

The practice constructivist teaching and learning in ordinary classroom settings

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Theoretical background

Numerous studies on constructivist-oriented approaches have been carried out in the past two decades (Duit & Treagust, 2003). However, studies on the practice of constructivist ideas in “ordinary” science classrooms are rather infrequent. Some of these studies are surveys on constructivist learning environments using teacher and student questionnaires (Aldridge, Fraser, Taylor, & Chen, 2000; Labudde, 2000; Taylor, Fraser, & Fisher, 1997). Employing questionnaires and interviews, such studies provide valuable information about classroom learning environments as perceived by the internal participants or *beta press* (Fraser, 1998), but they fail to inform the *alpha press*, i.e. learning environments observed by external observers. Studies that employ questionnaires and direct observations (Robinson & Yager, 1998; Yager, 1997), reported that internal participants’ perceptions were quite often different from what were actually observed.

Unfortunately, the number of observational-based studies is relatively limited. One of observational category systems designed to analyse the practice of constructivist ideas in the classroom is the “Secondary Teacher Analyses Matrix” (STAM) developed by Gallagher and Parker (1995). It provides ideas how to assess the extent lessons meet constructivist ideas. Since it is designed as a high inference instrument, it does not allow for time-based analyses as intended by the present study. For these reasons, time-based category systems were developed for the present study.

The first category system, the Constructivist Oriented Science Classroom (COSC) is designed to identify the appearance of key characteristics of constructivist learning environments. It is developed on the bases of key characteristics of the constructivist learning environments identified in the literature (e.g. Phillips, 2000) and attempts to assess classroom learning environments (e.g. Labudde, 2000; Taylor et al., 1997). The second category system, the Constructivist Teaching Sequences (CTS) is developed based on suggestions for the constructivist teaching sequences identified in the literature (e.g. Biemans, Deel, & Simons, 2001; Driver, 1989).

Objectives

The study presented here aims at investigating the appearances of key characteristics of constructivist learning environments and constructivist teaching sequences in ordinary science classrooms. It is not the intention of the study to use constructivism as criteria to judge teachers’ teaching, rather the main objectives of the study are to explore the appearance of constructivist ideas in “ordinary” classroom practice, to identify teachers’ difficulties to implement constructivist ideas, and to explore the possibilities of using constructivist ideas to improve teaching practice. Constructivist perspectives are chosen as a reference position since constructivism is a dominant paradigm in science education research and it is often suggested for quality development programs (Beeth et al., 2003).

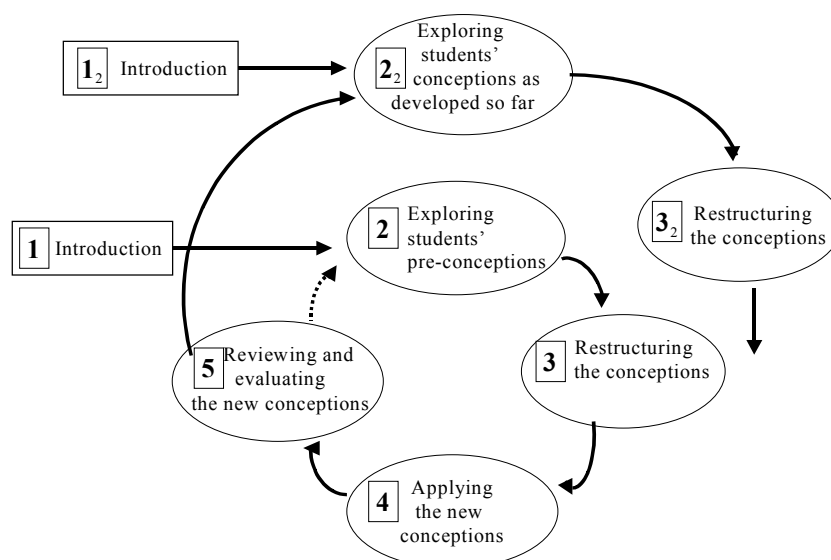
Methods

The sixty eight videos of physics lessons taught by our 13 teachers are analysed. The videos are analysed based on the categories of the COSC and the CTS. The COSC is composed of 5 main categories and each is divided in a number of subcategories (see table 1)¹.

Table 1 Constructivist Oriented Science Classrooms (COSC)

A. Facilitating knowledge constructions	B. The relevance and the meaningfulness of the learning experience	C. Social interactions	D. Fostering students to be independent learners	E. Science, scientific knowledge, and scientists
<ol style="list-style-type: none"> 1. Making the students aware of the status of their learning within the whole subject. 2. Exploring students' prior knowledge or ideas. 3. Exploring students' ways of thinking. 4. Providing thinking-provoking problems. 5. Addressing students' conceptions <ol style="list-style-type: none"> a. Using evolutionary ways. b. Using revolutionary ways. 	<ol style="list-style-type: none"> 1. Exploring students' interests, attitudes, and feelings. 2. Addressing students' learning needs. 3. Addressing real-life events, phenomena, or examples. 4. Using resources from everyday life. 5. Discussing applications of the concepts learned. 	<ol style="list-style-type: none"> 1. Student – student interactions. <ol style="list-style-type: none"> a. Simple interactions among the students. b. Students exchange ideas with other students. 2. Student - teacher interactions <ol style="list-style-type: none"> a. Simple interactions between students and the teacher. b. Students exchange ideas with the teacher. 3. Social organisation of the class. <ol style="list-style-type: none"> a. Individual setting. b. Group setting. c. Classroom setting. 	<ol style="list-style-type: none"> 1. Providing the students with some freedom to organise their own learning. 2. Encouraging the students to re-think their own ideas. 3. Encouraging the students to be self-regulative and reflective. 4. Taking into account students' critical voices. 	<ol style="list-style-type: none"> 1. Acknowledging the tentativeness of science. 2. Acknowledging differences in theories or views. 3. The roles of observation and evidence, hypotheses, theories, and laws in science. 4. Acknowledging differences in the ways to do science. 5. Acknowledging the limitations of science explanations.

The second category system, the CTS², is developed to analyse the sequences of the lessons. As presented in figure 1, constructivist teaching progresses in a spiral sequence of five steps:



¹ The COSC is available from the author on request

² The CTS is available from the author on request

Figure 1 Steps of the Constructivist Teaching Sequences

1. Introduction: It identifies efforts to prepare students for the topic, to promote students' readiness and to generate students' interest in the lesson.
2. Exploring students' prior knowledge: It identifies teachers' efforts to explore students' prior knowledge related to the topic.
3. Restructuring students' conceptions: It identifies attempts to facilitate conceptual change.
4. Applying the newly constructed ideas: It identifies attempts to apply the concepts learned to other contexts or to real life.
5. Reviewing the new ideas: It identifies attempts to encourage students to compare the newly achieved and the previous conceptions.

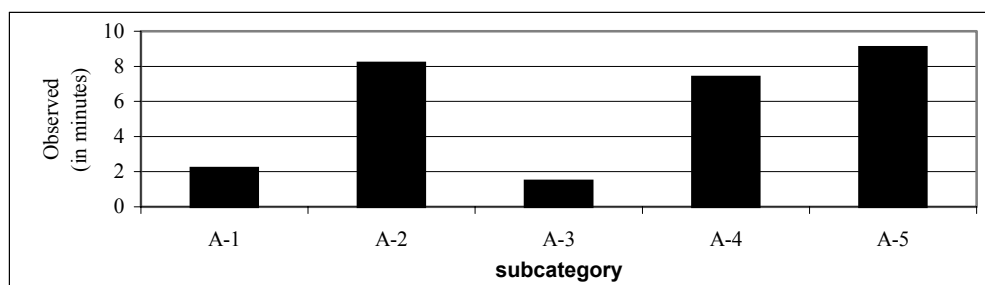
The COSC and the CTS are designed as time-based category systems. In this study coding time unit is 10 seconds. The COSC is designed as a two-option category system. In coding practice, after observing a 10-second unit, coders then decide whether the unit meets criteria for the related subcategories. When the unit meets the criteria, it is coded as "yes" and is coded "no" when it does not meet the criteria for the subcategories. The CTS is designed as a five-option category system. Coders decide whether an observation unit observed belong to step 1, 2, 3, 4 or 5. When the unit does not meet one of the steps, it is coded as 0. As time-based category systems, coding results is the duration a certain category/subcategory is observed.

Results

Learning environments of the lessons

In general, the results from the COSC show that the lessons meet the characteristics of the constructivist-oriented science classrooms only to a limited extent. Most subcategories are observed less than 10 minutes. A number of characteristics are not observed at all, i.e. subcategory D-3, D-4 and all subcategories under category E

As presented in figure 2, two important characteristics for facilitating students to construct knowledge, namely making the students aware of the status of their learning and exploring students' ways of thinking are very seldom observed, while the other three subcategories are observed slightly more often.

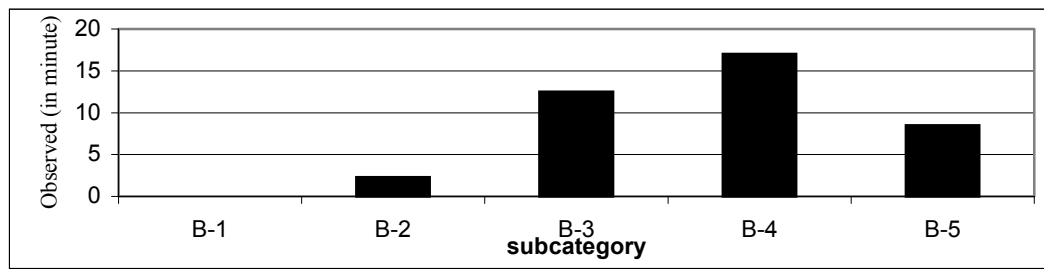


- A-1: Making students aware of the status of their learning.
- A-2: Exploring students' prior knowledge or ideas.
- A-3: Exploring students' ways of thinking.
- A-4: Providing thinking-provoking problems.
- A-5: Addressing students' conceptions.

Figure 2 Results of subcategories A-1 to A-5

Although students’ prior knowledge is relatively often observed, little is obtained from these attempts. First, the questions asked by the teachers are so general, for instance “What do you know about...?”, that the identified prior knowledge is not specific enough to allow the teachers to detect students’ pre-conceptions. Second, after exploring students’ prior knowledge, no further actions are taken to address it. It seems that the teachers do not have clear ideas of making use students’ prior knowledge. This finding is similar to Hewson’s et al. (1999) findings that prospective teachers explored students’ prior knowledge, but only few were able to use them to plan their teaching.

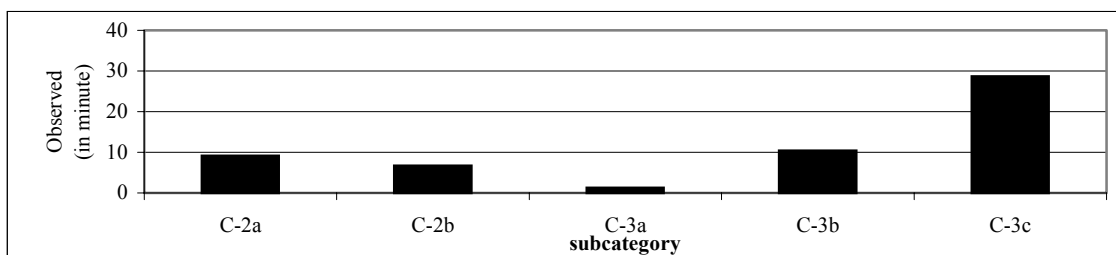
Results for category B (see fig 3) show that lessons seldom address issues related to students’ interests and students’ learning needs. However, the lessons are quite often situated within students’ everyday life as they quite often address real life phenomena or real life examples (B-3) and use resources from everyday life (B-4). These results suggest that there are significant efforts by the teachers to provide learning experience that are not detached to students’ life. Although it is less frequently observed than subcategories B-3 and B-4, application of knowledge (B-5) is given quite substantial attention. Amongst the issues are applications to real life.



- B-1: Exploring students’ interests, attitudes, and feelings.
- B-2: Addressing students’ learning needs.
- B-3: Addressing real-life events, phenomena, or examples.
- B-4: Using resources from everyday life.
- B-5: Discussing applications of the concepts learned.

Figure 3. Results of subcategories B-1 to B-5

As presented in figure 4, simple interactions are more common than intensive interactions that include exchange of ideas³. The form of social organisation of is “unbalanced”. Students have only limited opportunities to work in groups and to work individually. This suggests that students are rarely given opportunities to work individually. In some lessons, other forms of social organisation other than working in classroom settings are not observed. Since lessons are generally rather class-oriented and less individual-oriented, it is very unlikely that lessons cater to students’ individual learning needs and speeds.



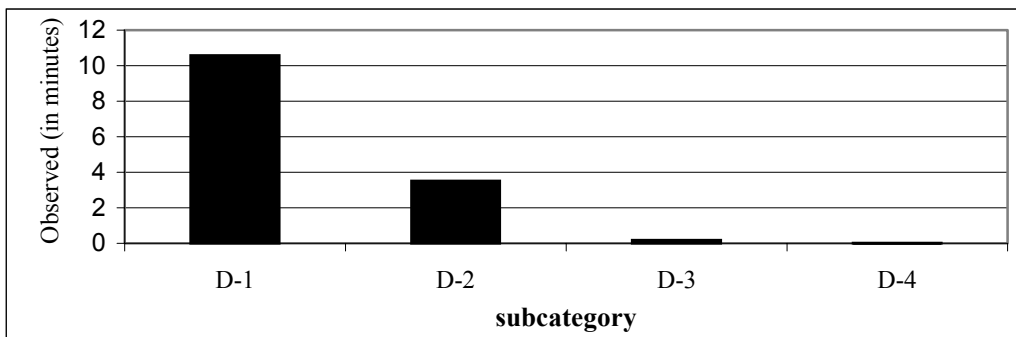
C-2a: Simple interactions between students and the teacher

³ Due to the difficulties to code student-student interactions, no results for subcategories C-1a and C-1b is available.

- C-2b: Students exchange ideas with the teacher
- C-3a: Individual setting
- C-3b: Group setting
- C-3c: Classroom setting.

Figure 4 Results of subcategories C-2 and C-3

As presented in figure 5, teachers have put some efforts to foster students’ independence (see D-1). However, other aspects required for students to be independent learners (especially D-3 and D-4) are seldom observed. This suggests that on the one hand, some teachers have shown some intentions to foster students’ independence, but on the other hand teachers have not “prepared” students how to be independent learners. For example, one of the important features of being independent learners is that students should be able to learn how to learn, how to control and to monitor their own learning. Unfortunately, these issues are not well addressed by the teachers.



- D-1: Providing students with some freedom to organise their own learning.
- D-2: Encouraging students to re-think their own ideas.
- D-3: Encouraging students to be self-regulative and reflective.
- D-4: Taking into account students’ critical voices.

Figure 5 Results of subcategory D-1 to D-4

Results of the CTS

As presented in figure 6, all five steps are observed in the lessons. However, it does not mean that each lesson always includes all five steps. A sum of the length of all steps reveals that in only 21 minutes of the time steps of the constructivist teaching sequences could be observed. This suggests that about 50% of teaching time is spent for other issues, such as addressing discipline issues, taking notes or doing activities that do not clearly refer to any of the five steps.

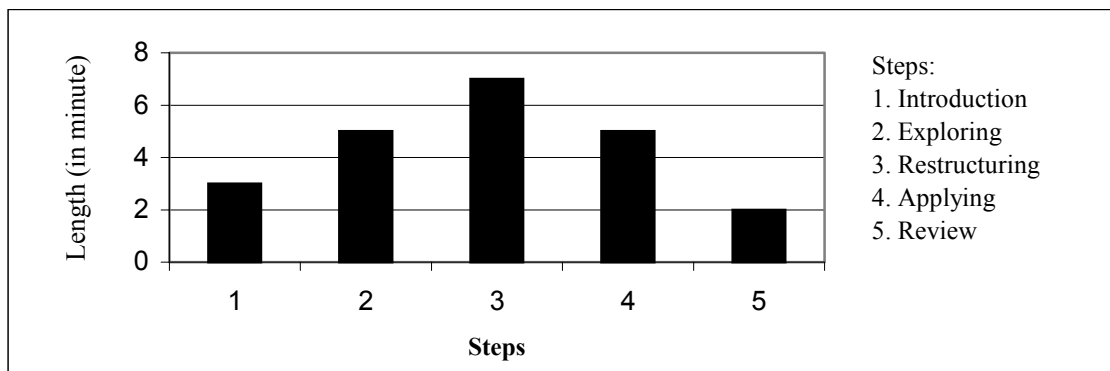


Figure 6 Average scores of each step

Analyses of the individual lessons show that many lessons do not progress in steps as suggested by the constructivist teaching sequences (see fig. 7). First, a number of lessons do not show complete steps. As presented in figure 7, T-7's lesson never include application and review. Second, a number of lessons do not progress in steps as suggested by the constructivist teaching sequences. As presented in figure 7, T-1' lesson is to a certain extent meets the CTS. It begins with a short introduction, followed with extended explorations of students' prior knowledge, and by the end of the lesson a short restructuring is done followed by application and review. In contrast, T-7' lesson includes only introduction, exploration, and restructuring.

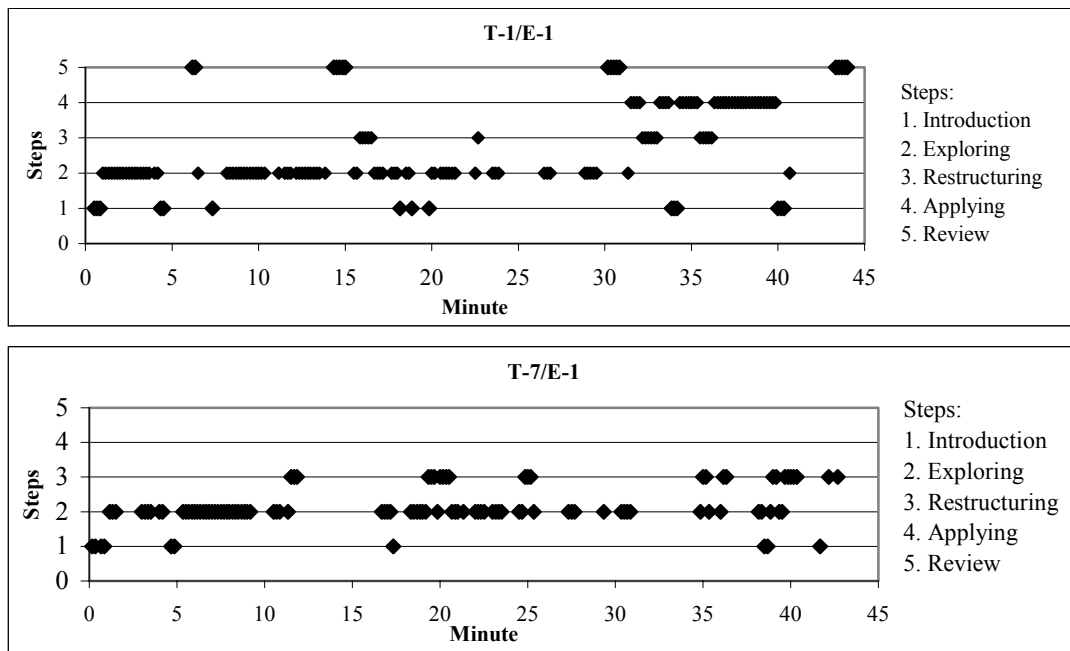


Figure 7 Analyses of the sequences of lessons

Analyses of the sequences of the lessons reveal the following findings. First, in 26 lessons (38%), one or more steps are missing. The fourth step (applying the conceptions) and the fifth step (reviewing) are two most frequently missing steps. Second, many lessons skip one or more steps or they progress in unclear sequences. For instance, instead of progressing in steps 1 – 2 – 3 – 4 – 5, lessons may progress in steps 1 – 2 – 1 – 2 – 3 – 4 – 5, 1 – 2 – 3 – 1 – 2 – 3, etc.

The appearances of the characteristics of the constructivist-oriented teaching and students' learning

Analyses of the correlations between the extent lessons meet the characteristics of the constructivist-oriented lessons and students' achievement indicate positive correlations - especially between the length of time during which students' are challenged with thinking provoking problems and the time spent in addressing students' conceptions. These results confirm findings from previous studies (e.g. Ditton, 2002) that constructivist learning environments may promote students' learning.

Substantial correlation scores are also observed between students' achievement and the length of the steps of the CTS. This result supports findings reported in previous studies that constructivist teaching sequences might promote students' learning (e.g. Biemans et al., 2001).

In summary, the results support findings of the previous studies that the adoption of constructivist-oriented teaching relates to higher students' achievement.

In brief

The video-documented lessons meet the characteristics of the constructivist-oriented approaches only to a limited extent. Most of the characteristics appear in relatively short time or completely absent. Analyses of the progress of the lessons show that many of the lessons do not progress in steps as suggested by the constructivist teaching sequences.

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