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Word meaning and conceptions. An empirical study of relationships between students' thinking and use of language when reasoning about a problem.

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Abstract

In considering students' thinking, the phenomenographic tradition has paid considerable attention to conceptions of various phenomena within the context of learning. However, this research has not explicitly examined the relation between words used and their meaning in the processes of understanding and learning. The present study concerns the character of the relationships between semantic expressions and thoughts about phenomena referred to. In order to understand these relationships more fully, an empirical study was carried out. Twenty-seven students from two institutes of higher education, a college of health science and a college of education, participated. Qualitative interviews were used to both stimulate students' thinking about the conceptions they expressed of a particular problem and to document their thinking. Contextual analysis was used to examine this data. The results of the analysis are presented in three related descriptive categories. The categories represent three different aspects of relationships between words used and thoughts about phenomena referred to and three different developments of these relationships. Finally, conclusions are drawn and are discussed in relation to research on understanding and learning and two major traditions in the philosophy of language.

Keywords

Learning Processes, Thinking Processes, Language Meaning, Language Usage, Self Understanding, Self Reflection.

Introduction

A major part of research on learning is concerned with students' understanding of knowledge which is mainly represented in verbal presentations. In spite of this, little is known about the character of the relationship between word meaning and understanding, how it develops or what role it plays. The relationships between symbols and underlying thoughts and their development have been discussed as a wide and general problem, mainly described as "how students' learn to mean" (Nickersson 1985; Neuman 1987; Bruner 1990; Gardner 1992; White and Gunstone 1992; Bloom 1992; Entwistle and Entwistle 1992, Marton et al., (1984/1997). The discussion has raised some basic questions concerning how personal understanding is related to language meaning (Entwistle 1995). Therefore the aim of this article, is to describe qualitative differences in experienced relationships between words used and conceptions of a problem, and the different developments of these relationships.

The empirical study in this paper is based on a phenomenographic perspective. Phenomenography is a research orientation (Svensson 1976; 1997; Marton 1981; Marton and Booth 1997) aiming at describing conceptions in different contexts like learning, studying, teaching and instructions. As an approach to students' learning it makes a valuable contribution because it does not divide students' thinking into context-free elements, but treats students' thinking acts as wholes in relation to a specific content. Phenomenography has methodological characteristics, also developed in the methodology of contextual analysis (Svensson 1985; 1997). There is a wide range of studies adopting a phenomenographic perspective, for an overview see for instance Marton and Booth (1997). The theoretical foundations of phenomenography are discussed by Svensson (1997) in relation to the development of the research orientation. An evaluation of phenomenography and its influence, particularly descriptions of "deep" and "surface" approaches to

learning has been made by Webb (1997). Responses to that critique have been given by Entwistle (1997) and Ekeblad (1997).

There has been a great deal of interest in examining students' understanding in relation to their thinking about concepts. In White and Gunstones overview (1992) of methods for probing students' understanding, in order to "direct the students to learning with deeper understanding" focusing on the learners' own construction of meaning in relation to concepts. Some of the techniques used include concept mapping, word associations, interviews about concepts, and relational diagrams assessing patterns of linkages between concepts more than linkage between concepts and their use in thinking. The techniques introduced concepts selected beforehand, and not concepts used in the act of conceptualising a problem.

There are differences between thinking focusing on concepts per se, and focusing on conceptions of a problem. To learn to handle isolated concepts and to learn to handle concepts when solving a problem or answering a specific question, involves different learning activities and results in different outcomes. It is important to learn what different concepts mean according to different patterns of association, since these meanings may represent the students' decontextualised knowledge of a concept. More important, seems to be how the concepts relate to a problem and to assess its relation to thoughts about that problem, and thus to the understanding of the students intended-referential meaning. Thus the aim of this article is to examine how students identify relationships between word used and understanding of a problem presented.

Word meaning and content of thought

In research on language there are two main traditions, the semantic-structural one and the intentional-relational one. The semantic-structural tradition has its origins both in analytical philosophy, as represented by Frege and Russell, and in the work of the structuralists, as represented by de Saussure and Chomsky. This semantic-structural tradition has had a great influence on cognitive science. In this tradition recognition of intention is not a central feature as it is in the intentional-relational tradition represented, for instance, in the work of Strawson (1950) and Wittgenstein (1974). The intentional-relational tradition, together with the socio-historical tradition (Berger and Luckmann 1967; Vygotsky 1975), has influenced research on learning, particularly those scholars who have focused on the social and cultural aspects of language and thinking (Rommetveit 1979; Säljö 1991; Wertsch 1991; Edwards 1993). This

perspective has been the origin of important research developments in educational settings. However, the intentional-expressive aspects of language and thinking have been neglected. The intentional-relational tradition implies more than a concern for communication and convention, it also concerns the relation between intended meaning and how this meaning is expressed by the individual. In this article it is referred to as the intentional-expressive perspective. This perspective has not hitherto been taken into close consideration in research on learning.

The statement that thinking is characterised by intentionality was one of Brentano's (1973) fundamental thesis; thinking is always about something, an object referred to. Thinking about an object gives rise to different contents of thought, depending on what intention we have. Thus the same object may be the source of different contents of thought. Intentionality is an important concept in phenomenography, it is treated in the terms of conception and a what- and how-distinction. This article is concerned with the identification of relations between content of thought and language used, described here as the intentional-expressive perspective. This particular perspective developed in the present study focuses on how students analyse and identify their expressed thoughts about a specific problem. The relationship between conceptions and word-use, in relation to a specific problem analysed in the learners' perspective, gives some insight into these intentional-expressive aspects.

The intentional-expressive perspective differentiates between word meaning and content of thought and focuses on the relationship between them as internal to practice (Wittgenstein 1967; Hacker 1990). The essential dependence between the intentional aspects and word meaning are in contrast to a causal account of the relationship in that the meaning of words depend both on the intentions and the linguistic prescriptive norms. The normative aspect of word meaning is not seen as identical to the subjective thought, therefore the relationships cannot be taken for granted.

In this paper the term utterance refers to a linguistic level and involves an act of intention. An utterance may include more than one word, but need not be a sentence or proposition. It is an essential part of language usage. The term conception refers to a unit of content of thought, as it has been formulated in the phenomenographic tradition.

The study is restricted by certain general reservations always present in studies of a meta character. The first is that language cannot step outside itself. The second reservation is that analyses of a person's thought processes can never be complete, there is always something that remains

out of reach. The relationships between the sign and the signified, focused upon here, are within a qualitative interview setting and the results reflect this. Results from the investigation point out only some educational critical aspects of how this relationship is experienced from the students' perspective and not the activity and the experiences as a whole. Educational critical mean critical in relation to how the understanding of the object is developed (Marton and Booth 1997).

Method

Phenomenography is a recent research orientation aiming at describing and comparing conceptions. Conceptions refer to content of thought as entities of intended-referential meaning.

A conception is a way of seeing something, a qualitative relationship between an individual and some phenomenon. A conception is not visible but remains tacit, implicit, or assumed, unless it is thematized by reflection (Johansson et al., 1985: 236).

Conceptions are accessible through different symbols. Language is the most common kind of symbol in educational settings. The phenomenographic tradition's concern with conceptions directs attention to the intentional-expressive dimensions of the conceptualising activity. When describing learning by focusing on students conceptions, the thinking behind the words is of fundamental interest. No general assumption is made about identity between word meaning and the underlying conception.

Conceptions may be expressed in different forms of action but they are most accessible through language. One variation is from an implicitly expressed not articulated conception to an explicitly focused on and formulated conception (Svensson 1997: 166).

Variations obtained depend both on the character of the conceptions developed and the access to a language. In this study the relationships between word meaning and conceptions are analysed in depth.

Sample

Ten students from a college of health sciences and 17 students from a college of education participated. These colleges were selected in order to study thinking in two areas, nursing and mathematics instruction. The areas differ in that nursing is more practical and concrete while

mathematics instruction is more abstract and theoretical. With regard to these differences, both a general and domain specific analysis of the thinking was possible. In this article, however, specific analyses are excluded and specific differences between the two domains are only marginally considered. The participants (trained nurses and teachers) attended professional development courses for two terms (20 credits). The nurses were interviewed when they had completed one unit of the course, while the teachers were interviewed after they had completed the whole course. The age of the students varied between 25 and 52 years and gender; five men and 22 women.

Interview procedure

The students reflected upon a problem (given in Appendix A) presented to them at the beginning of the interview. This problem was generated in relation to the courses and together with the teachers responsible for each course. The nurses were to reflect upon a problem concerning prophylactic nursing measures taken for patients with the syndrome Disseminated Intravascular Coagulation (DIC). The teachers reflected on different ways of managing fundamental mathematics instruction.

Before the interview started, time was reserved to create a relaxed atmosphere and to give detailed information about the purpose of the study and the interview. This period was necessary in order to facilitate the self-reflective character of the thinking. The interviewee was expected to make shifts from thinking about the problem to reflecting on the conceptions expressed while talking about the problem. Follow-up questions were intended to stimulate the students to analyse and identify the relationships between the utterances used and thoughts about the object. Thus the focus was shifted during the interview, from bringing out students' conceptions of a problem to students' reflections on how the conceptions were expressed. None of the students had been interviewed in this way before.

The interview started with a description of the problem followed by an initial question about the problem. At the beginning of the interview some time was spent exploring the interviewees' conceptions of the problem. The focus was then shifted to some of the central utterances with which the conception was expressed. The interviewer asked the student to identify what she/he meant by these selected utterances and why she/he had chosen them and how this choice was related to the conception of the problem. These kinds of questions led to an activity involving progress of a different character. The data gathering method is

exemplified in the six interview extracts included in the result section. The interview finished by returning to the question addressed at the beginning.

Each interview took approximately 30–60 minutes to complete. Before it ended the students' experiences of the whole interview were collected. This was important in order to capture any main differences between the researcher's and the students' understanding of the progress.

Analysis of data

The data gathered resulted in 27 transcribed protocols, each documenting the same general procedure, but representing activities with different progress. The aim of the analysis is to distinguish similarities and differences in the progress with regard to how the students identify the relationship between utterances used and conceptions involved.

Conceptions refer to qualitatively distinct ways in which an object or aspect of this object is understood (Svensson 1976, 1989, 1997). The outcome of this study shows that there are variations in how conceptions are expressed in language and in how, during a limited time, it is possible for the student to identify the relationships. The focus of the analysis is on the main similarities and differences in the educational critical aspects of these experienced relationships and how these relationships are developed. The analysis does not deal with levels of introspection or levels of awareness, but with the different character of experienced relationships. The results are presented in three categories, based on the analysis of the data.

In this study, the primary starting point has not been the communicative perspective; instead, the intentional-expressive activity has been emphasised. This emphasis does not mean a lack of acknowledgement of the communicative aspect in relation to meaning and understanding as influenced by social and cultural factors. However, the intentional-expressive perspective focuses primarily on how individuals use the socially and culturally constructed language in their thinking, without emphasising the social and cultural aspects of the activities performed.

The analysis was carried out using the methodology of contextual analysis (Svensson 1976, 1985, 1997). Characteristic of the method used is reflection on the concomitant process of discerning parts and wholes in the material when identifying and grouping different relationships.

The contextual analysis is analytic in the sense that the main focus is on differentiating parts of the data. One differentiation concerns the

delimitation of the phenomena to be described. Another differentiation concerns significant parts of the data representing fundamental whole-characteristics of the phenomena. In differentiating significant parts of the data, comparisons between cases are important. The significant parts make up a whole and this is summarised in a description in the form of a category (Svensson 1997: 170).

The interviews with the teachers and the nurses differ in ways that are significant to an understanding of the results. The differences depend on the character of the contents. The nurses' thinking covered distinct units of content (within each interview), which was not the case with the teachers. When the nurses reflected upon different symptoms of DIC, their reflection gave rise to distinct units of content, according to which the activity could be divided (here labelled: acts). Therefore the interviews with the nurses in the analyses are divided into acts. The ten interviews with the nurses gave rise to 21 thinking acts.

Delimitation of acts was a central part of the analysis of the data from the nurses, which was not the case in the analysis of the data from the teachers. The teachers' thinking does not represent such distinct units. The content does vary during the interview, but the variation did not give rise to such distinct units as in the case of the nurses. Therefore, the interviews with the teachers are seen as wholes and no delimitation of acts is made within the interview. In the following text these interviews with the teachers have also labelled as acts.

The analysis of the acts was then carried out in several stages. The first stages concerned the delimitation of significant parts of the acts in relation to the acts as wholes and against background of data on all the acts. The later stages of the analysis concern a specification and comparison of these parts between the acts in relation to the phenomena delimited. The acts are grouped into categories with regard to the whole-qualities of the experienced relationships and between utterances used and conceptions involved, and how the relationships were developed.

Results

In the investigation of how students identify the relationships between utterances used and conceptions involved, different aspects of the experienced relationships and different developments of these relationships appeared. These findings are presented in the form of three

descriptive categories, which summarise qualitative similarities and differences found in the analysis of the data.

Categories of experienced relationships and developments of these relationships:

1. Relations between utterances and conceptions remained weak and fragmented.
2. Relations between utterances and conceptions became explicit as corresponding to each other.
3. Relations between utterances and conceptions changed to new relations where utterances and conceptions corresponded to each other.

The three aspects of relationships distinguished in the category system represent the main development of the acts. The kind of the relationship described in the first category is to some extent present in all (38) acts a whole characteristic, but only nine acts are placed in this category. These acts did not represent any development like the acts placed in categories 2 and 3. This raises some particular questions about this category, which will be addressed later in the paper. The second kind of relationship developed is present in 29 acts, and among them 15 acts are placed in the second category. What these acts have in common is that on the whole they represented a development to close links between utterances and conceptions. The third relationship developed is apparent in 14 acts, all placed in the third category. These acts represented a development where change in relationship was the main feature, which was not the case in the other acts.

The distinctions made between the categories concern some characteristic ways of experiencing the relationships. The vague character of experiencing relationships, characteristic for acts placed in category 1 was also represented in the other categories as an element. It played the role as an intermediate stage. Looking at how category 2 differs from category 3 suggests that the thinking seems to be more oriented towards continuity. In category 2 the students' orientation was to convince themselves that there was a clear intentional meaning behind the utterance. In category 3 there was, both a reflection on what lay behind the words used and the flexibility to change established relationships. The thinking activity was working towards both confirming conceptions and changing conceptions.

The thinking in category 2 and 3 allowed for an elucidation of the relationships in two ways; one representing clarification of relationships (category 2) and the other change of relationships (category 3). Category one represents thinking that did not show any corresponding development, and neither of the qualities of close relations or change in relationships.

The following presentation of the categories has a double aim. On the one hand it should give a general and a detailed description of the meaning of each category; on the other hand it should illuminate how these descriptions are developed through the data analysed. Each category is presented starting with a general description and then goes into a more detailed description of acts in the category. This detailed description is followed by extracts from both the teachers and the nurses in each category with comments from the researcher.

Category 1: Relations between utterances and conceptions remained weak and fragmented (9 acts)

For the most part, in acts in this category utterances showed no stable relation to conceptions involved. Many connections were observed during the acts, but the students did not show confidence in these links when they were asked to explain or offer an exemplification of what they meant in relation to the problem referred to. The act was marked by tentative statements.

A summary of the typical characteristics of the thinking belonging to acts placed in category one is given in Figure 1.

Figure 1

Typical characteristics of thinking represented in category 1.

Inconsistency
Superficiality
Uncertainty
Certainty
Weak attention to discrepancies
Sporadic and vague efforts to construct connections

The meaning of the characteristics can be understood in relation to the description and exemplification of the thinking given in the text.

Two important characteristics deserving a short comment is the presence of both certainty and uncertainty. Certainty was a common characteristic, as was uncertainty. Certainty was revealed when the interviewee became demonstrative, for instance telling “how it is” and in that way giving up further reflection. So, when there arose a request for clarification of how utterances were used in relation to the problem referred to, some kind of evasion often followed. In other cases uncertainty was shown when the interviewee evaded any attempt at reflection on what she/he meant. These characteristics, demonstrative certainty and uncertainty, gave rise to a progress of sporadic links in the relation between utterances and conceptions. Superficiality and inconsistency, other typical characteristics, results in a restrained and isolated treatments of relationships to the intended whole.

This general description of the category will now be given a more specified meaning. This will be done with some extracts from the interviews and some short comments on the extracts.

The first extract is from an interview with a nurse named Sara. The interview with Sara took about 50 minutes (19 pages in the protocol). Five acts have been distinguished. Two acts are placed in this first category, one act is placed in the second category and two acts in the third category. The act from which the extracts below are taken concerns symptoms of respiratory organ deterioration in patients with DIC syndrome, not treated on a respirator machine. This act started with Sarah’s conception of how superficial respiration may be observed.

R: But is superficial in relation to normal breathing which is deeper.

I: Yes. When you say superficial, what are you thinking of primarily?

R: When I look at the patient?

I: Yes, what do you see in front of you right then?

R: I see discreet respirat..., no, what do you call it?

I: There’s no special ...

R: Well, the respiratory movements are smaller.

I: They’re smaller. How do you see that they’re smaller?

R: You see that they generally turn to gentle thoracic breathing. Instead of using the abdomen and the diaphragm. That the breathing is concentrated in the thorax and, and that they start auxiliary respiration, when they use

the auxiliary muscles. But some time will have passed then. That's not the first thing they show.

I: What is the first thing?

R: It's the superficial, I mean that there's a transition to auxiliary respiration, that you help and pull with active breathing. You know, first there's the superficial and rapid respiration, the feeling of being hungry for air, and that they get worried. (p. 14)

In the last expression she became a little confused about the difference between how a patient who has symptoms of weak respiration in the initial phase looks and how symptoms of weak respiration in a later phase look. It did not seem clear to her that superficial breathing or hypoventilation is a symptom of weak respiration in its later phase, nor that weak respiration in its initial phase is marked by hyperventilation, which means deep and rapid ventilation involving both abdomen and the diaphragm and not only thoracic breathing. She did not go any further with reflections on this. Instead she left the problem and started to talk in a general way about how different concepts mean different things in relation to weak respiration. She moved away from patients with DIC syndrome, and also from the specific problem referred to.

R: No, because hunger for air is a concept that I have ... it sounds stupid, but I have full control over it. Hunger for air is not a foreign term.

I: No, it's not foreign, no.

R: I understand the meaning and that there are many different shades of it, and that you can be hungry for air for many reasons. I think it's quite a good description of when you need more air than you can get for whatever reason. (p. 15)

After reasoning this way she did not consider how the utterance “hunger for air” was related to respiratory distress more specifically. Her utterance “superficial respiration” could have led her to explore her conception of the respiration of DIC patients, but instead she shifted to a more general level, patients with DIC were left. Thus, it seemed to be easier for her to find connections to “hunger for air” and it was done with demonstrative certainty as she declared “how it is”.

The next extracts are from a teacher named Clara, Clara discussed what “understanding” involves. At the beginning of the interview she said that understanding is “exercising”, “learning” and “aha-experience”.

R: *Yes, it is of course a learning process or ...*

I: *A learning process. When you say a learning process, what are you thinking about?*

R: *Well, I'm thinking of a time when you learn to measure and then work out these connections and that, all of that is ... a learning process (lowers voice).*

I: *A learning process. If you say understanding, what do you feel that you are describing then?*

R: *... Well, I think that when I've gone through this learning process then I have acquired an understanding ... of the whole thing.*

I: *So the understanding is, sort of, the learning is the process, then, or*

R: *Yes it is, and then comes the understanding, after I've gone through that part. (p. 3)*

After that she gradually shifted to another statement about understanding.

R: *... Well, then you have a, you know... you can have an aha experience that it's ... that's how it is.*

I: *That's how it is?*

R: *Yes. And if you've experienced that then I think it stays with you for the rest of your life.*

I: *Yes. And what have you got then?*

R: *I've got knowledge.*

I: *You've got knowledge, yes. And what is that, having knowledge?*

R: *(PAUSE) Well ...*

I: *It's not easy. But when you say it, what idea do you want to express?*

R: *Well, it's that you really have learned something ...*

I: *... You really have learned something. ... And what is that?*

R: *... Yeah, that's a good question (laughter) ... you mean, what happens inside the head here? (p. 4)*

Clara was stuck several times in the interview. She did not arrive at what she meant. She was in some way aware of this vagueness but did not take much notice of it. Instead she evaded the issue and finally abandoned it.

Category 2: Relations between utterances and conceptions became explicit as corresponding to each other (15 acts)

The relationship between utterances and conceptions was closer than in category 1. In the acts close links between utterances and conceptions are identified, unlike the acts in category 1.

A summary of the main characteristics of the thinking activity in the acts placed in category 2 is provided in Figure 2. Efforts to construct links and to retain these links between utterances and the conceptions involved are in focus. Mostly through exemplification and by repeating the reasoning, some sort of firm conviction that change is not needed is developed.

Figure 2

Typical characteristics of thinking represented in category 2.

Consistency
Certainty
Effort to construct links
Testing the links with help of exemplification's.
Satisfaction
Stability

The meaning of the characteristics can be understood in relation to the description and exemplification given in the text.

Characteristics of particular interest are certainty, satisfaction and stability since they together exhibit attempts to confirm relationships rather than to question them, a major difference from category 3.

The first extract comes from a nurse called Annie. The subject dealt with in the act is pain and, more specifically, how pain can be observed in patients who are treated on a respiratory machine. Patients who are treated with a respiratory machine are not able to communicate whether they have pain or not; therefore, pain may only be observed.

The act began when Annie pointed out that patients with multiple fractures receive more DIC if they are in pain. So painlessness is an

important prophylactic aim of treatment for patients having a disposition for DIC. When she was asked to explain what she meant by “painless” she answered

R: Painless, that’s when a patient is calm in the face ... you know, you can look as if you’re under terrible strain just from your facial expressions. With smooth, restful facial expressions, with normal pulse and normal blood pressure. You know, what I see in front of me now is an intubated patient. (p. 8)

She then went on to elucidate what she meant by this statement. No problem arose until she had to distinguish between what she meant by a patient under stress and a patient in pain.

R: Yes, a patient under stress doesn’t need to have such terrible pain, you know, ... it’s also a bit complicated for a stress, or a patient who’s under stress all the time because of ... you know, because of how he’s feeling or the treatment he’s getting can be in pain at the same time and react to it. But you can also have ... been given pain killers and still be under stress.

I: And still under stress, yes.

R: Because of general discomfort from feeling that your ... well, you’re probably very giddy in the head because of the drugs. You don’t really know what’s happened if it’s a trauma. You don’t know where you are. You don’t know if there’s anyone with you. You don’t know where your family is. And just thoughts like that are enough to make you feel stress. That you’re trying to communicate but you can’t. It’s hard for you to move. If you move maybe it hurts. You can’t control your thoughts completely because you might have been given morphine and other things. And that gives you stress too. This fluorescent tube on the ceiling, things there that go “bing” ...

I: So by stress and tension you mean different things, then ...

R: I make that distinction, that if you’re under stress you don’t necessarily have so much pain. Although you can have pain too. (p. 10)

R: Well, yes, people under stress like I described last, if they open their eyes, you see the difference. Someone in pain screws himself up, like, and the other kind has a more shifting, more staring gaze. He doesn’t focus anywhere, looking here and there. Yeah, he looks more worried. (p. 10)

After reasoning in this way, Annie returned to the starting point and indicated how painlessness might be observed. Annie has not changed her

conception. She has instead become more convinced of the significance of the expressions on patients' faces as a reliable symptom of pain. She expressed her reaction to the act after its conclusion in this way:

R: I've never structured it like this before. (p. 11)

The next extract is from a teacher called Lotten. The subject covered in this interview was why understanding must be the main focus in basic mathematics teaching, and how such understanding may be reached. Lotten convinced herself about what she meant by her expressions with the aid of examples derived from teaching situations. These examples confirmed the relationships between the utterances and the conceptions.

I: What do you think of when you say understanding?

R: Understanding. I can picture my own daughter when she was about five and her big brother was going to buy these stickers, they cost two kronor fifty each, and he was going to buy three and they were standing there at the counter and Mats was going to take out the money but the assistant hadn't said what it cost, and she, only five years old, she told Mats that it was seven kronor fifty, seven fifty, and I thought, she has a couple of years till she starts school and begins learning one plus two. But she said, "Mats, that's what it'll be, for two plus two plus two is six and fifty plus fifty plus fifty is one fifty, which makes seven fifty, Mats." ... So she had an understanding (replies with great certainty). (p. 4)

I: What do you think of when you say that?

R: (pause) I think that if a pupil ... quite simply has to write down seven and a half plus nine as I said and doesn't think that seven and nine makes sixteen ... seven units and nine is sixteen, then it must be sixteen and a half, but instead aligns them and puts the nine in the column for the tenths, ... well then they don't grasp this and so they have no understanding of what the different figures say. (p. 6)

Often when Lotten had come up with an example, she felt satisfied, or a feeling of confidence that allowed her to explore the subject in more depth. She did not show any need to change established conceptions. There was only the need to establish a conception behind the utterance and to be aware of this established conception. This was also a main feature in the other acts placed in this category. She ended the interview with this statement

R: *Well, you stop to think, I almost said, as an adult you reflect ... in a way, you think that what we said, insight, you want an explanation of that. Understanding, insight and aha experience and those concepts, you think they're really the same thing, don't you, but they aren't really, they're not, because understanding is a specific concept and an "aha" experience is temporary, so you really can differentiate. (p. 14).*

Category 3: Relations between utterances and conceptions changed to new relations where utterances and conceptions correspond to each other (14 acts)

Characteristic of this category is that a change in relationship was established. In order to be placed in this category both the initial and the new relationship had to be accessible for analysis and description. In comparison with acts placed in category 2, those placed in category 3 showed more flexibility when reflecting compared to those in category 2.

The main characteristics of the thinking are listed in Figure 3. Openness to changing established links are the main characteristic of this activity. There was no ambition to escape from periods of uncertainty when links to conceptions were loose. Instead, the approaches adopted allowed the thinker to accept uncertainty during the reflection, a kind of certainty to accept uncertainty. This led to intensive reflection to produce new links. These periods of reflection were frustrating during some acts, but the interviewee showed a greater acceptance of such periods than in the acts placed in the other categories. In some acts placed in this category, this period quickly passed, and in others it was rather lengthy.

Figure 3

Typical characteristics of thinking represented in category 3.

Effort to establish links
Effort to change established links
Agility
A willingness to accept uncertainty
Looking for alternatives
Attention focused on making discrepancies clear

The meaning of the characteristics can be understood in relation to the description and exemplification of the thinking given in the text.

Agility, one of the typical characteristics, means an open and intuitive character of thinking. It is one of the characters that seem to facilitate attempts to question one self and the relationships identified.

The first extract comes from a nurse named Sara; she was also represented in the extracts presented in category 1.

The subject of this act was the cause of unstable blood pressure and how this may be observed in patients with DIC. In the initial part of the act, she was reasoning through what she meant by saying that unstable blood pressure involves fluctuations. She saw a problem with this when it occurred to her that the words unstable and fluctuating in relation to blood pressure do not have the same meaning when related to patients with DIC. Unstable blood pressure, which patients with DIC usually have, is not fluctuating in that it may be at a rather uniform level, but still be considered unsafe blood pressure (it will suddenly shift).

R: Unstable in pressure for me can be either that he has a ... well, only a fluctuating pressure.

I: Fluctuating pressure.

R: Yes.

I: Yes.

R: It could be that he's unstable that he can stress himself so that he varies from high pressure to lower pressure. But unstable can also be that he is totally dependent on drugs. That it's medicine that keeps the pressure at a reasonable level. But that if he lowers his inner ? with drugs then his pressure falls too. Which is drug-dependent. That's unstable too.

I: And if you want to use the two concepts. How would you use unstable or fluctuate...?

R: Well, fluctuating pressure doesn't really need to be, so to speak, a direct cause of illness that your pressure fluctuates out of stress, for example. Then I don't see it as a cause of illness exactly.

I: No.

R: And also that his pressure goes up or down but, but I think that it's quite similar but it can be due to different things.

I: And that's what you mean by ...

R: *But his pressure can fluctuate without me knowing why. His pressure can fluctuate even when he's sedated. He can still be under stress in any case but ...*

I: *If you use unstable pressure. What do you think when you try out this concept in relation to fluctuating pressure, what does it say?*

R: *In an unstable pressure there's an unsafe pressure.*

I: *An unsafe pressure, yes.*

R: *Yeah, unstable is not really safe. Fluctuating pressure can be that he has that kind of pressure and that's that. You can feel safe in the situation all the same. But a stable pressure that suddenly becomes unstable means that there's no safety for the patient, and not for the staff either for that matter.*

I: *No. And in relation to this patient that you said, you said unstable pressure. If after this discussion you now, how would you ... if you look back ... how would you perceive his pressure was then?*

R: *Unstable. (pp. 5–6)*

The extract from the teachers' interviews comes from Martin. Martin was fascinated by his own reflections. He expressed a clear need to gain insight into what lay behind the utterances used. He differs from others in that he engaged in this reflection at a much slower tempo. He took a step and tested it and then he took one more step and tested it and so on. Other acts did not exhibit such a sequence of development, but showed more intuitive and drastic changes.

Martin's initial conception of what understanding mathematics involves was that it means adopting a strategy to solve the assigned problem instead of having only a method of calculation to reach the solution. The first extract shows how he ran into problems in the further discussion.

R: */.../ that they have some kind of, well, strategy, to solve it without just thinking arithmetic. That's what I mean by understanding before skill, you have to train them again to count, of course, for they must have skill in one way.*

I: *Strategy to solve it. What do you mean?*

R: *Well, thoughts ... to be able to think in different ways that you don't always have to do it the same way, that's what I think of as strategy I suppose, being able to change your way of thinking and see what it is ... what*

information to use and is all the information available and do I have to decide something for myself or ...

I: If you say understanding. What do you think of when you say understanding?

R: ... Well, it's a bit hard to explain. You say it so often, don't you. You often wonder if they've understood (laughter) and then they say, yes, ... but really what they have done?

I: Yes.

R: Yeah. Then they've arrived at something ... Yes, what have they understood? On the one hand what they're supposed to do ... what they think you should do, and then they've arrived at some answer too. ... But I don't know how to explain it. (p. 3)

After this he went on and tried different ways to reach a connection to what he saw mathematics understanding ought to be. After a long reasoning phase, he carefully thought through what he meant and what he did not mean. Soon after he reached some conclusions about what it must be.

I: What do you mean by understand?

R: Well, it's being able to compare with something that I have inside me, concretely, some frame of reference that I've been able to acquire in some way, and when I can compare with that then I can understand it.

I: So you can understand.

R: And the more concrete something becomes, the easier it is to understand something (p. 7)

R: No, maybe you don't understand in all situations because some things might go beyond your understanding, it's too complicated and then you maybe don't bother, that I must understand this if I know that I can use it for what I want it for. So maybe it's enough ... But it's just that some situations, because really you should understand as much as possible since I think that if, when you have understood it, then it's easier to remember it. (p. 9)

R: Yeah, that they see what it is, that it's not just something they sit writing during maths lessons ... understand what good it can be to them.

I: Understand what good it can be to them, what use it is.

R: *And then start from what ideas they have about it ... what they think, what they ... yeah, how they think and start discussing from that what they're supposed to do with the information they've been given and see if they can ... see how they should do it. That they decide what they're supposed to do with this, you know, that they test in different ways what happens ... count plus or minus or however they count. (p. 10)*

After reaching a conclusion he experienced certainty. This experience and the reasoning that led up to it can be interpreted as being a change of conception from the initial one. His initial conception was that understanding mathematics means the use of learning strategies in a general way. His concluding conception was that understanding mathematics is the skill in relating problems to a frame of reference developed through previous experience and that understanding is close to the practical use of mathematics.

Discussion and conclusion

The results show that there are different kinds of relationships between speech and underlying thoughts experienced, both within and between individuals. The present study illuminates the most significant differences among the interviewees. The result also shows how different developments are related to the experienced characteristics of the relationships. Some conclusions will now be drawn from the findings. They are grouped according to the three different themes generated by the study.

Differentiation between thought and language

In contrast to research on meaning within cognitive science, the present research provides an alternative approach derived from the phenomenographic tradition (Svensson 1976; 1997; Marton 1981; Marton and Booth 1997) and from the later philosophy of Wittgenstein (Wittgenstein 1974; Baker and Hacker 1980). Wittgenstein argued against a mentalistic view of thought and language, suggesting that language cannot be separated from the nature of human acts and that thinking is more than just a speech act. This view led him to focus on the relationships between understanding, meaning and experiences. These relationships have to be treated in a concrete and specific way, close to practice (apparent in Wittgenstein's connection to pragmatism and gestalt psychology) (Wittgenstein 1967; 1974; Schulte 1995; Segerdahl 1993).

According to Fodor (1976), Rosch (1978) and Neisser (1987), meaning in cognitive science is close to language and definition. Meaning is recovered as it relates to words, or to a network of concepts, in a definable and general way. The ontological question concerning the relationship between words and mental structure lies outside the theory which does not take up this ontological question. This way to approach meaning makes research into student learning within cognitive science less problematic regarding students' thinking and reasoning.

Expressed meaning at the semantic level is not identical to the intentional meaning. Discrepancies between these levels found in the present study stress the need for further clarification, because these discrepancies may have considerable impact on the way students gain understanding and the ways in which understanding is developed. The experiences of personal understanding is not expressed by a package of general associations of concepts (Entwistle 1995).

Bloom has pointed out that research into student learning in cognitive science has paid too much attention to aspects of meaning on a semantic level without analysing the relation to the intentional level and contexts (Bloom 1995; 1992).

In having such an impact, however, it is imperative that we begin to pay attention to the non-semantic components of knowing and to the wider context of meanings and the multiple perspectives or understandings they bring to bear (Bloom 1995: 180).

Svensson (1989) presents the same argument when he differentiates between concept, conception and conceptualisation.

Concept is taken to refer to an abstract and general meaning or structure either as it is present in a language or as it is present within the cognitive potential or repertoire of an individual. ... In our use of the term conception, we refer to the experienced meaning of a phenomenon within a unit of thinking. The meanings described as conception have the character of products of thinking. The thinking through which a conception is constituted is called conceptualisation (Svensson 1989: 531).

Focusing on conceptualisation in this meaning stresses the need for a deeper understanding of relationships between thought and language, which would lead to a deeper knowledge of students' approaches to learning and the nature of understanding.

Different experienced relationships between thought and language

Within this second theme the discussion concentrates on the differences between the categories. The discussion will focus on the differences between category 1 and the other two categories.

The differences between the first category and the other two categories deserve some special attention because they illustrate how an awareness of a lack of meaning may exist as both a trigger for an approach that involves efforts at reaching further elucidation, and as a trigger for an approach that involves efforts to escape from such elucidation. Acts representing the latter approach are placed in the first category. One could say that the acts placed in categories 2 and 3 were reflective and had a character of development, while the acts placed in category 1 were not reflective and showed very few signs of development. My comments will centre the discussion on the “awareness of lack of links”, which was common in all acts.

These periods of lack of meaning may be some kind of intermediate positions, as the students engaged in diverse explorations. Several times they became very confused and uncertain during these periods, and many times feelings seemed to play an important role. In categories 2 and 3 these periods led students to adopt approaches marked by further elucidation, which then led to closer relations between utterances already used and conceptions or to new close relations. Their experiences of these close relations then were combined with feelings of satisfaction.

Emotional components were also a common feature in the findings by Entwistle and Entwistle (1992), in their study on the nature of understanding and the development of understanding as experienced by students. The findings show “that the experiences of understanding generally had a feeling tone associated with it” (p7). Varied expressions of feeling, such as satisfaction, were a common feature derived from students’ recognition of meaningful understanding. Feelings and cognitive processes are seen as inseparable in patterns of understanding and the development of understanding. These findings are in line with findings in the present study, which suggests that emotions serve as triggers for different approaches for different levels or types of intellectual engagement and as a component in students’ expressions of understanding. However, the perspective of this analysis differs from that of Entwistle and Entwistle’s study in that, instead of examining the conception of understanding per se, it studies how the relationship between utterances used and conceptions during the act of

conceptualisation was clarified. This focus on clarification evoked up both feelings of satisfaction and uncertainty.

Among the influences affecting those placed in category 1 there could be a loss of underlying conceptions, or the underlying conceptions could be weak and fragmented. Another crucial influence could be that there are links, but that the relational character is not always experienced as links. Bloom (1995) suggest that unlabelled links could also indicate that students are bored with the subject and not interested in identifying what they mean. This statement stems from findings that examined the usefulness of context maps in elaborating the relationships between meaning and understanding among young children. Context maps serve as a means to uncover links between semantic and personal (non-semantic) contexts of meaning.

The variation in the feelings revealed may be grounded in students' varying tendencies to immediately recognise and describe what they mean by the words they use. There is the usual misconception that the thinking behind the words is taken for granted (Wittgenstein 1974). This misconception is grounded in the idea that every utterance conveys specific thoughts in an unproblematic way. Also, the general picture of thinking as a kind of language is misleading (Wittgenstein 1974) and is grounded in the dualistic-mentalistic conception of relations. There is no translation between speech and thought. Instead the relational character is about the expression of thought (Wittgenstein 1967; Hacker 1990). To express a thought is not to translate it. The relationship is not between inner and outer speech; nor is there simply something in our heads that has a character open to translation. Rather, there exists something that could be more or less expressed. This statement is grounded in the idea that thought is to some extent independent of the capacity to handle a language, while at the same time is dependent on this capacity when we have to conceptualise and express our thought in language. The question in education is whether we lead the students to develop closer links or if we promote a lack of links. The findings in this study raise fundamental questions to teachers and curriculum developers, which need to be addressed. How do students re-formulate knowledge in their own words and how do students explore their personal understanding of a scientific use of words?

Meaning and understanding

The third theme covers one aspect of the nature of understanding and development of understanding to which these results contribute.

Understanding and meaning have been related to each other in several ways and in several disciplines. However, the nature of the relationship is still unclear, as is the definition of understanding (Nickersson 1985; Entwistle and Entwistle 1992; Entwistle 1997).

Failure to understand the fundamental material in high school is the topic of Nickersson's overview (1985), and he discusses several aspects of understanding. One aspect he focuses on is the same as an aspect covered in this article, that is, what some symbols (concepts, numbers, etc.) mean for the student. In his study, Nickersson discusses this as a general problem in education, where the students too often lack the meaning of the symbols they learned, in spite of having completed the courses with fairly good results. Marton et al. (1997) article about Chinese students' ways of experiencing learning focuses on the same aspect, learning both without understanding and with understanding. Different ways of experiencing learning were found: learning by memorising words or learning by relating words to personal knowledge. The differences in learning among the students were in line with the distinctions concerning meaning focused upon in this article, semantic meaning or intentional-referential meaning.

The intentional-expressive perspective adopted in this study focuses on the relationships between language meaning and personal knowledge. It looks at the relation between semantic meaning and intentional meaning, and at how this relation is experienced in the way the words are found to be useful in expressing an understanding of the specific objects referred to.

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Appendix A

Problem presented to the student at the beginning of the interview.

Teachers: Where the basic teaching of mathematics is concerned, there are variations opinions on how it should be organised. Some think that skill should come first, followed by understanding, other thinks exactly the opposite. What would you yourself choose?

Nurses: Using the care of patients with DIC, what do you consider to be most problematic concerning the prophylactic measures that need to be taken and that you as a nurse need to think about.

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