USING RESEARCH TO ACTIVATE UNIVERSITY TEACHER TRAINING

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Abstract

In this debate paper the authors report on a project aimed at making selected data from research more quickly available to engineering educators. The educators involved are participants in pedagogical courses that they have undertaken to improve their teaching. During a workshop on group learning the educators, who come from various departments at a technical university in Sweden, are shown videotaped excerpts of a group of physics students solving a mechanics problem concerning force and friction. By using a Socratic approach the faculty members are encouraged to confront issues involved in small group work and discuss ways in which the benefits of group work can be maximised.

Key words:

Teacher training, group work, PBL, physics didactics, active learning

Summary of the session:

Our paper raises a number of questions concerning the relationship between research into active learning and active learning itself. Theoretical research can assist by helping practitioners better understand the assumptions that underpin competing educational paradigms and methods. Applied research on the other hand can present case studies of best practice or provide compelling reasons why a particular type of teaching (problem based learning for example) is important in developing deep and transferable learning. Both types of research are intended to contribute to a larger body of research knowledge and generate questions, that in their turn, might become the focus of future research. There is a danger however that unless teachers themselves can access the results, interpret them and act on their findings, the research may end up gathering dust on a shelf or, at best, be mainly of interest to other didactic researchers. Is it possible to make more immediate use of costly and time consuming research into active learning at the university level? Could preliminary data be used to stimulate thought and discussion among those who currently teach at this level? Are there enough general questions raised by preliminary research data for it to have benefits for engineering educators? If we agree that there are tangible benefits for practitioners what is the best way of delivering them? Our paper addresses these questions and hopefully raises others.

I INTRODUCTION

Physics is one of the more traditional subjects in engineering universities. Only recently has small group, problem based learning (PBL) made inroads into the lecture, tutorial, laboratory and closed book exam method of physics teaching. Teachers attracted to these new methods are often motivated by the hope that students will gain a deeper and more meaningful understanding of the subject if they are actively involved in the learning process. It is one thing to hope, and another to know, with reasonable certainty, that small group learning in physics is an effective way to promote real rather than rote learning. Unfortunately there is a lack of research into the effectiveness of such forms of teaching and learning at technical universities. We do not really know the extent to which small group work in physics helps or hinders the acquisition of conceptual knowledge and skills. We can be more certain that it has benefits in terms of acquiring generic competencies such as social and communication skills, at least in comparison with lecturing, where students sit for the most part silently, with

little contact with other students (Abercombie, 1980; Boud and Felettie, 1997; Jaques, 2001; de Graf and Kolmos, 2003). Although staff from departments such as business, architecture and the softer sciences are more used to small group work and often more positive about it, we know from the pedagogical courses we run that teachers are not always convinced about the usefulness of small group work. The workshop on group work that forms part of a course called *TLC102 Teaching, Learning and Evaluation* seeks to inform and motivate teachers about the use of well designed group work. It has taken different forms over the years. On one occasion David Jaques, author of the book *Learning in small groups,* ran the workshop. On another occasion a series of exercises were used to demonstrate different types of group work and the advantages and disadvantages of them. Other workshops have had as their focus PBL, including a particular engineering form of PBL called CDIO, an acronym that stands for a curriculum approach where students, via projects and group work, Conceive, Design, Implement and Operate a product or process and in doing so acquire the skills and knowledge that are the focus of that particular course or program (Gustafsson, 2006).

In the our workshops we selected a piece of data from a research project that we are currently involved in and used it as the stimulus for a discussion on the advantages and disadvantages of using group work. The workshop has been run twice. Once for experienced teachers and once for doctoral students. In Sweden doctoral students are employed 20% as part time teachers or tutors. The first workshop was run in autumn 2007 and the participants comprised 21 teachers from different departments. There were four lecturers from the Physics department in this group. The second workshop was run in spring 2008 and involved 30 participants, all doctoral students (and part-time teachers) from various departments. The aim of the autumn workshops was to engage teachers in a general discussion about the merits of small group work while the spring session focused more on how a tutor can best help out when students are engaged in small group work. In both cases the input data from the research project was carefully selected. In the first case (autumn 2007) it consisted of a brief, approximately 8 minute, videotape clip which showed four bio-engineering students engaged in solving a problem concerning force. In the second case (spring 2008) the first part of this excerpt was shown (the part where the lecturer contributes to the discussion) and then a different sequence was added. The second short sequence showed another intervention by the same teacher who on this occasion used a different technique to help the students. The workshop participants in spring had the opportunity to compare and contrast the difference in tutor/lecturer behaviour and that was the focus of the follow up discussion. Before elaborating on the results of our efforts to use preliminary research data as an educational stimulus we need to provide some background on the research project from which the video data was drawn.

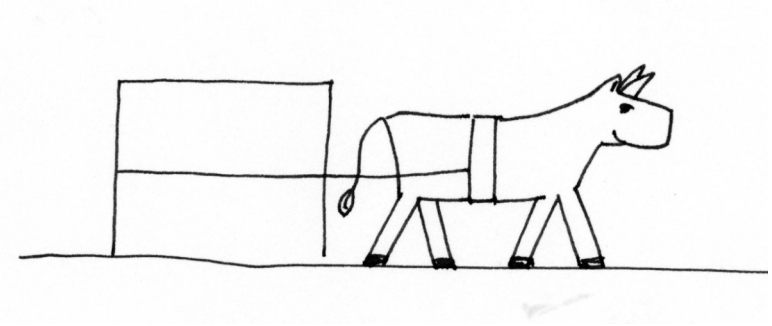
II THE RESEARCH PROJECT FROM WHICH WE DRAW PRELIMINARY DATA

Our research project is funded by the Swedish Research Council and involves a reference group, a full time PhD (third author of this paper), a main supervisor (first author) and a co-supervisor (second author) who applied for and was successful in gaining the funding. The overall intention is to improve learning in physics, especially in the early stages of university courses where failure rates are unacceptably high compared with other subjects. Our concern is not only with pass rates but rather how one can improve the quality of the learning that occurs in first year physics. This includes generic as well as subject specific capabilities. As other research indicates (Laurillad, 1993; Marton and Booth, 1997; Brown and Atkins, 1998; Ramsden, 1999; Biggs, 2003) it is possible to gain good examination results by adopting a surface approach to teaching and learning at the cost of quality learning. For this project we define quality learning as deep, meaningful, transferable and transformative learning. In other words we hope that a better knowledge and design of group work in physics can contribute to the way students see the world and enable them to use the knowledge and skills they attain to make it a better place (Brookfield, 1990; Mezirow, 1991; and Cranton, 1992).

Our research questions include: How do group participants themselves perceive the group work experience. Do they believe it helps them to actively construct conceptual knowledge rather than being informed about it? What sort of communication patterns can be identified in group work and do they influence how individuals in the group learn? For example, can we observe particular power positions that emerge in the group and do they have an influence on individual learning? Are the power plays that we observe in the groups consistent with power norms in society. For example is it natural for men to speak more or take a more dominant role in group work irrespective of the numerical composition of a group in terms of men and women? Is the intellectual status of the individual group member, say in terms of past performance at tests, another power factor? How important is design of the group work activity? When and how should a teacher intervene in the group work process?

In order to gather data about group work we collaborated with teachers from a first year mechanics course for physics students. With the teachers' help the students were divided into seven small groups of 3 to 4 students.

Four of the groups were physics engineers while the other three were made up of bio-engineering students The exercises were meant to take about 60 minutes to complete. The first task was called 'an ox with a box' and students were asked to indicate the forces on an ox that drags a box (see figure below). The students were also asked questions like 'What happens if the mass of the ox doubles?' and 'What makes it possible for the ox to move forward?'. The second task was also a force-friction problem, but one in which horizontal and vertical forces to the movement were important. For this problem the students were required to use equations in order to successfully solve the problem. On the whole the physics engineers solved the two tasks quicker than expected. One group of physics engineers only needed 45 minutes. None of the three groups from the bio-engineering program, on the other hand, finished the second task on time. All seven groups received guidance from a tutor who helped or checked on their progress, depending on the group. The group work sessions were taped, transcribed and analysed and all the students were interviewed about how they experienced their session. Some groups were also interviewed using 'stimulated recall' where group members saw certain (video) parts of their own group work and were asked for comments. These interviews were also taped and transcribed. The data is rich and can be analysed using several theoretical tools. So far we have used phenomenography, situated learning theory and positioning theory as analytical tools.



III USING PRELIMINARY RESEARCH DATA TO ACTIVATE TEACHER TRAINING

As mentioned above we used two segments of videotape in our workshops for teachers. Both of them dealt with sequences that occurred in the 'ox and the box' problem. They were selected because they showed the way group work can activate discovery learning and the importance of well designed intervention on the part of tutors. They also showed the effect of group dynamics on the learning process. The first sequence involved a group that was made up of three women and one man. Two of the women are particularly vocal while the man interjects at key points. The third women is the quietest in the group. During the short video clip, one can see how the members of the group gradually grope their way towards a deeper and more accurate understanding of the concept of force and try to define what forces act upon the ox as it drags its box. After three minutes, the tutor intervenes, attempting to coax the students' understanding by giving some general clues about force balance. The sequence continues for another five minutes and shows how, after the tutor has left, a vigorous discussion takes place and the students reach closure regarding the problem and seem to agree on their understanding of it. As one watches the video clip it is clear that group work is a social as well as an intellectual exercise. The video clips that was shown to the spring group, composed of doctoral students, used part of the sequence referred to above but also included a later intervention by the same teacher into the work of a different group made up of two women and one man. In this second group one of the women is the engine for most of the discussion. In the extra four minute video segment that the doctoral students saw, the tutor intervenes using a different strategy. In this case she makes use of questions in order to broaden the students discussion and challenges them to consider more aspects of the situation.

The rest of this paper describes what we have learned so far. Most of us are aware that PhD research, especially in the humanities, can take up to four or five years to reach an audience, depending on whether the results are published as a monograph or as a collection of scholarly articles in refereed journals. PhD research projects are undertaken for many reasons. One is to make an original contribution to scientific knowledge in the targeted area of research. Another is to educate an independent researcher. In the area of educational research the focus can be pure or applied. If it is the latter then a major aim is to improve practice but unfortunately the longer it takes to spread the results of the research then the slower the impact will be. In this paper we argue that the use of preliminary research data into small group work can have a two fold benefit. It can activate the learning of faculty by providing an immediate, local, meaningful and scholarly stimulus to their thinking about the use of small group work while at the same time giving researchers new insights into the data they have been collecting. When the research is, as it is in our case, focused on active learning methods, there is even more reason to avail oneself of such benefits as soon as possible.

In our first use of the video clip two of the research team were present. The first author, who was the course coordinator, acted as a participant observer. The second author, who had been active in collecting the research

data, introduced the video clip. He raised some questions for the group to think about as they watched the film sequence. These included: How does one prepare for small group work? What is happening when the teacher is somewhere else? When should a teacher intervene and what are the consequences? Is there a best way to enter, engage and end an intervention? Before starting the film he indicated that he was willing to take questions during the film and that he would lead a discussion, take further questions and sum up after the video. The group of teachers were mixed in terms of gender. There were fourteen men and seven women and they also differed in terms of subject expertise and seniority. A common factor was that they all were employed as engineering educators and taught in the same technical university. At the end of the day an evaluation form was handed out that included a specific question on the usefulness of watching and discussing the video excerpt. Based on responses to this question and participant observation by the first and second author we were able to gain an overall impression of the effectiveness of presenting preliminary research data to established teachers engaged in a pedagogical development course.

It clear from responses to the evaluation sheet and from participant observation that not all the teachers were equally engaged or as enthusiastic about the video clip and the discussion that followed, but the level of interest and participation was high. Of the responses 10 were very positive to the workshop, 7 were positive, 3 were neutral and 1 was negative). Naturally the physics teachers were the most engaged. One of them could not refrain from spontaneous comments during the showing of the excerpt, especially in the early stages, when he was astounded by what he believed were naïve and poorly informed student comments. He was particularly sharp in his critique of how the concept of force was understood. The interjection distracted somewhat from what was happening in the video excerpt. The students were in fact grappling with the problem of differing definitions and by the end of the clip it was clear that they had in fact negotiated a much better understanding of the concept of force and the forces that were acting on the ox. Although it was gratifying to have such active engagement from a few faculty members we also saw it as a problem and it was one of the points that was later discussed in assessing ways of improving the exercise. Would it be better to ask teachers to watch the video excerpt in silence the first time it is shown, making notes instead of comments, and then taking up a discussion in a more orderly fashion once the video had been seen and considered. Another consideration was how to manage the subsequent discussion.

For the autumn group the setting was a classroom with the participants seated in rows facing the front. Not unexpectedly a small number of the most engaged participants tended to dominate the discussion that followed the viewing and their questions and comments tended to be directed to the facilitator who stood at the front of the classroom. The discussion gravitated towards subject-specific aspects of the group work that they had seen, rather than the generic competencies that group work might develop, irrespective of the subject matter. The most positive thing that came out of the exercise was that most of the workshop participants saw a very vivid example of how a small group can negotiate their way to an agreement about key concepts and how to apply them in solving a problem. This ‘ah ha’ experience that is obvious in the video clip appears to be both memorable and meaningful. For the workshop participants the opportunity to see students from their own university tackling a problem that tested and extended their conceptual knowledge was a motivating factor. Watching the video also raised a number of key questions about introducing more active teaching and learning methods. The workshop participants agreed that in a more passive learning situation (a lecture for example) it is much harder for a teacher to know if individuals have understood an explanation. Such understanding is often only revealed in the exam. As the participants watched the video sequence they saw how group members explained to their teacher why they had reached a particular solution. Obviously this whole process took more time. This realisation led to an active debate over types of learning and how different types of teaching can encourage surface and deep approaches to learning (Marton and Booth, 1997). The video clip also gave the educators an example to analyse and use in sharing and contrasting their different views of learning and teaching.

In the second workshop, where the participants were doctoral students who act as teaching assistants in the early years of the engineering degree, the focus was on tutoring strategies. Two contrasting video excerpts were used. The first was part of the same sequence that had been shown to the more experienced teachers. In this case the focus was not on discovery learning but on the scene where the teacher/tutor intervenes in the discussion. The tutor, in this instance, informs herself of the students’ situation and then gives the students some general clues concerning the conceptual challenges they need to engage in. She chooses not to correct some of their apparent problems but leaves them to sort them out themselves. The second video sequence illustrates another strategy. In this case the teacher supports the students by being more involved with the problem-solving process, interacts with them by means of a series of conceptually broadening questions and challenges them to consider aspects of

the problem that they are ignoring. Apart from this, the structure of the two workshops was very similar and raised related questions. For example both workshop groups were asked to think about how one can make the best use of the time that is allotted to students for group work, what are the consequences of intervening, and how does one prepare for group work? Some specific questions included how important is it to be really on top of the subject matter, how to determine the individual strengths and weaknesses of the students and what you expect of them in terms of behavioural objectives. As with the evaluation from the teachers' workshop the doctoral participants were also very positive. In the doctoral session some group work was included (on the basis of our autumn evaluation) and this improved the interaction within the group. The workshop participants were given the same 'ox and the box' problem to consider in groups of three or four and this meant they were much more aware of the content and much better prepared to judge the quality of the teacher intervention.

V CONCLUSION

A major result from both workshops was the active learning of the participants. The viewing of the video excerpts stimulated discussion among the more experienced teachers and the teaching assistants. A reason for their engagement was the immediacy of the stimulus material. The video clips were shot at their own university, showed the sort of students they teach and involved teaching colleagues. The fact that the clips were introduced by someone who had spent hours going through transcripts, conducting follow up interviews and analysing the material injected an air of scholarship into the proceedings. Teachers, who might or might not introduce more small group work into their courses, agreed that because group work took more time it had to be designed and conducted well to ensure that the benefits in learning compensated for the time taken. The design should encompass the teacher's role and the roles of the individual group members. In the video excerpt the teacher's intervention seemed more random than designed and was one of the things that workshop participants took up in discussion. A teacher's intervention has to be clearly thought out to promote discovery learning. The teachers need to think how they will enter, engage and end any incursion into the group work. This presupposes preparation and there are three areas that the teacher/tutor needs to consider in preparing. The first is the subject matter itself. Teachers must be respond to or redirect questions in a knowledgeable way if they intervene in group work. The second is having a good understanding of the student body. This is important because if teachers are in control of the group composition they need to chose the mix of students that will most likely maximise the learning of specific and generic knowledge and skills.

The roles played by individual group members can also be included in the design since one of the objections to group work is that a few individuals can dominate. The repercussions of this in terms of individual learning, equity and generic competencies are too great to ignore. From our earlier studies (Ferdos and Christie, 2004) and related research (Belenky et alia, 1997; Curtin, 1997; and Williams, 2003) we know that certain male group members can dominate the discussion. If they are active in both solving the problems and explaining those solutions to others they are much more likely to get better pass rates than others who are alloted or assume more passive roles. Even in the videos that we analysed it was obvious that the more active group members, who could verbalise their arguments regarding the forces acting on the ox and refine them in dialogue with others, got more out of the group work than those who sat and listened. In this paper we have looked at how research into active learning methods in engineering education can benefit teaching staff if preliminary results are used in pedagogical courses that they attend. Those benefits can be increased if we, also, carefully design how we introduce those results. From our first workshop in autumn 2006 we saw certain weaknesses in our own workshop design and realised that it would be advantageous to get participants thinking about both the content and the process before showing them the video excerpt. In the spring workshop we did this by means of pair work. The teaching assistants looked at the 'ox and the box problem' themselves and were instructed to think about how they might help students who were working on it in small groups. In this same workshop we restricted ad hoc comments during the showing of the video clip. After watching the excerpt in silence the teaching assistants were then given the opportunity to discuss it in groups of three or four before returning to a plenary session. We will also build in a more extensive evaluation form so that we can go on making further refinements to our workshops each time they are given. For example for our next workshop in autumn we envisage more small group activity and the conscious creation of roles that impose a better spread of active engagement. This should benefit the individual teachers and at the same time become a discussion point in the plenary. The results of the workshop discussions can, in their turn, provide new insights into the research project. In this way we can see ourselves adding value not only to our own research but also to our teaching of good

group work design. In other words data from the workshop can inform the research we do, just as our research can be used to inform and activate engineering educators.

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