Disciplinary learning in a second language: a case study from Swedish university physics

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Abstract
This paper reports the results from a qualitative study which explores the relationship between the teaching language (English or Swedish) and the related learning experiences of undergraduate physics students at two separate Swedish universities. Students attended lectures in both English and Swedish as part of their regular undergraduate program. These lectures were videotaped and students were then interviewed about their learning experiences using selected excerpts of the video in a process of stimulated recall. The study shows that although the students initially report no difference in their experience of learning physics when taught in Swedish or English, there are in fact some important differences which become apparent during stimulated recall. The pedagogical implications of these differences are discussed and recommendations are made.

Reference
“Almost all of what we customarily call ‘knowledge’ is language, which means the key to understanding a subject is to understand its language.”

Postman & Wiengartner (1971:103)

1. Introduction

In Sweden, as in many countries, although English is not the first language, its use is commonplace in higher education. Surveys of language use in Swedish universities have revealed high proportions of English textbooks prescribed in engineering, natural sciences and medicine (Falk, 2001; Gunnarsson & Öhman, 1997). For example, in our own area of interest (undergraduate physics) the usual division of languages is to have lectures in Swedish with course texts in English. However, the presence of a single exchange student on a course can change the lecture language to English (Airey, 2004). Moreover, with the implementation of the Bologna declaration on harmonization of European education, the role played by English in Swedish higher education seems set to increase dramatically. This has prompted at least one Swedish university vice-chancellor to recently declare that he expects all higher education will be delivered in English within 10-15 years (Flodström, 2006).

There are, of course, many positive effects of the widespread use of English in Swedish universities. Important amongst these are: accommodation of overseas students, availability of relevant up-to-date course texts, involvement of foreign academics, competitive advantages on the job market and preparation of students for an academic world dominated by English (Airey, 2003). However, it is perhaps somewhat premature to assert that English is the new lingua franca, for despite its frequent use, we actually know very little about the effects of second-language lectures on student learning. What happens to students’ disciplinary knowledge when they no longer have access to teaching in their L1?

2. Disciplinary learning in L1

Even without the added complication of a second language, we believe language problems in undergraduate physics lectures are particularly acute due to the experienced complexity and abstractness of the subject. Östman (1998) has suggested that scientific language is abstract and represents special communicative traditions and assumptions. Moreover, Halliday & Martin (1993:8) claim, “language is not passively reflecting some pre-existing conceptual structure, on the contrary, it is actively engaged in bringing such structures into being.” Learning any subject therefore depends on learning the language in which the knowledge of that discipline is construed (Lemke, 1990). To this end, Englund (1998) has suggested analysing the causes of problems in student understanding with a view to changing institutionalized communicative patterns, thus making the discourse of disciplines more accessible. The other side of the coin is expressed by Wickman & Östman (2002) who view learning itself as a form of discourse change. Thus it can be argued that the relationship between a student’s first language and physics learning is by no means straightforward. But what about the effects on disciplinary learning when students are taught in a second language?
3. Research into learning in a second language

The relationship between teaching in a second language and the subject matter to be taught is not well understood, particularly at the university level. There are a number of studies from the lower levels of schooling which suggest that there may in fact be some direct benefits of bilingual education (See Willig, 1985 for a summary of research findings in bilingual education). However, Marsh, Hau & Kong (2000; 2002) found negative effects of high school teaching in a second language on non-language subjects. They point out that the focus of earlier bilingual studies has been on learning languages with "a remarkable disregard for achievement in non-language subjects" (Marsh et al., 2000:339). Moreover, they suggest that results found at a lower level of schooling may not transfer unproblematically to higher levels due to the increasing demands placed on language in the formulation of knowledge (c.f. Halliday & Martin in the previous section). With this in mind, we will confine our survey here to research into content learning outcomes at university level.

The majority of Scandinavian studies that have been carried out in higher education have either been surveys of the extent to which a second language is used in educational situations or have focused on the language learning effects of such teaching, (Hellekjaer & Westergaard, 2002; Tella, Räsänen, & Vähäpassi, 1999; Wilson, 2002). Surprisingly, there has been very little research into the relationship between content learning and the teaching language at university level. In Sweden no studies have been carried out into the effects of lectures in a foreign language. Two recent studies did, however, examine the understanding of written text, both concluding that the ability to judge broad relevance is greatly reduced when text is in a second language (Karlgren & Hansen, 2003; Söderlundh, 2004).

Internationally, researchers have concentrated on quantitative comparisons of results from various types of tests before and after teaching in a second language. Despite the fact that the majority of experienced lecturers feel that there ought to be large differences when lectures are in a language other than the students’ L1, the most striking aspect of these studies is often the similarity between research and control groups. It would seem that university teaching in a second language may not necessarily be associated with negative consequences for subject knowledge. There are, however, a few studies that claim to have found measurable language effects. Researchers in New Zealand report negative correlations between second-language learning and performance in undergraduate mathematics, with students disadvantaged by 10% when taught in a second language (Barton & Neville-Barton, 2003, 2004; Neville-Barton & Barton, 2005). These negative effects were found to be at their worst in the final undergraduate year. Similar relationships have been confirmed to some extent by Gerber, Engelbrecht, Harding & Rogan (2005) in their study of speakers of Afrikaans learning undergraduate mathematics in English in South Africa. Research in the Netherlands has also identified negative effects for Dutch engineering students’ learning when they are taught in English (Klaassen, 2001; Vinke, 1995). In contrast to the other studies, Klaassen’s work gives us a possible explanation for the common finding that there is no clear-cut language effect. In her study, the negative effects of language change were temporary. After one year of study there were no longer any measurable differences in engineering grades between research and control groups. Klaassen concludes that the students had adapted to the language change. This finding is, of course, not unusual in pedagogical research where
we talk about the *teaching and learning paradox*, i.e. that there is rarely a one-to-one relationship between what is taught and what is learnt. Put simply, students do whatever they need to do to pass a course—regardless of the quality of the teaching. In one of the replies to Klaassen’s student questionnaire, a student expresses this as follows:

“My achievements in the English-medium programme are entirely my own credit and are unrelated to the performance of the lecturers in this programme.”

(Klaassen, 2001:182)

This is, of course, an unacceptable state of affairs. If we accept Klaassen’s finding that there are negative effects of teaching in a second language, but that students through their own strategies can compensate for these effects, then we are left with a new set of questions. What is it specifically that students initially find problematic? How do the students compensate for the language switch? Do all students have this strategic ability or are certain groups disadvantaged by second-language teaching? Can the lecturers do anything to help their students cope with the language shift? etc.

The present research situation has been well summarized by Flowerdew (1994). In his survey of international research relevant for academic lectures given to second-language listeners in all disciplines, he points out that whilst there is much research relevant to second-language lecture studies, the majority of the work raises more questions than it answers:

“One thing that is clear from this review is that a lot more research is needed before we have a clear idea of what constitutes a successful second-language lecture. A lot more information is needed – in terms of how a lecture is comprehended, in terms of what a lecture is made up of, and in terms of how the variable features of a lecture may be manipulated to ensure optimum comprehension – before meaningful statements can be made about many aspects of lectures which will have concrete effects on pedagogy.”

Flowerdew (1994:25)

The research reported in this paper attempts to fill some of these gaps in our knowledge.

4. A qualitative case study

Drawing on the experiences of earlier researchers we quickly came to the conclusion that attempting to document language effects in a quantitative study would be problematic. Moreover such a study, if successful, would only be able to answer the question of the *extent* to which changing the teaching language might affect content learning. Although such information would undoubtedly be interesting from a policy perspective, we would still know very little about the mechanisms at work when students attend lectures in a second language. It was therefore decided to carry out a qualitative study where we documented differences in students’ experiences and learning patterns when they were taught in English and Swedish. We achieved this through in-depth, semi-structured interviews (90 mins. per student) with 22 undergraduates from two Swedish universities.
The students attended physics lectures in both Swedish and English as part of their regular degree programme. A number of these lectures were videotaped, with each interviewed student being present at one lecture in English and one in Swedish. Since at this stage it was not known what aspects of a lecture might be important, it was decided to focus on as many different types of activity as possible. Thus, the two-hour video footage from a typical lecture session was edited down to four short clips which together lasted less than ten minutes. These clips dealt with similar types of activity for both lectures—a mathematical derivation, an oral explanation, a diagram, and a question asked to the class by the lecturer.

Student interviews were split into two stages. First, students were invited to talk about their experiences of learning in the two courses they had attended, their working patterns for each course and their thoughts about learning in English rather than in Swedish. Then, building on Klaassen’s (2001) recommendations, the eight clips from the two lectures that the student had attended were shown replayed in a process of stimulated recall (Calderhead, 1981). This technique allows students to describe what they did and how they were thinking during the lecture and how they experienced the material presented (Bloom, 1953). We adopted this two-stage approach to interviewing since one of our research goals was to ascertain whether there were differences between students’ perceptions of their learning in the two languages and their ‘actual’ learning experiences as recounted during stimulated recall.

5. Data analysis
All interviews were recorded digitally, enabling direct access to their various sections. This, together with the structure generated by the stimulated recall approach, led to the following form of data analysis. Each of the digital interview files were “cut” into sections where students discussed similar themes. Each of these sections was given a filename consisting of the topic discussed, the student’s name and a five digit identification code which was in fact the excerpt’s time stamp in the original master recording. It was then easy for us to either listen to all the excerpts dealing with a given topic or to select excerpts from a given student in order to efficiently build up an overall picture of what students were saying as individuals and as a group. We did this recognizing that the audio recording is a step further away from the interview itself, which is in turn several steps away from the actual learning experience in the lecture (c.f. Kvale, 1996; Säljö, 1997). We argue that this approach had the benefit of better capturing the situatedness of the interview when we were working with the transcriptions. Maintaining this situatedness was considered important since in the interviews we were attempting, through stimulated recall, to vividly recapture for the students the essentials of their experience of being in a specific lecture.

6. Results
A comprehensive description of the results of the study has been previously published for the physics community in Airey & Linder (2006) and Airey (2006). Results will therefore only be summarized in this paper.
Language is unimportant
The most compelling result of our study is that all the students we interviewed felt that language played an insignificant role in their disciplinary learning. This result is similar to those of Neville-Barton and Barton (2005) where second-language mathematics students self-report levels of understanding similar to those of first-language students. However, despite their expressions to the contrary, during stimulated recall the same students could readily identify a number of problems they had experienced due to the shift to a second language (see below).

Reduced interaction
Early in the study we noticed that student willingness to ask and answer questions appeared to be reduced when the lectures were in English, and in the interviews students confirmed this observation. We believe this to be an important finding. If the interaction between teacher and students is limited in this way (in the worst case lectures can turn into a monologue) then the shared space of learning (Tsui, 2004) will be correspondingly reduced.

Focus on notetaking
When lectures were in English, those students who took notes described how a large portion of their attention was focussed on the process of writing instead of on understanding content. The disciplinary learning of these students depended on work done after the lecture. Naturally we do not mean to suggest that, when lectures were in Swedish, students did not need to do work outside the lecture, but rather that students were less good at taking notes whilst following the lecturer’s line of reasoning when the lecture was in English.

Student coping strategies
The students in our study employed a range of strategies in order to cope with the shift from Swedish to English. In many cases students who had said nothing during the lecture came forward at the end to ask questions. Other students had changed their study habits so that they no longer took notes in class. A number of students reported that they had started reading sections of work before the lecture, and without exception these students showed a better understanding of the lecture content. Finally, for some students second-language lectures had become sessions for mechanical notetaking with extra work needed to make sense of these notes later.

Multiple representations
Students reported finding second-language lectures easier to follow when the lecturer either followed a book closely or wrote on the whiteboard a lot. We interpret this as students utilizing the redundancy and extra affordances made available by these multiple representations in order to better make sense of the disciplinary content.

7. Conclusions and recommendations
Although this study is based on interviews with 22 students, we believe that the results reported here form a useful illustrative case study of disciplinary learning in a second language. The main conclusion of the study is that there are differences in the way
Swedish physics students experience lectures in Swedish and English and that on the whole students are unaware of these differences. The following is a list of recommendations for second-language lectures based on our findings and our own experience:

- **Discuss language differences**
  Since we find that students are often unaware of the changes that occur when they learn in a second language, it would seem to be a good policy to discuss these language differences. Students will be better able to cope with a change of language if they have an understanding of the problems that can occur in second-language lectures and have thought through their own coping strategies.

- **Stimulate discussion**
  We recommend using short, small-group discussions within a lecture. These buzz groups allow students to check their understanding, come up with answers to questions and to generate new questions for the lecturer. Those students who dislike speaking English during lectures will still avoid speaking in class, but at least they participate in vicarious interaction with the lecturer (Bligh, 1998).

- **Allow time for student questions**
  Allow time after the lecture for students to ask questions. Here, it may be useful to finish lectures early so that people do not need to be somewhere else. If possible, students should be allowed to ask questions in their L1.

- **Follow a book or lecture notes that students have read before the lecture**
  It is a good idea to ask students to read sections of work before the lecture. The lecture can then be used for clarification and confirmation of what students have already seen. The problem of notetaking can also be minimised by choosing a book or producing your own lecture notes that are followed closely in the lecture. Students can then follow this text and annotate it rather than making their own notes from scratch.

- **Use complementary representations**
  Oral explanations should be supported by other representations such as writing on the whiteboard, diagrams, pictures, overhead slides, handouts, demonstrations, computer simulations, etc. However, it is important that this extra input reinforces the message of the lecture. Using multiple representations in an unreflected way will only confuse students.

8. **Disciplinary learning in other situations**
There will always be questions of generalizability with studies such as this. The results presented here only apply to the Swedish physics students that we interviewed. Naturally we cannot claim to say anything about situations in other disciplines and countries. We can, however, speculate that since Sweden is widely believed to be one of the countries in Europe with the highest levels of second-language English ability, the problems we have described may be even more pronounced in countries with generally lower levels of
English language competence. In any case, we believe that lecturers from a wide range of countries and disciplines will be able to recognize the results presented here in their own experiences and translate them into their own specific teaching situations. If nothing else, we hope our findings will encourage lecturers to rethink their pedagogical strategies when they give lectures in a second language.

References


