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Micro processes of learning. Exploring the interplay between conceptions, meanings and expressions.

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Abstract

The article describes qualitative variation in micro processes of learning, focusing the dynamic interplay between conceptions, expression and meanings of expressions in students' learning in higher education. The intentional-expressive approach employed is an alternative approach to the function of language use in learning processes. In the empirical investigation, a dialogue model was used that both stimulates and documents students' ways of processing meaning. Results were grouped into three descriptive categories: vague, stabilising and developing ways of processing. Educational implications include, firstly, two distinct types of vague constitution of meaning in learning: one connected to fragmentary relationships between expressions and meaning, and another that triggers and creates close relationships and changes in relationships. Secondly, the categories display different unexplored ways of processing, related to deep and surface approaches in students' learning.

Keywords

Processes of learning, language meaning, micro processes, deep and surface approaches

Introduction

Process-oriented research on learning has initiated an increasing number of studies focusing cognitive styles, learning styles, as well as learning and study approaches (for an overview see Desmedt and Valcke 2004; Cuthbert 2005). Attention has also been devoted to combining different perspectives (Dyne, Taylor and Boulton-Lewis 1995; Vermunt and Verloop 2000). However, in spite of considerable research in the field, the instruments used and the conceptual basis seem only to have deepened the confusion concerning processes of learning (Murray-Harvey 1994; Desmedt and Valcke 2004). What is actually going on from a process perspective still remains an open question. Most efforts have focused on thinking prior to, and after instruction, while the actual process of learning has been overlooked (Roth 1998; Fensham 2003).

In the present article, we suggest an alternative approach to the function of language use in learning processes: the alternative approach - intentional-expressive approach - developed (Anderberg 1999, 2000; Alvegård and Anderberg 2006; Johansson et al. 2006; Svensson et al. 2007; Anderberg et al. 2008) invites to a deeper and more thorough investigation of the actual process of learning from a micro process perspective. The approach forms the basis for an inventory of ways of processing relationships between conceptions and the function of language use in learning. In the present article, we examine micro processing occurring in students' ways of reasoning about a problem in the context of a special dialogue structure. An additional aim is to integrate micro process findings into macro processes of learning.

Theoretical framework

In contrast to research on learning in both cognitive and socio-culturally based theories, the present research is based on an view on the interplay between language meaning and understanding, derived from the Gestalt dimension in the philosophy of Wittgenstein (1974), as developed by Baker and Hacker (1980) and Schulte (1995) and phenomenographic perspective on learning (Marton 1981; Svensson 1997; Marton and Booth 1997). The common argumentation of this view is against mentalistic (Fodor 1976) and structuralistic (Bakhtin 1986) views of thought and language, suggesting that use of language cannot be separated from the actual process and from the learner's perspective. The intentional-expressive approach gives the opportunity to focus relations between understanding and language meaning in terms of the interplay between components inherent in the actual process of learning. A differentiation between the inherent components - conceptions, meanings and expressions - is made to better grasp the complexity, ambiguity and dynamic character of the actual processes found in empirical research carried out by the authors. In *Figure 1*, we show what we regard as the underlying character of the interplay between the components, illustrated as the "broken" triangle (Anderberg et al., 2005; Johansson et al., 2006; Anderberg et al., 2008).

Figure 1. The interplay between conception, meaning and expression: the "broken" triangle

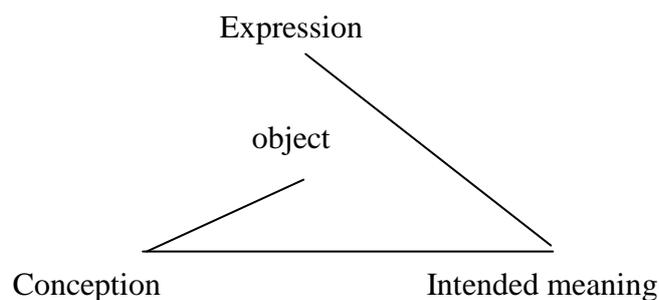


Figure 1 and the "broken triangle" illustrate what we regard as components in expressing understanding of subject matter, as well as some of the fundamental characteristics of the interplay between these components. At the base is what we regard as the foundation of the interplay, while we consider the tip to be more arbitrary with respect to meaning-making in knowledge formation. By "meaning" in the triangle, we refer to how the individual makes use of the linguistic semiotic resources that expressions offer. The meaning is the *intended meaning* that is used by an individual speaker in expressing his or her conception. This meaning is not represented or named, but constituted in actual use of the expression, since any particular expression could be given a number of different and/or overlapping meanings. The broken part of the triangle illustrates that there is no direct knowledge relation between the

expression and the object, or between the expression and the conception (Wittgenstein 1974). The function of the expression is constituted through the ways the conceptualisations of the object are developed and manifested over time (Anderberg, et al. 2008).

The broken character of the triangle illustrates two points of importance. One is that the object that is talked about is placed, not at a corner, but in the middle of the triangle. This illustrates the use of language as related to objects talked about, where the directedness towards the object (in a phenomenographical sense) is put at the centre of the understanding of the use of language. The other point illustrated by the triangle is the idea that there is no direct knowledge relation between a specific expression and conception of the object talked about, but only an indirect relation as part of the conceptualisation of the object. This is illustrated by the fact that there is no line between the expression and the object talked about, nor is there a direct line between the expression and the conception expressed. The triangle does not say anything about the causal or temporal direction of relations between expression, meaning, conception and object. Directions could be in both ways, or interchangeably in one and the other way. The picture illustrates a set of relations between the four components in a situation when a person is using a specific expression to express a meaning that forms part of his/her conceptualisation of a complex object focused and talked about, at a given point in time.

Design

The intentional-expressive approach focuses particularly on how the interplay between conceptions, meanings and expressions is constituted from the student's perspective, using a special dialogue model (Anderberg 1999, 2000; Anderberg et al. 2005) presented below. This gives us access to the interplay, and to how this interplay is experienced, contextualised and developed from the student's point of view. The same dialogue model has been used in three empirical investigations, with a total of 74 dialogues covering different subject areas in higher education (mathematics, nursing, geography and physics).

The participants reflected upon a problem presented to them at the beginning of the dialogue. In investigation one and two, the problem was generated in relation to the courses, and decided upon together with the teachers responsible for the courses the students participated in. Emphasis was placed on presenting a problem that could serve as a basis for meaningful and thorough reflection. In the third investigation, the problem was generated both in relation to an earlier investigation and a course the student had participated in.

Participants were:

Investigation 1: Trained nurses and teachers attending professional specialisation courses for two terms (27 dialogues). Problems presented in the beginning of the dialogue include the following:

Teachers: Various opinions exist concerning how the basic teaching of mathematics should be organised. Some think that skills should come first, followed by understanding, others think exactly the opposite. What would you yourself choose?

Throughout the course this basic problem has been treated as the red thread.

Nurses: Concerning the care of patients with DIC (Disseminated Intravascular Coagulation), what do you consider most problematic relating to the prophylactic measures that need to be taken and that you as a nurse need to think about?

Students had been working on the course with a case of a patient with DIC.

Investigation 2: Students from the teacher-training programme (for upper secondary school teachers and compulsory school teachers). Three dialogues were recorded with each student (24 dialogues with eight students). The problem presented at the beginning of the dialogue was:

How should major flooding be prevented?

This problem was generated considering that students had previously participated in courses in the disciplines of human geography and physical geography, where flooding was one of the issues treated.

Investigation 3: Students from an institute of technology completing a course in mechanics (23 dialogues). The students had participated in two courses in classical mechanics, one in statics and one dynamics. In this second course different coordinate systems were discussed and it had been demonstrated that Newtons' mechanics are only applicable in inertial systems, and not in accelerated systems. As Newtons' second law is "elegant" and "easy" to use, one would like to extend its applicability to accelerated systems, which is done by "introducing" fictitious forces. These constructs, which do not represent any interaction, have as their origin the mathematical relation between the coordinate systems. This issue, as well as several examples had been studied on the courses. Two problems were presented in the dialogue:

What happens when you hit a puck on the ice with a stick?

What happens when you throw a ball obliquely up into the air?

The dialogue model

The dialogue model was expected to lead to shifts from students' reflection about the problem itself, to reflecting on how their conceptions were expressed. The questioning during the dialogue had a special structure, intended to stimulate the students to explicate how they had been thinking in connection with some key expressions used, and their function in expressing the conception of the problem. Thus the focus was shifted during the dialogue, from bringing out students' conceptions of a problem, to students' reflections on how the conceptions were expressed.

1. The original question

The dialogue started with a description of the problem, followed by an initial question about the problem itself. At the beginning of the dialogue, time was spent exploring the students' conceptions of the problem.

2. Analysis of the function of expressions and meanings used

This was done as the researcher selected some of the key expressions with which the conception was expressed, and asked the student to identify what he/she meant by these selected expressions used, why he/she had chosen them, and how this choice was related to their conception of the problem. Questions were posed to lead the students to reflect on the function of expressions and meanings by:

- Articulating relationships between key expressions used and their meanings

- Exploring other possible expressions and meanings
- Identifying the functions of the expressions and their meanings in expressing conceptions of the problem

3. Return to the original question

The dialogue was concluded by returning to the question addressed at the beginning.

Thus, focus was on students' thinking and reasoning about how the conceptions of the object were expressed. In other words, the aim of the investigation was not primarily to capture their conceptions of problems in their field of study, but rather to capture how the conception was expressed. Some time was therefore spent before the dialogue started to inform the students of the purpose of the dialogue and why the dialogue had this particular character. Each dialogue took approximately 30-60 minutes to complete. At the end, the students' own impressions of the whole dialogue were collected. This was important in order to capture major differences between the researcher's and the students' understanding of the process. All dialogues were tape-recorded and transcribed, except two.

Analysis of data

The data gathered resulted in 71 transcribed protocols, each documenting the same general procedure, but displaying considerable variation with respect to how the relationships were handled and the ways students reflected on them from a micro process perspective. The analysis aimed at distinguishing similarities and differences in these variations of the processing, using the methodology of contextual analysis (Svensson, 1976, 1997) in all transcripts. Characteristic of this method is discerning parts and wholes in the material when identifying and grouping different relationships. The aim of the analysis is not to capture all the experiences, or all the processes, but to capture critical variations in educationally relevant ways. A deep micro process analysis was applied to the dialogues, and carried out in several steps. The first step concerned the delimitation of significant parts or sequences of the dialogue, in relation to the dialogue as a whole, and against the background of data from all the dialogues. The later steps of the analysis specified and compared these sequences between the dialogues.

Results

Differences and similarities in how different ways of processing the function of word meanings used in expressing understanding about the problem that was presented have been grouped into three descriptive categories:

1. Vague processing
2. Stabilising processing
3. Developing processing

Vague processing involves fragmentary and passive treatment, as well as vague experience of relationships between conceptions, meanings and expressions. Relationships were seldom identified by the student or described. Typical characteristics were: inconsistency, sporadic and fragmentary efforts to establish connections, and attitudes shifting between assurance and uncertainty.

Stabilising processing involves processes establishing relationships between conceptions, meanings and expressions. Typical characteristics represented here were: efforts to establish links, stability, consistency and certainty.

Developing processing. In these processes, relationships were reconsidered as new relationships, and tested in a flexible and intensive manner. Typical characteristics represented in this category were: efforts to shift/change established links and create new connections; flexibility, and a willingness to accept uncertainty as a basis for further reflection.

One significant difference in the ways of processing concerned how students treated vaguely experienced relationships. When such relationships were identified, they gave rise to diverging reactions: either an attempt to avoid the question, or else the willingness to further reflect in a deeper way on the interplay between the components. When avoiding the issue focused in the sequence, the expressions' meanings were isolated and only sporadically identified. Processes of this kind are grouped into the category "vague processing". In very reflective dialogues (stabilising and developing processing), vague experiences of relationships were also rather common. In these dialogues, however, they played an important role as intermediary steps, compared to the group of processes that represented an avoidance of this type of reflection. Inversely, whenever reflection was deepened, the relationship of the verbal expression employed and its meaning with respect to the problem in question was more closely identified, relationships were clarified, and in some processes a change in relationship developed.

Below, excerpts from the transcripts are taken out and presented to illustrate the main characteristics of the categories. However, in qualitative process studies, illustrating findings can be exceptionally difficult. In general, one is restricted to providing short extracts illustrating a categorisation which in fact was based on the process as a whole.

1. Vague processing

Processes grouped into this category presented vague characteristics. With this we mean that in the dialogue, treatment of the interplay between conceptions, meanings and expressions was more fragmental than in the processes placed in the other main categories. In vague processes the students show a great acceptance of vaguely identified relationships, compared to processes in the other categories. The meaning of the selected expression was mentioned, but not explored further, in spite of lack of assurance and great hesitation. Consequently, the relationships were seldom identified and the conceptions involved were taken for granted

The reflection on what a formulation stood for often became isolated, when the students refrained from identifying more closely what was meant by the selected expression in relation to the problem. Acceptance of the vague character of experienced relationships without any further reflection was a main characteristic. Although such acceptance was occasionally present in some segments of the way of processing placed in the other main categories, in those categories it was usually followed up with the ambition to identify more distinct relationships.

The first extract is taken from a dialogue with a nurse, Eva, reflecting on different expressions she had used while expressing her conception of prophylactic measures in the care of patients with DIC. One of the measures she had observed was the patients' "breathing pattern". The extract from this dialogue illustrates a phase in the vague way of processing:

R: *Yes, it's this business of kidney functioning and urine production, if it deteriorates then these microclots form, just like I said before, and then with respect to breathing if they change their breathing pattern.*

I: *What do you mean by breathing pattern?*

R: *Well, it's usually the case that they raise their breathing frequency, so to speak.*

I: *Breathing pattern, raised breathing frequency, can you think of anything else?*

R: *(pause) Well, the result is that the saturation goes down ... and that they maybe work more to exert themselves to get air.*

I: *They exert themselves more, as if they ... the breathing pattern is changed in what way?*

R: *Well, they maybe raise their shoulders more or need to sit up more in bed to make it easier and /.../ (p. 8)*

Eva's response to the question of what she meant by "changed respiration pattern" in describing patients was "Well, it's usually the case that they raise their breathing frequency" and "and that they maybe work more". These answers were interpreted in the analysis as lacking in a distinct use of meanings of the expressions "breathing patterns". The vague character of constitution of relationships lies on two levels. First, "usually the case" and "they maybe" express vague distinctions. Secondly, "raise their breathing frequency" and "work more" delimit rather vague and unclear conceptions of breathing patterns as such. Her delimitation of "breathing patterns" could, for instance, not be immediately applied to direct measurements of patients' values using instruments. During the process as a whole, Eva did not express any need to clarify or to identify more closely what she meant by "breathing pattern", or to delimit more precisely the meaning of the expressions she had used with respect to her conceptions of breathing patterns in patients with DIC.

The next extract is taken from one student dialogues in classical mechanics, a second year student of technology. The problem presented was: *What happens when you throw a ball obliquely up into the air?* The extract shows how Oskar's way of reasoning turns out to be problematic, since he uses the expressions 'force' and 'energy' with dual meanings. On the one hand, in Oskar's way of conceptualising the motion, "force" gives "energy" and, on the other hand, both "force" and "energy" influence and explain changes in the way the ball moves:

R: *It's the same thing – I see a picture in front of me with a ball moving through the air, and I see different forces affecting the ball. I don't think directly, because kinetic energy is just a kind of energy affecting the ball. Then you have a lot of other forces, such as gravitational force and potential energy and things like that. So kinetic energy is actually just a form of energy affecting the trajectory of the ball.*

Here Oskar uses the expressions 'force' and 'energy' in order to express his conception of what influences the actual motion of the ball. He puts kinetic energy on the same footing as gravitational force and potential energy, as examples of force.

I: *What are you thinking of when you say that it is a form of energy which affects the trajectory?*

R: *Well, there are many other forces that change the ball's energy, such as air resistance and gravitational force and other forces affecting the ball's final energy. That is how I think.*

I: *Final energy? What's that?*

R: *When all the forces have cancelled each other.*

In this part of the dialogue, the expression 'force', for example gravitational force, is given the meaning of being a cause of change of 'energy'. The expression 'force' could thus be seen, both as a more general expression for summing up the meanings of "force" and "energy", and with a more limited meaning of force as a cause of change in energy.

I: What about potential energy? How did you get to the idea of using that expression?

R: Yes, well the potential energy of the ball changes when the ball rises and sinks, as you might say. Of course I know that the term exists if you take a body and raise it to another height, so I know it exists as a term, potential energy. So that was just something that popped up.

I: What do you mean when you say "I know that the term exists"?

R: What I mean? Well, I have really studied so much physics that it, well, it feels self-evident. Particularly throwing movements and kinetic energy and that sort of stuff. I actually don't know why I used it. It feels so trivial. (p.5)

Oskar avoids the issue of the uncertainty he experienced when using these expressions to describe his conceptions of the ball's movement, and does not attempt any further reflection on how the expressions are used. He rather expresses self-confidence about knowing the expressions, in spite of not knowing how to use the meaning of the expressions adequately when explaining the ball's movement. Oskar's reasoning in this dialogue is an example of vague processing of the interplay between the components. In spite of the problems he has to find out the function of the meanings used in expressing his conception and explaining the ball's movement, he does not further clarify the relationships between the components. It was "trivial" for him to find out the relationships between the meanings suggested and the conceptions of the object (in other words, to explore the baseline of the broken triangle). Rather he seemed to be satisfied to assume a direct relation between expressions and conceptions of the object (what we have called the broken line of the triangle). The problem with his use of the expressions illustrates a central and general problem students have, that reproducing disciplinary language use/ways to communicate disciplinary subject matter, does not guarantee a disciplinary understanding.

2. Stabilising processing

Strengthened constitution involves processes of establishing relationships between conceptions, meanings and expressions, and being more precise in exploring and identifying such relationships. Processes placed in this category represent an effort to identify meanings behind the expressions used, in close relation to how the problem in question was approached (the baseline of the broken triangle). Low acceptance of vaguely experienced relationships was combined with exploring and identifying meaning connected to conceptions of the problem.

The main difference in Category 3 is that the way of processing the interplay became more self-questioning, intense and developing than in Category 2, where the students showed more of an attempt to confirm relations between expressions, meaning and conception, rather than to question them.

The next extract is from a teacher named Britt, chosen to exemplify the processes placed in this category. The clarity of the interplay experienced came through an activity that also specifies the conception of the teaching problem presented: *Various opinions exist concerning how the basic teaching of mathematics should be organised. Some think that skills should*

come first, followed by understanding, others think exactly the opposite. What would you yourself choose?

I: What about directing? Have you any other expression you could think of to describe what you mean by that?

R: Well, I give them hints and ideas.

I: Hints and ideas, yes.

R: But not, not facts like (bangs on the table) but I, I ...

I: What are hints and ideas? What are you thinking of?

R: Well, it's more a case of making something clear, like a picture, or that by experiment and measurements or the like they arrive at something, you know, I think that directs them a bit. You can take the circle, for example, you have to calculate the circumference of a circle, I would call it facts if I go to the board and write the circumference of a circle is pi times the diameter, I want you all to work out these figures, that's like what I would call facts, but if instead I give them a tape measure and things like that and say I want you to go out and measure all the circles you can find and calculate the circumference and the diameter, then I have directed them, that's what I call directing them, and then that we work with that, let's see if we can combine this, you could add or divide or something and like that and then if they don't arrive at anything I direct them, could you think of dividing the circumference by the diameter and see what you get, and then if they see some relationship then it's roughly three all the time, it doesn't matter whether it's big or small circles, then ... but I have still directed them.

I: You have directed them.

R: Yes, I think I have to, for I can't expect that they themselves, the way they're carrying on now it might have taken them maybe two weeks before they arrived at it.

I: And what do you mean by hints and ideas, then?

R: Well, that I say that now you should go out and find circles outside or in the school or in the classroom or whatever. I'm the one who has to tell them what they should do, that's what I call hints.

I: You call that hints?

R: Yes, and maybe I might produce a little sheet, a page of exercises for them to do, and that I, I ... You have to direct them towards what they have to do.

I: Yes. And if you say directing or hints or ideas do you see any difference in the way you would use these expressions?

R: No. It's roughly the same thing, just that I use different words.

I: You mean, you feel that they're roughly the same?

R: Yes, sure, yes. (p. 4-5)

The excerpt involves Britt reasoning on her ways of teaching the “circle” and the “tape measure”, and the ways she makes clarifications of distinctions between her use of the expressions ‘directing’, ‘facts’ and ‘hints and ideas’. In the process she divides the conceptions of the problem into different areas of mathematics - in this excerpt mainly geometry and equations.

3. Developing processing

Developing processing also involved vague experience, but in these processes the interplay between expressions, meanings and conceptions was questioned more extensively, testing new relationships in a more flexible and intensive manner, compared to the processes placed in Category 2. The somewhat open and intuitive character of ways of processing facilitated both identification of relationships, and change in relationships.

Sara, a nurse, began by seeing the DIC patients' "unstable" blood pressure as "fluctuating" blood pressure when reasoning concerning prophylactic measures that need to be taken in the care of patients with DIC (Anderberg 2000).

I: This unstable pressure. What do you mean?

R: Unstable pressure for me can mean either that he has a, that a fluctuating pressure just. (p. 6)

A further step in the process shows that she was not satisfied with the meaning of "unstable" blood pressure is simply fluctuating blood-pressure. The vagueness of meaning of the expression she had used gave rise to further reflection, where she identified that fluctuating pressure was rather common, and that fluctuations could sometimes be safely attributed to stress, drugs and illness:

R: It can be that he is unstable, that he can get all stressed so that he varies from high pressure to lower pressure. But unstable can also be that he is wholly dependent on medicines. That it's the drugs that keep the pressure at a reasonable level. But if you lower your internal ?? with drugs then his pressure goes down too. Which is drug dependence. That's unstable too. (p. 7)

R: Yes, a fluctuating pressure doesn't need to be, so to speak, a direct cause of disease that you fluctuate in pressure because of stress for example. I don't see that as a cause of disease exactly. (p. 7)

The ensuing exploration confirmed her conviction of what safe blood-pressure was, and what she regarded as unsafe, and ended in the following way:

R: An unstable pressure is an unsafe pressure.

In the process she focused her conceptions of unstable blood pressure for DIC patients: it does not usually fluctuate, but is still an unstable pressure. She found that patients with DIC usually have a blood pressure at a uniform level, but that patients with DIC shift blood-pressure suddenly. Therefore, she did not replace the expression 'unstable' by 'fluctuation', since fluctuation for her also reflected a safe stable blood pressure that was not supposed to shift suddenly:

R: Well, unstable means that it's not really safe. Fluctuating pressure could be that he just has that kind of pressure and that's that. Then you can feel secure in that situation in any case. But a stable pressure that suddenly becomes unstable does not give any security to the patient, and not to the staff either for that matter.

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

R: Unstable. (p. 7)

This shift of meaning of the same expression 'unstable blood-pressure' was related to the fact that different interpretative frameworks were identified for patients with DIC: stressed patients, patients treated with drugs and with different kinds of illnesses. It was through the process of identification of these frameworks that the meanings of fluctuations ("safe" and "unsafe"), became obvious, and then the meaning intended by the expression 'unstable' shifted to also mean a blood pressure that is stable, but suddenly could shift, although the expression remained the same. This way of processing developed new meanings associated to the key expressions used.

The next extract is from the dialogue with Urban, also a student of technology. The problem presented was: *What happens when you throw a ball obliquely up into the air?*

Urban initially has a problem with the physical terms he used, since the meanings are not clear to him. However, when this vague meaning is experienced, he reflects further on the physical terms and meanings he had used to explain the ball's movement:

I: What made you think of centrifugal force? How is that involved in this case?

R: I suppose it has to do with inertia. It is a way to explain what inertia is.

I: Could you use another expression than inertia to describe what you want to say?

R: It's just that you get stuck to the words you have learned. (pause) No, nothing I can think of now.

I: This inertia, does it only apply to a horizontal direction so to speak?

R: Of course it also applies in a vertical direction.

I: And then you had "gravitation". What did gravitation do?

R: That is what makes the ball come down again.

I: Yes.

Trying to find an appropriate expression to express his meaning of the expression 'inertia', Urban uses the expression 'centrifugal force'. Within the discipline, however, this construct is seen as a fictitious force, only indirectly coupled to inertia. In the continuation of the dialogue, Urban tries to further explain the meaning he conveys to the expression 'inertia':

R: It has to fight what you might call a battle, with inertia, right at the beginning, before the ball reaches the highest point. From there on you have a, then gravitation takes over and pulls it downwards.

I: What - -

R: - - You might say that it conquers inertia there. Because inertia is... The velocity upwards decreases because we don't have a force acting upwards, just a force acting downwards.

I: So what does that imply?

R: At the end it implies a ball which comes down.

I: But in relation to the expression you had, inertia?

R: It means that the velocity upwards decreases. Against inertia you, well inertia is a mass velocity or whatever you would call it, somehow. Mass is constant in this case. So when velocity decreases, in one way inertia decreases,

I: So what were you thinking of when you used the word mass velocity?

*R: Well, in fact, $m * v$ quite simply. (p. 6)*

Inertia is thought of as something that has to be overcome. In this context, Urban connects inertia to something which decreases as the ball moves upwards. He uses the expression ‘mass velocity’ and expresses his meaning through a formula – actually the same formula that is used in the discipline for expressing momentum. But Urban is not satisfied with the way he used expressions while explaining the ball’s movement, and in the last part of the dialogue he goes on to further reflect on the meanings of the physical terms he used:

R: Well, it has to be a force field, so, because it has an effect all around the earth.

I: Whereas air resistance would be a force, or?

R: No, that also becomes a force field. Now things are getting complicated. (pause) Well yes, but that is what it has to be somehow. (pause) Well, I’d better not say anything about that.

I: And then we had centrifugal force.

R: Which is not a force.

I: Which is not a force. So then it isn’t a force field either?

R: No, it is an inertia.

I: So how does it enter your discussion? Because you did bring it up right at the beginning.

R: Yes. (pause) It, (pause) Well, it’s got to do with a circular motion, or part of that sort of motion, and that the ball wants to strive forwards in the direction it has right at that moment.

I: So, how do inertia and centrifugal force fit together? With respect to this ball we are throwing?

R: Eh, (pause) The centrifugal force, which didn’t exist... Mass inertia strives to make the ball continue but is opposed by air resistance and gravitation.

I: So how do you see the actual difference between mass inertia and centrifugal force?

R: (Pause) Centrifugal force, well then you’re thinking about what is pulling outwards. Something is attached in the centre. Mass inertia is what makes the ball want to continue forwards, but which is then prevented by centrifugal force which pulls the ball inwards. (p. 10)

Urban introduces a new expression, ‘mass inertia’, to replace ‘mass velocity’. At the same time, he focuses on a property *per se* of the movement, and not on the change. We have interpreted this as shifts in both expressions and meaning. He then also returns to the expression ‘centrifugal force’, distinguishing its meaning from the meaning of ‘mass inertia’, and here we have a shift of meaning, but not a shift in expression.

In spite of the problems he experiences using physical terms, and the numerous steps involving vague experience which occur in this dialogue, Urban does not give up, or attempt to break away from the process of clarification the relationships between meaning used and conception, the baseline of the broken triangle (fig. 1). This is a fundamental difference from the dialogues placed in the category “vague processing”. During the process, Urban develops the interplay of expressions and meanings used, constantly reconsidering the relationships between expressions, meanings and his own understanding.

Discussion

This paper is about micro processes of learning. More particularly, it shows how different ways of processing on the word meanings used in expressing understanding about problem presented. The investigations carried out in this study range across several domains and have general implications. The intentional-expressive approach adopted (Anderberg 1999, 2000; Alvegård and Anderberg, 2006; Johansson et al. 2006; Svensson et al., 2007; Anderberg et al., 2008) provides results showing new qualities perceived in the processes of learning, and in the following discussion we shall pay particular attention to these qualities as such.

Micro process qualities

The three ways of processing the interplay between conceptions, meanings and expressions distinguished above represent essential characteristics of the processes in these dialogues. The vague way of processing, characteristic of the dialogues placed in Category 1, was also represented in the other two categories as a part of the dialogues, which we called vague experience of relationships. We see that three ways of processing the interplay between conceptions, meanings and expressions were exclusive, while vague experience of relationships was inclusive. Vague processing and stabilising processing are both of major interest, since these two ways of processing lead to negligible change, and much research on learning shows that students' learning is in fact relatively resistant towards teaching. The closer study of these types of processing could therefore provide clues to how and why students maintain the stability of pre-existing conceptions.

An important educational implication, drawn from the different characteristics displayed in the micro processes of the dialogues is that it is not *vague experience* which causes problems, but rather the *vague processing* of the interplay between conceptions, meanings and expressions. Vague experience was actually most common in those dialogues where the dialogues were marked by developing processing. Vague experience here played a role as an intermediate step, which was not the case in the dialogues grouped into the category "vague processing". Vague experience displayed in the category "vague processing" was not connected to any effort to establish or change links in the interplay of relationships, resulting in a dialogue which as a whole was vague and fragmented. The presence of vague experience in the interplay between conceptions, meanings and expressions appears to be an integral part of the processes of learning. In education, we need to devote increased attention to helping students experience the interplay between conceptions, meanings and expressions during the micro-learning processes, and in that way foster awareness of their conceptual knowledge, thus opening the path to change of understanding subject matter.

Furthermore, the dialogues with the students show considerable differences with regard to *passive* and *active ways* of processing the interplay between conceptions, meanings and expressions. These differences have consequences for how the interplay of the relationships between the components was constituted. When the students were unsure about what they meant by an expression, they would either avoid further constitution (Category One), or adopted an activity that eventually either led to clarification (Category Two) of the interplay, or else brought about shifts of relationships (Category Three).

Micro- and macro processes of learning

So how can the findings in this study be integrated into macro processes of learning, including both Information processing and SAL perspectives? According to Schmeck and Geisler-Brenstein (1991), in the revised version of ILP (Inventory of Learning Processes), the second major division, reflective processing includes three subscales: deep-processing, elaborative processing and self-processing. This research within the Information processing perspective

concerns macro processes, focusing on relationships between personality variables and learning styles. We see that reflective processing, as defined above, is in a way compatible with findings in this study, since the subscales have been found to be very influential on learning processes with regard to developing ways of expressing oneself. While reflective processing is based on students' formulation of statements about their process over a fairly long stretch of time, the ways of processing found in our own investigations are based on the actual process of self-expression during a limited time. We see that the results of analysing micro processes provides a complement to the macro process analysis of learning, especially concerning the processing regarding the categories "stabilising" and "developing processing". The common characteristics of these two categories concern especially the willingness to reflect, and the efforts to both identify existing relationships and change identified relationships in self-expression. However, we see these characteristics more as content related than related to personality.

Stabilising (Category Two) and developing processing (Category Three) both involve a search for intended functional relationships between the components of the interplay: conceptions, meanings and expressions, and vaguely experienced relationships were treated in intermediate steps, linked to feelings of confidence or lack of confidence. These ways of processing the interplay represent essential qualities inherent in a deep approach to learning (Svensson 1976; Marton and Säljö 1976; Entwistle and Ramsden 1983) within SAL perspectives in that they enable close relationships between conceptions, meanings and expressions relating to the problem (object focused) when clarifying the relational-functional character of how the interplay of relationships is identified. By contrast, vague processing (Category One) exhibits qualities inherent in a surface approach to learning.

Socio-cultural research on learning

The intentional-expressive approach deals with the process of interplay between conceptions, meanings and expressions, a process that often seems to be taken for granted in one orientation in socio-cultural research on learning. In this orientation that stems from Vygotsky (1975) and was further developed by Wertsch (1998) - language is seen as a "mediating tool" for understanding, without considering how students learn about how that tool is used, or the function of the use of language in expressing understanding of subject matter. The process of mediating differs from the micro processes investigated and the particular approach adopted in this study, in that socio-cultural research on learning, on the one hand does not differentiate between the components in the process of learning illustrated in the broken triangle (see *Figure 1*), and on the other hand, that a "mediated" language use does not always "mediate" understanding. For instance in Category 1, the vague way of processing, language is used without a clear awareness of what is expressed or learned about. According to Wertsch (1998), expressions used mediate both meaning and content/understanding. Consequently, meaning and content/understanding coincide, and are followed by the expression used. In other words, learners are "guided" through appropriating patterns of talk in different discourses. We see consequently that the learner's perspective on the interplay between understanding, meanings and expressions is mostly taken for granted in research, and how the relationships are constituted between these components inherent in the process of learning is not seen as problematical. The intentional-expressive approach therefore gives opportunities to come closer the function of language use in expressing understanding from the learner's perspective.

Further research

Incorporating the learner's perspective on the interplay between the components raises new, central and basic questions concerning how fruitful relationships between language meaning and understanding are constituted, developed and contextualised from the learner's perspective in an ongoing activity. We have in the present study seen that the categories found point to fundamental questions about processes of learning that have not been sufficiently taken into consideration in current research practice. We therefore argue that the intentional-expressive approach would be a particularly fruitful field for further investigation, both to explore the theoretical relevance of this approach on the relationships between language use and understanding in processes of learning in phenomenography, as well as by extending practical and methodological applications to other areas in teaching and learning.

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References

- Alvegård, C. & Anderberg, E. (2006). *The interplay between content, language meaning and expressions*. Paper presented in the symposium The interplay between language and thought in understanding problems from a student perspective at AERA (American Educational Research Association) Annual Meeting, San Francisco, April 8-12.
- Anderberg, E. (1999). *The relation between language and thought revealed in reflecting upon words used to express the conception of a problem*. Diss. Lund: Lund University Press.
- Anderberg, E. (2000). Word meanings and conceptions: an empirical study of relationships between students' thinking and use of language when reasoning about a problem. *Instructional Science* 28, 89-113.
- Anderberg, E., Alvegård, C., Svensson, L. & Johansson, T. (2005). *Språkanvändning och kunskapsbildning*. Rapport nr 85, Pedagogiska institutionen, Lunds universitet. [Http://www.pedagog.lu.se/forskning/research_programme_for_language_use_and_individual_learning/publications/](http://www.pedagog.lu.se/forskning/research_programme_for_language_use_and_individual_learning/publications/)
- Anderberg, E., Johansson, T., Svensson, L. & Alvegård, C. (2007). The epistemological role of language use in learning. *Educational Research Review*, 3(1), 14-29.
- Baker, G.P. & Hacker, P.M.S. (1980). *Wittgenstein: Understanding and Meaning, an Analytic Commentary on the Philosophical Investigations. Vol. 1*. Oxford: Basil Blackwell.
- Bakhtin, M.M. (1986). *Speech genres and other late essays*. Caryl Emerson & Michael Holquist (eds). Austin: University of Texas Press.
- Cuthbert, P. F. (2005). The student learning processes. Learning styles or learning approaches. *Teaching in Higher Education*, 10(2), 235-249.
- Desmedt, E. & Valcke, M. (2004). Mapping the learning styles "jungle". An overview of the literature based on citations analysis. *Educational Psychology*, 24(4) 445-463.
- Dyne, A.M., Taylor, P.G., & Boulton-Lewis, G.M. (1995). Information processing and the learning context. An analysis from recent perspectives in cognitive psychology. *British Journal of Educational Psychology*, 64, 359-372.

Entwistle, N.J. & Ramsden, P. (1983). *Understanding student learning*. Beckenham: Croom Helm.

Fodor, J.A. (1976). *The Language of Thought*. Hassocks: Harvester Press.

Fensham, J.P. (2003). *Defining an identity. The evolution of science education as a field of research*. Dordrecht; Boston: Kluwer

Halldén, O. (1997). Conceptual change and the learning of history. *International Journal of Educational Research*, 27(3), 201-210.

Johansson, T., Svensson, L., Anderberg, E. & Alvegård, C. (2006). *A phenomenographic view of the interplay between language use and learning*. Pedagogical Reports Nr 24,. Lund: Department of Education, Lund University.
http://www.pedagog.lu.se/forskning/research_programme_for_language_use_and_individual_learning/publications/

Marton, F. (1981). Phenomenography. Describing conceptions of the world around us. *Instructional Science*, 10, 177-200.

Marton, F. & Säljö, R. (1976). On qualitative differences in learning 1. - Outcome and process. *British Journal of Educational Psychology*, 46, (4-11).

Marton, F., & Booth, S. (1997). *Learning and awareness*. New Jersey: Erlbaum Associates.

Murray-Harvey, R. (1994). Learning styles and approaches to learning. Distinguishing between concepts and instruments. *British Journal of Educational Psychology*, 64, 373-388.

Roth, W.M. (1998). Learning processes studies. Examples from physics. *International Journal of Science Education*, 20(9), 1019-1024.

Schulte, J. (1995). *Experience and expression. Wittgenstein's philosophy of psychology*. Oxford: Clarendon Press.

Schmeck, R.R. & Geisler-Brenstein, E. (1991). Self-concept and learning. The revised inventory of learning processes. *Educational Psychology*, 11(3), 343-362.

Svensson, L. (1976). *Study skill and learning*. Göteborg: Acta Universitatis Gothoburgensis.

Svensson, L. (1997). Theoretical foundations of phenomenography. *Higher Education Research & Development*, 16(2), 159-171.

Svensson, L., Anderberg, E., Alvegård, C. & Johansson, T. (2007). The interplay between language and thought in understanding problems from a student perspective. Pedagogical reports no 26. Lund: Department of Education, Lund University.
http://www.pedagog.lu.se/forskning/research_programme_for_language_use_and_individual_learning/publications/

- Svensson, L., Anderberg, E., Alvegård, C. & Johansson, T. (2008). The use of language in understanding subject matter. *Instructional Science* <http://dx.doi.org/10.1007/s11251-007-9046-1>
- Vermunt, J.D. & Verloop, N. (2000). Dissonance in students' regulation of learning processes. *European Journal of Psychology of Education*, 15(1) 75-87.
- Vygotsky, L. S. (1975). *Thought and language*. Cambridge, Mass: MIT Press.
- Wertheimer, M. (1959). *Productive Thinking*. New York: Harper & Brothers.
- Wertsch, J. M. (1998). *Mind as action*. New York; Oxford: Oxford University Press.
- Wittgenstein, Ludwig. (1974). *Philosophical Investigations*. G. E. M Anscombe (trans.). Oxford: Blackwell.