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Use of Transfer Teachers in Developing a Teaching-Learning Sequence: A Case Study in Physiotherapy Education in Finland

Abstract

This paper describes how two transfer teachers implemented a teaching-learning sequence designed and developed by the model of educational reconstruction. This is part of a wider study where the purpose of the study was to determine how the understanding of moment of force and its applications can be improved by developing and evaluating a teaching-learning sequence on the moment of force in physiotherapy training. An eight lesson teaching-learning sequence was designed, consequently implemented and evaluated in two pilot studies and two teaching experiments. In the teaching experiments the teaching-learning sequence was implemented by two Finnish teachers (transfer teachers) who were not engaged in the planning of the sequence. The teacher in the second teaching experiment followed the guidance notes better than in the first, which may have resulted from the changes in the teaching-learning sequence and adjustment of the guidance notes following the first teaching experiment. The results of this study can be applied in designing and developing teaching-learning sequences, lesson materials and guidance notes (including the guidance of the classroom discourse) for teachers.

INTRODUCTION

Designing and evaluating research-based teaching-learning sequences can be considered as a natural way of conducting research on science classroom education. A teaching-learning sequence includes a gradual research-based evolutionary process aiming to link the scientific and student perspective. It targets a close link between the teaching and learning of a particular topic (Méheut & Psillos, 2004). Méheut and Psillos (2004, p. 516) define a teaching-learning sequence as “an interventional research activity and a product, which includes well-researched teaching-learning activities empirically adapted to student reasoning”. Research-based teaching-learning sequences with close linkage between the scientific and the student perspective of different science contents have been done, for example, by Buty, Tiberghien and Le Maréchal (2004), Kabapınar, Leach and Scott (2004), Komorek and Duit (2004), Méheut (2004) and Viiri and Saari (2004). Also, this study (Nurkka, 2006) can be considered as a teaching-learning sequence study because the purpose of the study was to develop the teaching and learning of moment of force in physiotherapy

training by taking into account the science content and students' perspectives. In designing the teaching-learning sequence, the results of previous studies, for example, studies of students' misconceptions of moment of force (e.g. Rowlands, 1997; Rowlands, Graham & Berry, 1998; Viiri, 2002) and the study of importance and meaning of the moment of force in physiotherapy (Nurkka, 2003) were applied.

In research of developing teaching of specific science topics, it is important to pay attention to how teachers can make good use of research results in practice. Lijnse (2000) declares that it is often very difficult or even impossible for teachers to apply theory-driven research results (Andersson & Bach, 2005; Lijnse, 2000). Recently, several methodological approaches, e.g. "developmental research" (Lijnse, 1995), "design research" (Anderson & Wallin, 2006, Brown, 1992; Cobb, Confrey, diSessa, Lehrer & Schauble, 2003; Edelson, 2002), "design-based research" (Design-based Research Collective, 2003; Juuti & Lavonen, 2006) and educational reconstruction (Duit, 2000; Duit, Grobengiesser & Kattman, 2005; Komorek & Duit, 2004) have been developed endeavouring to combine educational research and praxis.

In this study, a model of educational reconstruction was used in designing and developing the teaching-learning sequence on the moment of force. The model was chosen because it takes into account the content structure and carries out an analysis from a scientific point of view and from the perspectives of the educational aims (Duit, 2000; Duit et al. 2005; Komorek & Duit, 2004). That is especially important in professional training, such as in physiotherapy training, where the emphasis of physics studies is on practical applications.

The model of educational reconstruction consists of three closely interrelated components: (1) clarification and analysis of science content, (2) investigation into students' perspectives and (3) design of learning environments (Duit et al., 2005). The first component, clarification and analysis of science content, includes a clarification of the science content structure and an analysis of the educational significance of the content. The aim of these analyses is to construct the core ("elementary") ideas of the content and their relationships. The second component includes empirical studies on teaching and learning and on students' perspectives. Students' perspectives include students' conceptions about the content as well as their interests, motivations and attitudes. The third component is the development and evaluation of instructional modules (Duit, 2000; Duit et al., 2005; Komorek & Duit, 2004).

The role of the teacher is important when learning is seen from the Vygotskian sociocultural perspective. According to the sociocultural perspective, learning is a process of internalisation, where individuals appropriate and become able to use, on the individual plane, conceptual tools that are first encountered on the social plane (Leach & Scott, 2002; Mortimer & Scott, 2000, 2003; Millar, Leach, Osborne & Ratcliffe, 2006; Ryder, Hind & Leach, 2003; Scott, 1998; Scott, Mortimer & Aguiar, 2006). During the process of internalisation, students' understanding develops through social interactions between students and a teacher and among students themselves (Howe, 1996). In the classroom, the role of the teacher is to make scientific ideas available on the social plane, to assist students in internalising those ideas and to support their learning process. The classroom discussion plays an important role in student's learning (Leach & Scott, 2003; Mortimer & Scott, 2003).

When studying students' learning it is important to study the patterns of classroom discourse in different teaching situations. It is not only important what the teacher and the students are doing, but also in relation to the kind of talking involved in activity. This should be taken into account in planning teaching activities (Leach & Scott, 2002; Millar et al., 2006). According to Ryder et al. (2003) a teacher experienced in whole class discussion about epistemic issues would be able to recognise the distinctive patterns of classroom discussion (authoritative/dialogic) and their differing roles, and make informed decisions about the pattern of classroom discussion needed to support

student learning at different points of the lesson. In this study, the guidance notes given to teachers who participated the study included also guidance for patterns of classroom discourse.

In this study, the classification of classroom discourse uses the method of Viiri and Saari (2004, 2006). This method identifies five categories of classroom discourse patterns: teacher presentation (TP), authoritative teacher-guided discussion (AD), dialogic teacher-guided discussion (DD), peer discussion (PD) and other (O). The method is mainly based on the ideas of Scott (1998) and Mortimer and Machado (2000), and it has similarities with the classification method presented by Mortimer and Scott (2003). Mortimer and Scott (2003) have analyzed patterns of discourse in two dimensional fields (dialogic/authoritative and interactive/non-interactive) from the point of view of communication. Scott et al. (2006) presents that in any teaching sequence of science lessons there should be variation in classes of communicative approach covering both dialogic/authoritative and interactive/non-interactive dimensions. The purpose of an interactive/dialogic communicative approach (in this study, teacher guided dialogic discussion) is to explore students' ideas. Interactive/authoritative approach (in this study, teacher guided authoritative discussion) is used in working on (shaping, selecting and marking ideas) some aspects of the content. The purpose of non-interactive/authoritative (in this study, teacher presentation) approach is to review and summarize key points (Mortimer & Scott, 2003; Scott et al., 2006).

One important reason for choosing the classification method of Viiri and Saari (2004, 2006) was that they took into account the students' discussion as one element in the classroom discussion. According to them, peer discussion forms an important part of the teaching and learning discussion making up the lessons. In peer discussion, students are talking in groups and the discussion has a specific purpose. Peer discussion is very often teacher-guided (Viiri & Saari, 2004; 2006). In this study, the classification of classroom discourse was also extended by the sixth category called student's initiative (SQ). Characteristic of student's initiative is that a student asks a question or takes an initiative that elicits new ideas or guides the teacher to clarify the ideas under discussion.

When researchers and designers of the educational innovations or teaching sequences evaluate their innovations in the classroom, the innovations work well and researchers achieve promising results in the learning aspect. However, these new ideas are difficult to transfer to "ordinary" teachers, and similar promising results are no longer acquired when these "ordinary" teachers try teaching according to the designed sequences (Linn, 1996). Therefore, transfer teachers were used in this study. In this study, the term transfer teacher is used for teachers who implemented the teaching- learning sequence but who were not involved in designing the teaching-learning sequence and lesson materials.

According to Leach and Scott (2002), in order to develop physics classroom teaching in normal school settings it is important to study how the teaching sequences will be implemented by teachers (transfer teachers) who are not involved in the design of the teaching-learning sequence, the lesson materials and guidance notes. It is important that the designed teaching interventions can be generally adopted so that they are usable by teachers not involved in their development. There has to be some evidence that the positive effects of the teaching intervention can be transferred from the site of development (Millar et al., 2006). Use of transfer teachers may motivate other teachers to adopt new teaching practices developed by research. According to Millar et al. (2006), teachers are not ready to change their practice unless the research results are in accordance with experience or beliefs. Communications with other teachers, and teaching materials and guidelines that can be directly used in the classroom are more likely to have an impact on teachers' practice.

The purpose of using transfer teachers in this study was that by implementing the teaching-learning sequence according to lesson plans and guidance notes, transfer teachers assist in developing the teaching-learning sequence in such a way that is easier for other teachers to apply research results in practice. The aims of the study were to develop the teaching-learning sequence, lesson

materials and guidance notes, to find out how the teaching-learning sequence is implemented by two transfer teachers and how the teachers follow the guidance of the classroom discourse patterns and what patterns they use at different points of lessons.

The success in developing the teaching-learning sequence was evaluated on the basis of implementation of the teaching-learning sequence, students' learning, and conceptions of teachers and students participating in the teaching experiments. In this paper is described how the teaching-learning sequence was implemented by two transfer teachers who were not involved in designing the teaching-learning sequence. The research question is:

How did two transfer teachers, who were not involved in the design of the teaching-learning sequence, the lesson materials and guidance notes, follow the lesson plans and guidance notes (including guidance of classroom discourse)?

METHOD

In this study the process of educational reconstruction included two pilot studies and two teaching experiments (figure 1). In the pilot studies, the researcher worked as a teacher, and in the teaching experiments, the teaching-learning sequence was implemented by two transfer teachers in two Finnish universities of applied sciences. The data was gathered in pre and post tests by interviewing teachers and students and by observing and videotaping lessons. In this study, the ideas and methods of mixed research were used. Mixed research is based on ideas of pragmatism, and it involves the mixing of quantitative and qualitative research methods or paradigm characteristics (Johnson & Christensen, 2004; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998).

In the first pilot study, an eight lesson teaching-learning sequence on the moment of force was designed, tested and evaluated. In designing the teaching-learning sequence, important ideas were practicality, problem solving and social interaction. In physiotherapy, there are many applications dealing with the moment of force. Physiotherapists need an understanding of the moment of force and the moment rule, for example in analyzing human movement and lever systems of the body in ergonomics, biomechanics and medical exercise therapy. The teaching-learning sequence was divided into four sessions of two lessons. The moment of force was studied in groups of four to five students by solving practical problems dealing with lever systems in the body, doing experiments with a lever and a static wheel, and presenting solutions for practical problems to other students. Groups of students were formed on the basis of student answers on the pre test so that the groups were as heterogeneous as possible. Difficult concepts concerning the moment of force were clarified with teacher guidance and examples. The aim of the first pilot study was to find out what kinds of difficulties students have in learning and applying moment of force (Nurkka, 2003; 2005).

In the second pilot study, the most important aim was to work up, test and evaluate lesson materials and guidance notes for teaching experiments. In designing the guidance notes, attention was paid to classroom discussion. Patterns of classroom discourse at different points of the lessons were designed and tested.

In the first teaching experiment, the aim was to find out how a transfer teacher implements the sequence and uses lesson materials. The purpose of the first teaching experiment was to develop the teaching-learning sequence, lesson materials and guidance notes for the second teaching experiment. In the second teaching experiment, the lesson materials given to the teacher included lesson plans (including e.g. teaching contents, teaching strategies, timetable, guidance notes for the teacher, and guidance of the classroom discourse), student sheets (e.g. written instructions for the experimental work, practical problems dealing with lever systems in the body), solutions to practical problems dealing with lever systems in the body, and overhead transparencies.

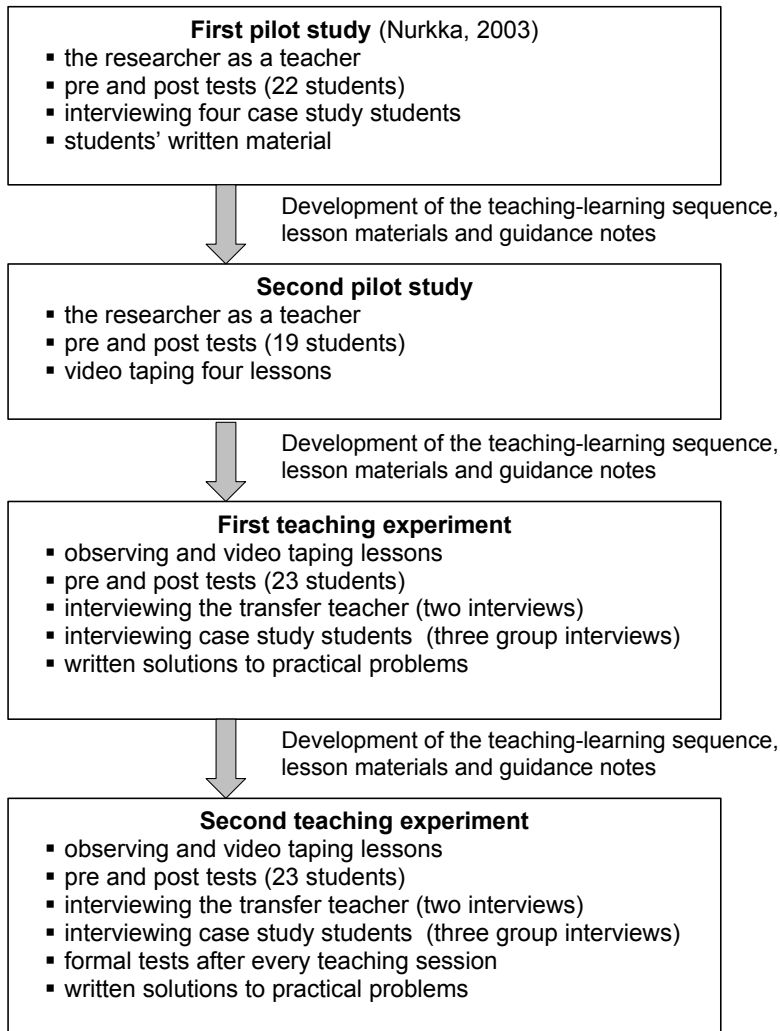


Figure 1. General outline of the research process.

The teacher in the first teaching experiment had been working as a teacher for almost thirty years. The teacher in the second teaching experiment had a little more than one year of teaching experience before the teaching experiment. The researcher and transfer teachers did not know each other before the teaching experiments. The researcher met each transfer teacher for the first time approximately two weeks before the teaching experiment. During the meeting, the researcher gave the lesson materials and explained some important matters (e.g. patterns and guidance of classroom discourse) to the transfer teacher. In the meeting, the teacher had the opportunity to make clarifying and specifying questions about the lesson materials.

Students participating in the teaching experiments were quite similar in terms of age and experience with physics studies. The ages of students in the first teaching experiment ranged from 19 to 37 years (average age 22.0 years) and in the second teaching experiment from 21 to 43 years (average age 26.1 years). Most of the students had only studied about 30 lessons in physics during upper secondary school and most of them were not likely to have previously studied the moment of force.

The implementation of the teaching-learning sequence was analysed by comparing lesson plans and guidance notes given to the teachers to the implementation of the sequence. The purpose of the analysis was to find out how the teachers followed the teaching contents, teaching strategies and timetables, and how the teachers explained changes they made to the lesson plans. In the analysis of classroom discourse, how the teachers followed the guidance of classroom discourse was studied, as well as what patterns of classroom discourse they used in different points of the lessons.

All the lessons and interviews were video-recorded and transcribed. The digitised video-recorded data was analysed using the Atlas/ti qualitative analysis program. The advantages of video data are that recorded events in the classroom can be viewed in flexible ways as frequently as necessary, and it offers the possibility for participants to assist in providing interpretations. Video data provides more contextual data than audio recorded data because video can capture simultaneously details of ongoing behaviour in speech and non-verbal behaviour (Bottorff, 1994; Dufon, 2002; Erickson, 1992). In the analysis of the classroom discourse, capturing of non verbal behaviour is necessary. In this study, in some classroom situations it was impossible to interpret patterns of discourse based solely on the transcribed data.

In order to make the analysis of the classroom discourse more valid, some parts of the transcribed lessons were analysed by a parallel classifier who was very familiar with the classroom discourse analysis and the classification method of Viiri and Saari (2004, 2006). There were some interpretative differences between the classification done by the researcher and by the parallel classifier. The reason for these differences was that the parallel classifier analysed the classroom discourse only using the transcribed data. After short discussion, the researcher and the parallel classifier totally agreed about the classification.

Collecting data with video camera can have an intrusive effect on the persons who are video-recorded and it may change their behaviour (Bottorff 1994). In this study, according to transfer teachers, the observation and video-recording of the lessons did not have an effect on student behaviours. At the beginning of the teaching sequence, the video camera had a slight effect on the behaviour of the transfer teachers, but they reported that after the first lesson, the presence of the video camera and the researcher ceased to disturb them.

RESULTS

In tables 1 - 4, the guidance and implementation of the teaching-learning sequence on the moment of force in the first teaching experiment, is presented. The implementation of the classroom discourse is presented on a general level. An example of more detailed analysis of classroom discourse is presented in figure 2. For the second teaching experiment, some changes were made to the teaching-learning sequence and lesson materials according to the implementation of the sequence and the conceptions of the teacher in the first teaching experiment (table 5). Especially, the guidance notes for the teacher were defined.

After the changes made to teaching-learning sequence on the basis of the first teaching experiment, the teacher in the second teaching experiment followed the lesson plans and the guidance notes very accurately. All the teaching contents were taught in the order presented in the lesson plans. In implementation of the teaching-learning sequence, the most remarkable differences between the two teaching experiments were in emphasising certain teaching contents and making good use of experimental work in supporting students' understanding of concepts concerning moment of force, e.g. the lever arm.

An example of classroom discourse analysis is presented in figure 2. The teaching episode included the summary of concepts learned by experimental work. In figure 2, arrows portray the "rhythm" of classroom discourse. For example, in subject 2, the "rhythm" of classroom discourse was AD-DD-TP.

In the teaching episode presented in figure 2 in three subjects (2, 3 and 5), the patterns of classroom discourse followed the same “rhythm” (AD-DD-TP). The teacher prompted discussion about a new subject with teacher-guided authoritative discussion (AD). With teacher-guided dialogic discussion (DD), the teacher explored observations made by the students during experimental work and students’ conceptions about the subject. Finally, by using teacher presentation (TP), the teacher summarized key points of the subject. At the beginning of the episode, the first subject (moment rule) was dealt with using teacher-guided dialogic discussion (DD), but later in subject 4, the teacher came back to moment rule by using teacher-guided authoritative discussion (AD) and teacher presentation (TP).

Table 1. Guidance and implementation of the first teaching session in the first teaching experiment. TP = teacher presentation, AD = teacher guided authoritative discussion, DD = teacher guided dialogic discussion, PD = peer discussion, O = other and SQ = student’s initiative.

| The first teaching session (two lessons) | | | | | | |
|---|---|-----------------------|-------------|--|-----------------------|-------------|
| Teaching content according to lesson plans | Guidance | | | Implementation | | |
| | Teaching method / guidance to teacher | Class-room dis-course | Time (min.) | Implementation | Class-room dis-course | Time (min.) |
| Presentation of the teaching-learning sequence | teacher presents | O | 5 | teacher presented | O | 4,5 |
| Formation of groups of students and presentation of timetable | students form the groups | O | 15 | students formed the groups | O | 12,5 |
| Moment of force and concepts concerning moment of force | | | 30 | teaching contents were presented in the different order than in the lesson plans | | 24 |
| ▪ concept of moment of force (pulling and turning effects of force) | teacher presentation, teacher guided classroom discussion | TP DD | | only one example of turning effects of force (a position of the forearm*) (5 min.) | TP | |
| ▪ some applications of the moment of force in physiotherapy | teacher presentation, teacher guided classroom discussion | TP DD | | applications were presented after presentation of concepts concerning moment of force (4 min.) | TP AD | |
| ▪ concepts concerning moment of force | teacher presentation, teacher guided classroom discussion | TP AD | | teaching contents were presented in the different order than in the lesson plans; teacher added an example of the position of the forearm* (15 min.) | TP AD DD SQ | |
| | | | | | | |

Table 2. Guidance and implementation of the second teaching session in the first teaching experiment. TP = teacher presentation, AD = teacher guided authoritative discussion, DD = teacher guided dialogic discussion, PD = peer discussion, O = other and SQ = student's initiative.

| The second teaching session (two lessons) | | | | | | |
|--|--|-----------------------|-------------|---|-----------------------|-------------|
| Teaching content according to lesson plans | Guidance | | | Implementation | | |
| | Teaching method / guidance to teacher | Class-room dis-course | Time (min.) | Implementation | Class-room dis-course | Time (min.) |
| Experimental work in groups | introduction of experimental work equipment (especially a static wheel); students work in groups | O PD | 55 | there was no common introduction of experimental work equipment; teacher guided each group in working with a static wheel | O PD | 65 |
| Summary of experimental work | summary of experimental work and most important concepts, such as lever arm | TP AD DD | 15 | there was no summary or discussion about experimental work | | 0 |
| The example of applying concepts concerning moment of force to practical situation in physiotherapy (different positions of the forearm) | teacher presentation, teacher guided classroom discussion; calculation of forces needed to keep the forearm in certain different positions | TP AD DD | 20 | teacher did not calculate forces needed to keep the forearm in certain positions; the definition of length of the lever arm in different positions of the forearm was left to next lesson | TP AD DD | 10 |

Table 3. Guidance and implementation of the third teaching session in the first teaching experiment. TP = teacher presentation, AD = teacher guided authoritative discussion, DD = teacher guided dialogic discussion, PD = peer discussion, O = other and SQ = student's initiative.

| The third teaching session (two lessons) | | | | | | |
|--|--|-----------------------|-------------|---|-----------------------|-------------|
| Teaching content according to lesson plans | Guidance | | | Implementation | | |
| | Teaching method / guidance to teacher | Class-room dis-course | Time (min.) | Implementation | Class-room dis-course | Time (min.) |
| Beginning of the lessons and giving instructions for group work; Giving instructions to students for the experimental homework | teacher presents | O | 10 | teacher gave instructions for the experimental homework after the example of the different positions of the forearm | O | 11,5 |
| Not in lesson plans, teacher's addition | | | | teacher presented a solution of the example presented in the previous lesson by using symbols of magnitudes (no numerical values) | TP DD | 7,5 |
| Solving practical problems in groups | working in groups; teacher guides students' group work | PD | 80 | students worked in groups; teacher guided students' group work | PD | 67 |

Table 4. Guidance and implementation of the fourth teaching session in the first teaching experiment. TP = teacher presentation, AD = teacher guided authoritative discussion, DD = teacher guided dialogic discussion, PD = peer discussion, O = other and SQ = student's initiative.

| The fourth teaching session (two lessons) | | | | | | |
|--|---|-----------------------|-------------|---|---------------------------------|-------------|
| Teaching content according to lesson plans | Guidance | | | Implementation | | |
| | Teaching method / guidance to teacher | Class-room dis-course | Time (min.) | Implementation | Class-room dis-course | Time (min.) |
| Timetable and running order of group presentations | teacher presents | O | 5 | teacher presented | O | 7 |
| Presentations of groups | groups present their solutions to practical problems; teacher guided discussion about the solutions; teacher gives feedback to groups after each presentation | PD TP AD | 85 | short discussion about the solution after each presentation; the teacher did not give any feedback to groups; two groups had few mistakes in their solution | PD O AD DD TP SQ | 66 |
| Not in lesson plans, teacher's addition | | | | teacher guided discussion about solving the practical problems and validity of the solutions | DD PD AD SQ TP O | 10 |

Table 5. Main changes that were made to the teaching-learning sequence and lesson materials on the basis of the first teaching experiment.

| | Changes |
|---------------------------------|---|
| Studying the concepts | Studying concepts of gravity and centre of gravity were added. The example of different positions of the forearm was added to first and third teaching sessions. |
| Lesson plans and guidance notes | Overhead transparencies were numbered. Key words were italicised. The most important teaching contents and guidelines were marked with colours and exclamation marks. Timetable was checked and specified. Teacher was given example solutions to practical problems. |

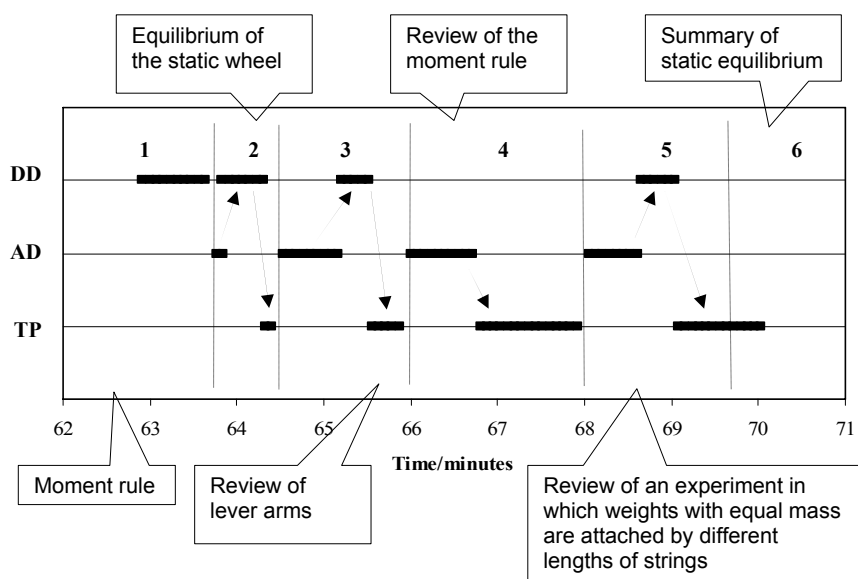


Figure 2. Patterns of classroom discourse in one teaching episode of the second teaching experiment presented subject by subject (1 - 6). TP = teacher presentation, AD = teacher guided authoritative discussion, DD = teacher guided dialogic discussion.

DISCUSSION AND CONCLUSIONS

In this study, transfer teachers had an important role in developing the teaching-learning sequence on the moment of force. In developing the teaching-learning sequence, it was important to note how the teachers implemented the teaching-learning sequence according to the lesson plans and guidance notes and how they explained the changes they made. The implementation of the teaching-learning sequence and the conceptions of the teacher in the first teaching experiment were important in developing the sequence. Changes that were made to the lesson plans, on the basis of the first teaching experiment, seemed to be working in the second teaching experiment. According to Millar (2005), a case study discussing in detail how the new approach worked in another school may have greater impact on teachers than the findings of a controlled experiment. Successful experiences of other teachers may help teachers in adopting a new teaching approach (Millar, 2005).

In the first teaching experiment, the implementation of the teaching-learning sequence deviated in some parts from the lesson plans and guidance notes (tables 1 - 4). For example, the implementation did not include an introduction of experimental work equipment (table 2), nor giving instructions to students for group work outside the lessons (table 1). Some of the teaching contents, such as the summary of experimental work (table 2), were left out accidentally, but the teacher also consciously made some changes to the lesson plans. The teacher in the second teaching experiment followed the guidance notes better than in the first, which may have resulted from the enhancement of the teaching-learning sequence and the adjustment of the lesson plans and the guidance notes following the first teaching experiment (table 5). This supports the views of Leach and Scott (2002). According to them, in developing and evaluating a teaching sequence, conceptions of teachers who have not been involved in the research process and in designing the teaching sequence should be taken into consideration (Leach & Scott, 2002). Usefulness and applicability of lesson materials can be increased on the basis of conceptions of teachers who are not involved in designing the lesson materials.

The transfer teachers followed the guidance concerning patterns of classroom discourse quite accurately. In the second teaching experiment, the teacher used different patterns of classroom discourse in a more versatile manner than was presented in the guidance notes. Depending on the teaching situation, the teacher often followed a certain “rhythm” and used different classroom discourse patterns, taking into account the teaching purposes. The function of teacher-guided authoritative discussion was often to introduce new concepts. The purpose of teacher-guided dialogic discussion was to explore students’ ideas about the teaching content. Teacher presentation was mainly used in reviewing and summarizing key points. The results resemble the findings of Mortimer and Scott (2003) and Scott et al. (2006). Knowledge about different purposes of classroom discourse patterns can help the teacher to achieve a balance between different patterns of classroom discourse in order to support the learning process. According to Leach and Scott (2003) it is also important that a teacher be able to change the pre-planned patterns and the “rhythm” of classroom discourse if necessary.

In implementation of the teaching-learning sequence, there were some differences between the two teaching experiments in the way the lesson materials and guidance notes were put into use by the transfer teachers. In the study of Ryder et al. (2003), three teachers followed the same detailed lesson materials and guidance notes and yet there were significant differences between the three lessons. According to Ryder et al. (2003), “what happens in a lesson will be influenced by teachers’ understanding of science, their expertise in particular teaching approaches, students’ knowledge and attitudes, and teachers’ understandings of the purposes of the teaching”. Teachers also need to respond to students’ questions and other contingent factors within the classroom (Ryder et al., 2003). According to the teacher in the first teaching experiment, the implementation of the teaching-learning sequence would be more successful a second time. This resembles the view of Millar et al. (2006). According to them better learning results may be achieved if the transfer teacher would implement the teaching-learning sequence a second time.

The results and methods of this study can be applied in designing and developing teaching-learning sequences, lesson materials, and guidance notes for teachers. Use of transfer teachers in implementing the teaching-learning sequence assist to develop lesson materials and guidance notes in a way that they may be more usable also for other teachers. For example the changes that were made to lesson plans and guidance notes can be taken account also in designing other teaching-learning sequences. The results of the use of different patterns of classroom discourse may be helpful in determining appropriate usage of different patterns of classroom discourse, and in designing the guidance of the classroom discourse.

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