning group and three from the contact education group wrote, that they only had general knowledge on research before the course. Two members of the latter group said that they did not know "nearly anything". At the end of the course, all the students wrote that they had learned about many kinds of ethical and concrete issues in research. At the beginning, a student in the contact education group had worked as a researcher before the course. However, all students had a general picture of how it is to be a researcher. At the end of the course, most students told that they had learned both many concrete things about the tasks of researchers and report writing, and theoretical issues such as ethical principles and responsibility of researchers. Students in both groups expressed that ethical education is useful, because it helps them to achieve aims, to gather information and to foster interest in research. The studies in ethical topics were experienced to be slightly easier in the contact education group than in the distance learning group. The difference was not statistically significant. The students also wrote that they would be able to use the information and skills gained during the course, in other contexts, for example in their M. Sc. theses.

Nearly all students in both groups participated actively in the courses. Only one student in the distance learning group mentioned that he was not very active. With the term 'activity', the students in the contact education group meant that they were eager to listen to presentations and to make notes, while the students in the distance learning group meant that they searched information from the Internet and reflected on it. As for conversations, both groups were quite passive. The main problem during contact education was the same in this study as found earlier, i.e. in finding a time for the lessons and discussions suitable for all participants [3]. Some students of the contact education group made suggestions for developing the course. One of them presented that lessons should include more presentations on practice, another wanted more information on writing reports, and a third one wished for a higher pace in lectures. The students in the distance learning group were satisfied with the course. They wrote that *Discendum Optima* is a very good way to study and learn, because one has freedom to choose when and where to study. They stressed that when studying at home, one is able to reflect on the answers in more detail. One of these students had problems because he had no computer and Internet access at home.

6. CONCLUSIONS

The present findings show that during the study period, all the students were able to develop their knowledge of research as well as ethical ideas of research work and science. The students also said that their awareness of the importance of ethical principles increased. It seems that, based on our findings, students in a distance-learning group attempting to find relevant information in complex, open-ended situations, may need special scaffolding during the project. Questions and supporting feedback facilitate students when they develop their conceptions both on the general and especially on the detailed level. The teachers should not give right answers; instead, the students must be allowed to make decisions or alter their conceptions based on their own findings and observations. *Discendum* allows students to externalise their thinking for peer critique, discussion and revision. Peer feedback seemed to be efficient in helping the students to identify and revise inaccuracies in their answers. Another way is to integrate the theory and study topics with the students' earlier knowledge, practice of engineering profession, and other studies [10].

Although the present findings support the idea that distance learning is as good as contact education in developing ethical conceptions in research and

science, it is impossible to draw any long-run conclusions, due to the results being based on a small number of the students, and the short length of the study period, which was only two credits (a credit being equivalent to 40 hours of work). To confirm whether the students' conceptions have really changed, further research is required, not only during their studies, but also when they work in their profession.

Some of the important results of the project were the design of a new way of study using Information and Communication Technology, and bridging the gap between undergraduate and postgraduate studies, by giving an opportunity for the students to get familiar with the research and laboratory staff during their undergraduate studies. From the students' point of view, the knowledge and skills gained are useful in working on their M. Sc. theses. The present findings support Keiski's results [3]. The collaboration between the Department of Process and Environmental Engineering and the Department of Educational Sciences and Teacher Education should be further developed.

The main problems during the studying processes in the contact group were in finding time for the lessons suitable for all participants, while in the distance learning group, it was the lack of computers and Internet connections at home. The project demanded a lot of time from the teachers. It will, however, be worth the effort, if the students stay as postgraduate students in the research groups. The findings were similar to Keiski's results [3]. It is expected that a combination of these two approaches and ways of learning will give the best results in researcher and research ethics education, and thus we would like to encourage our teachers and students to adopt and use both ways of learning and teaching.

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