Teachers' aims of laboratory work in secondary school in Sweden

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Introduction

Laboratory work and practical work are common and significant components of science education. Teachers are expected by tradition, culture and curriculum (e.g. Boud, Dunn and Hegarty-Hazel, 1989; Lunetta, 1998; Skolverket, 1998) to involve labwork as a part of science education. Swedish National Curriculum (Skolverket, 1998) renders objectives involving for example development of students' scientific skills, knowing how to plan and perform investigations and to critically analyze results. Two of the most important goals with labwork are to act as a link between theory and practice and to offer laboratory skills. There is an ongoing discussion about the efficiency of labwork for learning science (Hult, 2000; Tiberghien, Veillard, Le Maréchal, Buty and Millar, 2001). Based on my experience as a science teacher, there is a need to alter labwork. Individual teachers play a significant role in labwork conducted in science teaching and thus affects learning outcome from labwork. In this sense, teachers have to present comprehensive curriculum aims to motivate and engage students in meaningful labwork (Leach and Scott, 2003).

The study presented here deals with teachers' choices which depend on their views of science and learning in addition to e.g. practical and institutional constraints. By interviews and text analysis related to their own science teaching, secondary school teachers' views were explored. The study was designed to describe and increase knowledge and understanding about teachers aims of laboratory work, e.g. their pre-labwork decisions. Some questions are: What choices are made by teachers, and how are they motivated? Do teachers' aims with labwork correspond to teachers' descriptions of labwork? How do teachers' choices affect students' prerequisites of learning from labwork? The purpose is to enlighten teachers' labwork aims and objectives, motifs and priorities. Further studies in the PhD-project will explore what implications teachers' aims have in reality and how students interpret these aims.

Methods and sample

Interviews were central in this study and they were used to analyse teachers' aims with labwork. An initial presentation to 13 secondary school headmasters from two counties in northern Sweden was, after approval, followed by personal contact with 55 appointed teachers. Teachers were given directions to bring along two typical laboratory exercises and prepare to discuss why these laboratory exercises were chosen. Eleven teachers in science education derived from four schools, two from each county, volunteered to participate (Table 1). Each teacher participated in an individual semi-structured interview, promoting an open-ending to both content and direction of the interview (Bogdan and Biklen, 2003; Erickson, 1998). Each interview was audio taped and transcribed.

Labsheets were analyzed regarding science discipline and connections to theory, origin and modifications, structure of laboratory instruction and focus of learning objectives. Learning objectives were for example to observe an event or to make an object (Tiberghien, et al., 2001). Each labsheet was compared to the teacher's description of it and same teacher's aims with laboratory work.

Table 1. Description of teachers' background and labwork chosen by teachers. (B, C, P and T equals Biology, Chemistry, Physics and Technology, respectively. LS and OR equals Labsheet and Oral. + and 0 equals positive and neutral)

Teacher	*Gender (F/M)*	*Teaching exp. (years)*	*Interview time (mins)*	*Science discipline 1*	*Labwork instruction 1*	*Science discipline 2*	*Labwork instruction 2*	*Attitude to profession*
1	F	35	50	C	OR	C	OR	+
2	F	4	30	P	LS	B	OR	+
3	F	4	30	C	LS	C	LS	+
4	F	6	40	P	LS	P	OR	+
5	F	3	50	C	LS	C	LS	+
6	M	33	45	C	OR	C	OR	+
7	M	6	35	P	LS	P	OR	0
8	F	35	35	T	OR	P	OR	+
9	F	11	40	B	LS	P/T	LS	+
10	F	25	25	C	LS	C	LS	+
11	M	6	45	P	LS	P	OR	+

Data analysis and results

Interviews were initially transcribed and coding was defined by the research purpose; how teachers choose to describe their labwork aims. Coding was developed by trying to find phrases or words related to teachers' aims, methods, strategies and general perspectives on teaching and learning from labwork (Bogdan and Biklen, 2003). Reoccurring, but independent, words and phrases regarding teachers' aims emerged. These specific coding categories were classified and fit into three domains, i.e. the cognitive, psychomotor and affective domains (Anderson and Krathwohl, 2001; Harrow, 1972; Krathwohl, Bloom and Masia, 1964). An additional rereading of the transcripts was performed with the aim to further analyze how these categories were linked, i.e. whether semantic relations occurred on the subject of teachers' aims. Excerpts including identified semantic relationships between teachers' specific expressions were clustered to form thematic relationships, which in turn were analyzed how they were joined into thematic patterns (Lemke, 1990). Emerging categories and thematic patterns were synthesized and analyzed to form relationships between teachers' aims.

Teachers' examples of laboratory experiments brought to the interview came from all three science disciplines and technology. Science textbooks or Internet served as sources in 65% of the laboratory exercises. All laboratory exercises were connected to theory in respective science discipline by introducing, explaining or concluding theory. Students were expected to use a laboratory device, make an event occur or observe an event in 75% of the laboratory exercises. In only 25%, students had to present or make an object or a material. Desires to use additional time to prepare perform and evaluate laboratory experiments were expressed by 65% of the teachers. An interpretation is that the lack of time influence teachers' choices of laboratory work. Choices were not always preferred by teachers nor constructed for student prerequisites. Easy-to-use labsheets might instead be chosen to engage students in labwork.

In the cognitive domain, understanding is most frequently used. The affective domain is used to justify why students have to do certain laboratory exercises. Teachers' aims are sometimes motivated with connections to practical and institutional constraints. The psychomotor domain includes expressions concerning tool-using. Teachers express most aims in the affective domain (Table 2).

Table 2. Examples of how teachers express their aims of specific labwork. Teacher number and number of described laboratory exercise are presented in brackets.

Direction of aim	*Teachers expression(s)*	*Emerging category*
Cognitive domain	"…to make them understand theory and practice, that there is a connection" (T5, L2)	Understanding
Affective domain	"they think it is fun" (T1, L1) or "they experience something new or exciting" (T2, L2)	Affection
	"Through science, I want them to see the reality around us. That it [science] is not plain theory." (T4, L1)	Intention
Psychomotor domain	"…follow instructions" (T3, L2) or "…learn how to use laboratory equipment" (T3, L2)	Manipulating

Thematic patterns emerging from semantic relationships within, and thematic relationships between, teacher expressions revealed other primary objectives of teachers' aims and also how those primary objectives correlated to each other. Examples of thematic patterns will be offered in the presentation. A frequent thematic pattern found in described laboratory exercises, highlight the objective *activity*. A second thematic pattern apparent in other described laboratory exercises emphasizes the objective *understanding*. In the third thematic pattern, *manipulating* was the primary objective.
An overall synthesis of three identified thematic patterns and the three domains suggested a comprehensive category, activity, and its relations to the other categories (Figure 1).
Results showed that the primary objective activity had a predominant position and thus acted comprehensive to all other objectives expressed as categories.

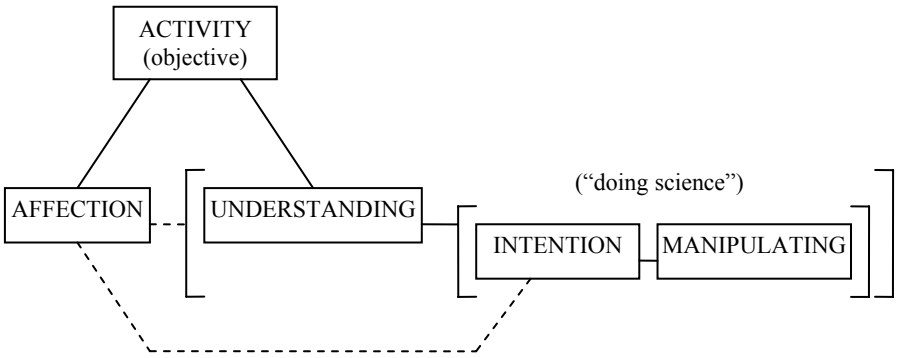

Figure 1. Mutual relationships between categories based on thematic patterns.

Conclusions and implications

The most important result in this study revealed that teachers commonly describe their aims of labwork as creating activity for the students. Also, goals in the affective domain tended to have greater influence than psychomotor or cognitive domain on teachers' pre-labwork choices in secondary school in Sweden. Thus, activity is the primary objective emerging from the combined analysis of labsheets and interviews. Other results, for example findings from analysis of labsheets compared to other studies (e.g. Tiberghien, et al., 2001) relations to Swedish National Curriculum (Skolverket, 1998) and implications for teacher education will be discussed. Furthermore, how teachers in secondary school express their aims will be compared with how these aims are expressed in reality in a following-up study.

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