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‘What do you know about fat?’ Drawing on Diverse Funds of Knowledge in Inquiry Based Science Education

Abstract

Connecting students' worlds, knowledge and experiences with school science has been a central issue in science education research. Here, we conceptualize processes of drawing on students' personal experiences and knowledge in terms of 'funds of knowledge'. We scrutinize two sixth grade classroom practices where the inquiry curriculum reform effort, Naturvetenskap och teknik för alla (NTA), is used. This curriculum material explicitly incorporates ideas of 'learning science from experience'. Our aim is to contribute to a discussion on what conditions of inquiry based science education (IBSE) practices may open up opportunities for science to become personally relevant to students. The research question investigated is: What do students do when they draw on funds of knowledge that are related to students' memberships and experiences out-of-school in IBSE practices? We then use Cultural-Historical Activity Theory framework to analyze how students' actions of drawing on different funds of knowledge gain meaning in relation to different cultural-historical motives. Our findings indicate that students, when positioning themselves as part of different communities in relation to different goals and overall motives, make use of quite different funds of knowledge. Finally, we discuss possibilities for expanding and acknowledging students' funds of knowledge when working with investigations in the science classroom.

INTRODUCTION

A central issue for educational research is how education may contribute to the personal development of children. In a developmental teaching tradition this involves helping children to "gain insight into and a capability for using subject-matter traditions to better understand the social and natural world" (Hedegaard & Chaiklin, 2005, p. 11). A necessary condition for developing such classroom practice is that children are offered opportunities to expand personal experiences with academic concepts in the classroom. Here, we conceptualize processes of drawing on students' personal experiences and knowledge in terms of 'funds of knowledge' (cf. Calabrese-Barton & Tan, 2009; Gonzales & Moll, 2002; Moje et al., 2004; Moll and Greenberg, 1990; Moll et al., 1992). We do this to scrutinize students' possibilities for expanding diverse funds of knowledge when working with investigations in the science classroom.

A design research study on teaching food and nutrition by Calabrese-Barton and Tan (2009) illustrates that it is possible to create science classroom situations where students are offered opportunities to draw on household funds of knowledge about food and cooking and to apply scientific knowledge to their daily living. Another example is given by Upadhyay (2006) who describes a case study of how a female elementary teacher, as part of a practice developing program, integrates her life experiences with that of her students. However, when looking at everyday science classroom practices, as in the study of Moje et al. (2004), young people appear to rarely volunteer to share personal experiences in the classroom whereas they are able to relate a variety of family and household activities to science issues when questioned during interviewing. In sum, we know from previous research that it is possible for researchers, teachers and students to collectively create classroom practices where students are given opportunities to draw on diverse funds of knowledge but that this probably is not common practice in schools. There is thus a need for further exploration of conditions for offering students opportunities to expand personal experiences in the science classroom.

Funds of knowledge in activity

The concept funds of knowledge was developed by Moll and Greenberg (1990) and their concept refer to knowledge and skills gained through historical and cultural interactions that are essential for individuals to function in their community. Funds of knowledge are conceptualized as embedded in practice, in what individuals and communities do, in their personal and collective histories (Gonzales & Moll, 2002). The concept funds of knowledge has been used to focus on social sharing of knowledge and incorporating ideas, interests and activities of students and their families into classrooms. Moll and Greenberg argue that by developing social networks that connect classrooms to outside resources it is possible to transform classrooms into more advanced contexts for teaching and learning.

From a Cultural-Historical Activity Theory perspective (CHAT), what personal experiences, or funds of knowledge, students draw on in science education needs to be understood as inevitably embedded in activity and shaped by the goals, desires, demands, and traditions constituted through practice. Säljö and Wyndhamn (1993) have given empirical evidence for the notion of different school subjects as different contexts of thought. They showed that the meaning of the actions students engage in, when they were solving a given 'everyday problem', differ in different school subjects (they gave students in Mathematics and Social studies, respectively, a task to calculate what it would cost to send a letter by using a table of postage rates and received different types of answers in the different classes relating to traditions of Mathematics and Social Studies). This is in line with Lave's (1988) findings of arithmetic problem solving being built into setting and activity. Lave shows that one cannot understand the context of arithmetic practice, e.g. in the supermarket, without considering the experienced dilemmas of the person engaging in activity in a particular arena, i.e. the person shopping in the supermarket, in relation with which the setting and further activity is constituted. In a previous study, in one Swedish lower secondary science classroom practice, we showed that when 'everyday life' problems were brought into the science classroom – by a teacher, textbook or other resource –

the contexts were inevitably transmuted; the 'everyday-life' problems became classroom tasks and part of school culture (Andrée, 2005). In this classroom practice 'everyday-life' examples were used to illustrate science concepts and as examples to be analyzed and classified, whereas relevance to students' everyday-lives or issues of citizenship was not constituted as primary goals (op cit).

When scrutinizing science education practices, previous research shows that different students may be engaged in activities corresponding to different objects/motives, i.e. the activities students engage in gain meaning in relation to different societal needs (cf. Leontiev, 1977/1986). This means that what students do together in the science classroom may mediate quite different activities. Hasse (2002) found, in a study of university Physics education at the Niels Bohr Institute, that students and teachers were motivated by two related, but different, objects of activity; education and science. The object of education activity was related to actions aimed at solving exercises and passing exams, and a division of labor where students and teachers collaborate in a production of education. The activity of science was related to preparing future scientists; involving predominantly male students transforming educational tasks by making up their own experiments. We have found similar differences in Swedish lower secondary science education, where students engaged in two different activities relating to different objects (Andrée, 2007; 2011). One activity was related to an object of science enculturation corresponding to a transformation of the student as knowledgeable in, and part of, a cultural community of science, the other activity was related to an object of science education corresponding to a transformation of the student as formally qualified.

IBSE as a way of recognizing 'what students already know' in classroom practice

In this article we look closely at one curriculum reform effort of IBSE that incorporates ideas of 'learning science from experience' in a Swedish school setting. IBSE has been attributed great promise as an instructional approach. It has been identified as a 'key-approach' to primary science education (Harlen, 2009), and recommended as the 'renewed pedagogy for the future of Europe' (European commission, 2007). The considerable investment in IBSE curricular policy and practice calls for in-depth research into how such initiatives may, or may not, be developed in order to promote students' science learning.

Our study was conducted in two Swedish classroom practices where a program called NTA (*Naturvetenskap och Teknik för Alla*) is used (for an introduction see Wickman, 2007). The NTA program aims at supporting municipalities in their in-service training of teachers in science and technology related subjects. The NTA program consists of units, ranging in target groups from pre-school to the last year of compulsory school (school year 9 in the Swedish school system), e.g. *The Chemistry of food, Sink or float, From seed to seed, Life of Butterflies, Properties of matter*. The NTA curriculum program is described on the NTA website (www.nta.se) as "a question-based inquiry oriented way of working based on experiments" aimed at giving students opportunities to "work as researchers". Today, NTA has become a widespread curriculum program in Swedish primary school, involving 104 municipalities throughout Sweden (NTA, 2011a). An evaluation of the program shows that students, who had been attending NTA classes, registered better results concerning learning about scientific concepts and the nature of science than those students who had not experienced NTA (Anderhag & Wickman, 2007).

Teachers using the NTA-material are specifically instructed to create situations where science content is to be related to what students already know about a topic. In this article, we study what opportunities the NTA practices offer for linking diverse funds of knowledge with canonical science content. Our aim is to contribute to a discussion on what conditions of IBSE practices may open up opportunities for science to become personally relevant to students. The research question guiding our study is: What do students do when they draw on funds of knowledge that are related to students' memberships and experiences out-of-school in IBSE practices?

METHODOLOGY

This article reports from a cross-disciplinary project on learning, narrative knowing and remembering with use of different technology (the LINT project). Our study, which focuses on learning and remembering in IBSE, was conducted in two Swedish compulsory schools where the NTA program is used in 6th grade.

We analyze the work of students and teachers in grade 6 (the children are app. 12 years old) within the unit *The Chemistry of food* in two schools. School A is situated in a residential community and school B in a suburban community with mainly apartment blocks. The class in school A consists of 26 students (13 girls and 13 boys) and the class in school B of 25 students (14 girls and 11 boys). The class in school A is taught by a male teacher specialized in teaching middle school science, whereas the class in school B is taught by a female general middle school teacher. Both teachers have participated in the in-service teacher-training associated with the NTA curriculum program and both have prior experience of working with the program. Data was collected throughout a ten-week-period using video- and audiotape recordings of classroom work with the NTA material. In each classroom seven audiotape recorders were distributed each science lesson to collect data from groups of two to five students. The audiotape recordings were transcribed verbatim with the video recordings used as support. All the names used are pseudonyms.

Description of the unit 'Chemistry of food'

The unit Chemistry of food "...*begins in students own knowledge and questions about food and nutrients. Thereafter they use different methods for finding out what nutrients there are in different food. In relation with these investigations students enhance their knowledge in what functions different nutrients have in the body, what happens when you get too little or too much of them, where and how different food is produced and so on.*" (NTA 2011b, our translation, italics added). The core content of the unit Chemistry of food is that humans need a variety of nutrients including carbohydrates, fat and proteins and the unit consists of twelve commissions (lessons).

The twelve commissions have somewhat different foci. The first two commissions are introductory lessons involving whole-class discussions on food. In the first two commissions of the unit "the Chemistry of food" students are supposed to prepare these lessons by asking parents and grandparents about their habits of eating when they were children. In these lessons, when students bring back narratives, from parents and grandparents about their habits of eating, to whole-class discussions on food, the teachers explicitly make space for students to draw on family funds of knowledge to make historical and cultural comparisons about food and eating. The following ten commissions involve testing of starch, glucose, fat and protein in selected food and reporting test results in class. When it comes to the investigations of nutrients of food, however, there are, few examples where students make explicit use of what they know about the investigated food, the nutrient or of science as an enterprise in relation to performing tests in the science classroom. The situations we found are all from students' investigations of fat within the unit 'Chemistry of food'. We have found no situations where students make explicit use of 'what they already know' in relation to starch, glucose and protein. For example, a group of girls spend fifteen minutes discussing what they know about fat whereas a boy and a girl finish their discussion on what they know about glucose in one exchange:

Lisa: [reads task instruction in work book] "Discuss with your group"
((inaudible)) "what do you know about glucose"

Gustav: Nada [said in Spanish]

Lisa: Me neither. I get nothing, or I get it but I think it's a bit strange ((inaudible)) it's now we're to find out where it is

When Lisa and Gustav have concluded that they do not know anything about glucose they go on to the task of testing different food for glucose. They then focus on making predictions and performing the test without explicitly referring to what they might know about glucose or its relation to the investigated food. In light of our research question concerning how students do draw on personal funds of knowledge in working with inquiry, we have, therefore, delimited our detailed analyses to the lessons about fat in the two classes (tot. 12 groups).

During the lesson about fat the students work with three tasks. Students first discuss what they know about fat, second make predictions on whether selected food will contain fat, and third test what food contains fat. This structure of tasks is consistent with the other commissions of investigation in the unit 'Chemistry of food'. The materials to be used in the investigation are brown paper, different dry food and liquids. The test procedure in this particular commission is to rub dry food samples against brown paper and put drops of liquid food samples on the paper. If the food contains fat a greasy stain will be left on the paper (for liquids this is the case after the paper has dried). The predictions and test results are recorded in two protocols, one for liquids and one for dry food (see table 1 and 2), which is handed out by the teacher as student work sheets (these are copied from the NTA teachers' manual).

Data analysis

We analyze situations where students draw on out-of-school funds of knowledge when working with the question of what they know about fat and in performing the investigations of fat in the different food. We operationalize students drawing on out-of-school funds of knowledge on a discursive level as utterances the students make about them knowing something about fat or the investigated food. This includes students making claims about there being fat in a particular food, students contesting test-results with reference to out-of-school contexts or students talking about fat being significant in their lives. Students' utterances, in form of what funds of knowledge they draw on, are understood as mediating the concrete realizations of the goals the students set for themselves during a task of inquiry (cf. Roth & Lee, 2007).

Table 1. Protocol for tests on fat in liquids (students fill in the liquids, predictions and test results)

Test on fat in liquids	Predictions (+/-)	Test results (+/-)
<i>milk</i>		
<i>water</i>		
<i>food oil</i>		
...		

Table 2. Protocol for tests on dry food (students fill in the dry food, predictions and test results)

Test on fat in dry food	Predictions (+/-)	Test results (+/-)
<i>apple</i>		
<i>honey biscuit</i>		
<i>wheat flour</i>		
...		

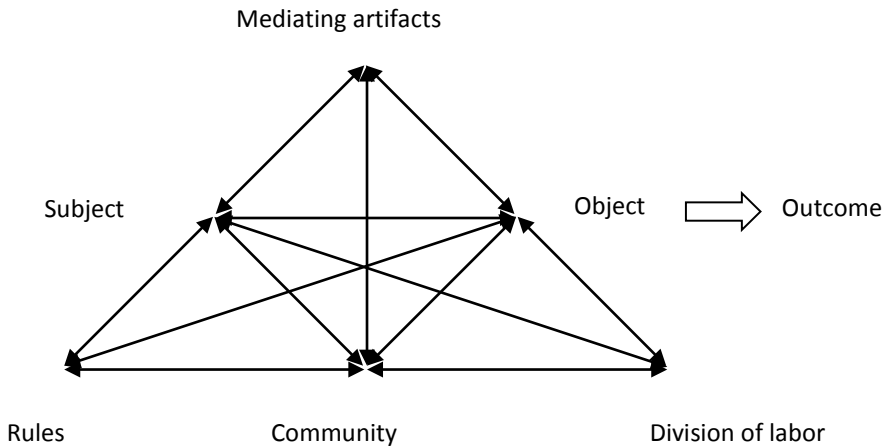


Figure 1. Engeström's model of an activity system as presented in Engeström (1999, p. 31).

In order to make sense of how students draw on out-of-school funds of knowledge in terms of activity we use Yrjö Engeström's (1999) triangular model of human activity systems. The original model, presented by Engeström (1987), identifies subject, instrument, object-outcome, rules, community, and division of labor as central aspects of activity. We have used the version presented by Engeström (1999) which is represented in figure 1. In this model the term instruments have been exchanged by *mediating artifacts*. By use of mediating artifacts, the meditational character of the artifacts or resources used for activity is underscored. A critical aspect in discerning what constitutes different activities relates to the question of what constitutes an object of activity. Students may engage in an activity corresponding to a particular object but be engaged in different actions in terms of participating in different communities, employing different divisions of labor, or enacting different norms/rules. *Objects* refer to what is transformed through activity, thus the innate connection with the *outcome* or implications of activity. The *mediating artifacts* refer to what tools are used in the transformation of the object. *Subject* refers to the persons engaging in activity (in our case the students engaged in performing tests). *Rules* refer to norms and codes of conduct that are enacted through activity. *Community* refers to the group of collaborators in relation to which the subjects position their work. Finally, *division of labor* refers to how work and responsibilities are divided among participants in activity.

RESULTS AND ANALYSIS

In the following we account for three examples of how the students' draw on out-of-school funds of knowledge in their investigations of fat in nutrients. The examples illustrate how the students' use of out-of-school funds of knowledge is embedded in activity. They also illustrate that students, when positioning themselves as part of different communities in relation to different goals and overall motives, make use of quite different funds of knowledge.

Example 1: Questioning the test-result of fat in milk

There are few instances in the data where test results are questioned by the students. There is, however, one test result which is questioned by several groups – the test of fat in milk. This test result is

commonly negative as the students in both classes test semi-skimmed milk with 1.5% fat (the test is not sensitive enough to detect such low proportion of fat). Some groups acknowledge that they receive a negative test result on fat in milk but are uncertain about what to do with the negative test result. A group of five girls make predictions on whether there is fat in milk, concluding: “yes there is fat in milk cause it says you know, yes there is too because on the milk carton it says, fat content”. When they do not get a positive test result one of the girls says: “But rub more!” thus expressing a wish to produce a positive test result by rubbing the brown paper to produce a fat stain. The girls acknowledge the contradiction between what they know about fat in milk and their test result. However, the question of what to write and how to deal with the negative test is left unresolved.

In one group of students in school A the teacher intervenes, acknowledging that the test result “isn’t all unproblematic”:

- Filip: Fat, plus we thought, it was minus on
Agnes: Milk, should I read again
Filip: Milk
[...]
Filip: I know that it contains, milk, cause it says on you know
Agnes: It was in food oil. Milk, no. We thought no too.
Marcus: What did you say? Hey was it in milk [to the teacher]?
Edith: But hey it should be in milk too. Anders [the teacher’s name]!
Teacher: Yes. Milk, you know that there is, right?
Marcus: But it doesn’t become
Teacher: No, and that’s... that that is, like this here isn’t completely unproblematic
Filip: Will it or won’t it
Marcus: It says like zero point five
Teacher: Yes
Filip: Should you take plus then?
Teacher: What?
Filip: Should you take plus then
Teacher: You can write, if you get the result no, you write minus, but you can write “I know that there is”
Filip: I write plus
Teacher: This here is semi-skimmed milk, what’s the percentage of semi-skimmed milk?
One point five, or?
Students: Yees
Agnes: Or one point four
Filip: But I write plus then

Fat appears to be a characteristic of milk that the students in this excerpt are familiar with (Marcus refer to the percentage of low-fat milk, 0.5%, and the teacher refers to semi-skimmed milk with a percentage of 1.5% fat). In the above excerpt the students clarify that they thought the test result would be positive. Marcus refers to what is written on the milk carton to substantiate his claim that milk contains fat: “it says on you know”. When the teacher enters the conversation he makes the contradiction between test results and prior experiences explicit by saying that “this here isn’t all unproblematic”. The problem the students try to deal with in the excerpt above concerns what to write in their protocols. Filip asks “should you to take plus then”. The teacher offers a way of dealing with the contradiction between what they know about fat in milk and the test result by saying that they should write minus in their protocol but add a note that they know there is fat in milk. However, in spite of the teacher’s offer, Filip concludes: “then I write plus”. This statement may be read as ‘since the teacher has confirmed there is fat in milk I write plus’. Filip writes what he knows to be true rather than what the test-result showed. Here, what Filip knows about fat in milk functions as an answer-key

in relation to the test-result. Thus, the protocol he produces is one of what food contains fat rather than a protocol of data from a test of fat in different food.

The following lesson is devoted to discussing and comparing results from the tests of fat in the different food. In the beginning of the lesson the students are asked to share between two groups what they thought about fat in the different food and what test results they got. The group discussions are finished in approximately two minutes. The results and predictions are then compared and summarized in a teacher-led whole class discussion. The teacher asks Marcus what result he got for milk. Marcus responds: "Well I read on the carton but really I didn't see any". The teacher then asks if anybody got a positive result. One girl claims to have gotten a positive result and backs this by saying: "It says too on the carton. I think it was semi-skimmed milk we had, it is zero point five" [sic]. This initiates lively discussions with a group of students nearby who question the result. The teacher interrupts and concludes:

Teacher: The thing is that it is pretty hard to get it. It says pretty clearly on the milk carton how much fat it contains. And it was semi-skimmed milk we had, and how much fat does semi-skimmed milk contain? One point five percent. It wasn't so much, then you know, then you can precisely imagine how much it is. One hundred old men then it is one and a half of them.

The teacher then moves on with the list of food without resolving or acknowledging the conflict between what both the students and the teacher make explicit as common knowledge (that there is fat in milk) and the negative test-result.

Figure 2 illustrates the students' work with the task of measuring fat in milk and producing a protocol as concrete realization of activity. The students' struggle with the negative test result may be interpreted in terms of them working toward a goal of producing a correct protocol. When the students acknowledge the contradiction, between what they know about fat in milk (drawing on what is written on the milk carton) and the negative test result, they engage in discussions with teachers and peers on what to write in their protocols; plus or minus. After the teacher has confirmed that there is fat in milk Filip concludes: "then I write plus". In other words, he writes what he knows to be correct rather than what the test result showed. The resources students put to use in this activity are the envisioned the milk-carton, the test results and the protocol. The division of labor constituted in the activity is that students perform tests and record correct answers in the given protocol and the teacher acts as

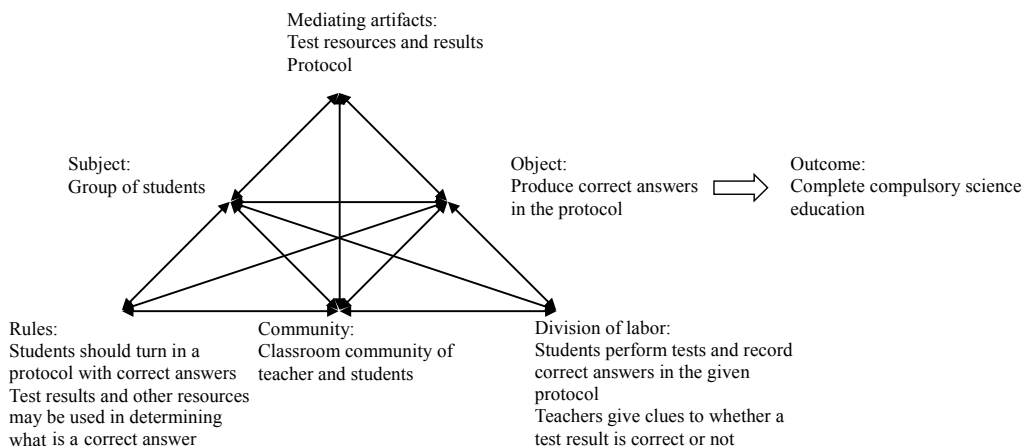


Figure 2. Drawing on personal funds of knowledge to produce a correct protocol

a resource of information; giving clues to whether a test result is correct or not. The rules constituted through activity are: to turn in protocols with correct answers, that test-results do not have priority – in terms of what is true/correct – over other resources e.g. what the teacher and the students already know. The actions students engage in may be understood in terms of a concrete realization of a motive of complete compulsory education; an example of a moment of formal education activity.

Example 2: Imagining there could be fat in water

In this section we account for a group of boys (Lukas, Sigurd and David) in school B working with the test on fat in water. As in the example above, where students tested fat in milk, the boys express that they ‘know’ that there is no fat in water. David, however, initiates an imaginary situation by claiming that there is, or at least could be, fat in water.

- Lukas: Ahh, here it is. Oops sorry hehehahahe oh oh fat test on liquids. Water is there no fat in.
Sigurd: Is there, what did you say? Water
Lukas: Wat-, in water there is no fat
David: Oh yes!
Lukas: Nope. Hehe
David: Or yes in fact, it should be
Sigurd: Mm you get fat of it
Lukas: Yes, you get fat of water
David: If you drink too much
Lukas: Hehe

David claims that there may well be fat in water. Sigurd confirms the claim and acknowledges the imaginary set-up. By the end of the above excerpt Lukas also confirms the imaginary set-up by saying “Yes, you get fat of water”. When continuing with the testing they emphasize the play situation by simulating excitement over what the test results will be:

- Lukas: Okay, now I’ll try with water
Sigurd: Oh that’ll really
Lukas: *Tadadadatadadatadadadan. I’m the witch’s man* [said in English].
Hehe. Okay, do we have two of these

Lukas and Sigurd both engage in exotizing the test. Lukas frames the test in terms of magic and excitement stating that he is the witch’s man. When the boys begin the actual measuring, writing their predictions on their worksheets the boys express explicitly to one-another that they do not believe there is fat in water, and that they are joking, as if reassuring themselves not to be misinterpreted.

- David: Yes, I think it is a little. No, no.
Lukas: Oh! In water there is fat. I’m kidding.
David: You rubbed maybe a bit much I think
Lukas: Yes maybe. Wait, wait I
David: Was this here too much?
Lukas: Oh here. I’m just kidding. Hehe it was just a joke.
David: Yes but everybody knows that there isn’t fat in the water, water
Sigurd: It could be
Lukas: Yes it could. It’s absolutely sure anyway.
Lukas: So! Now everyone sees that there is no fat in water.
Sigurd: But one should still
Lukas: ((*inaudible*)) get the Nobel prize

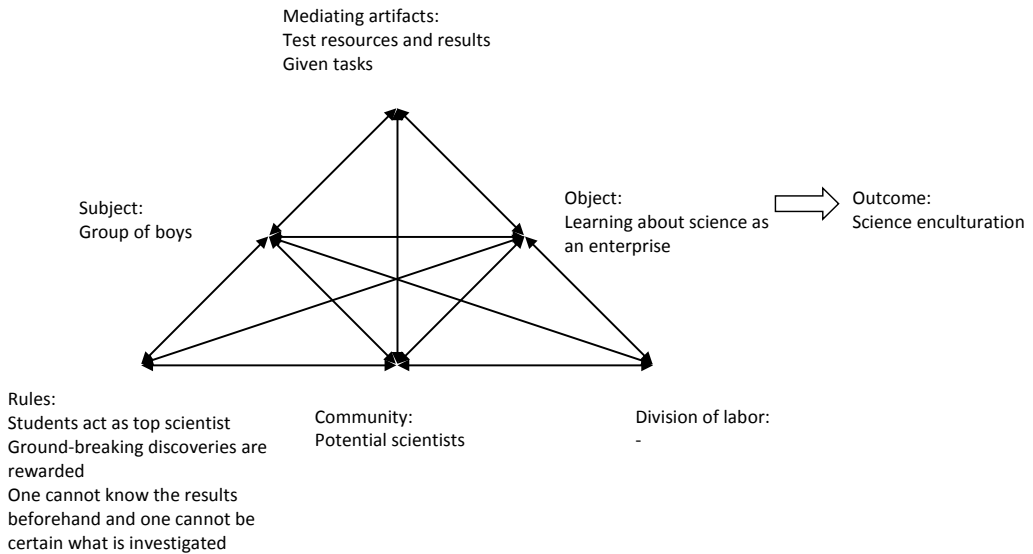


Figure 3: Drawing on personal funds of knowledge to elaborate on science as an enterprise.

In the end David again claims that even if “...everybody knows there’s no fat in the water, water” one has to be open for what the test results will show. Lukas also mentions the Nobel Prize. Here, the boys play with cultural norms and values of science culture: that you have to be open to what the test-results will show, that the results may be counter-intuitive (there could be fat in water) and that important groundbreaking discoveries will be rewarded e.g. with the Nobel Prize. The boys play with the classroom task to perform a test of fat in water in relation to the ideas of fair testing which the whole unit Chemistry of food is rhetorically framed in.

Figure 3 illustrates the boys’ discussion about the possibilities to detect fat in water in an activity system perspective. The example may be understood as a moment of a concrete realization of science enculturation activity. At times, the boys talk to each other as members of a community of potential scientists. There is no clear division of labour constituted among the boys, even though there are instances of division as when Lukas acts as “the witch’s man” when performing the test. The rules enacted in activity are rules of an imaginary situation; that the boys are to act as top-scientists, that groundbreaking discoveries are rewarded and that they cannot know the result of their investigation beforehand. The boys reassure one-another that what they say is part of an imaginary set-up by underscoring that they are joking (e.g. “I’m kidding” and “it was just a joke”). Their reassurances indicate that the humorous/imaginative framing of their work is not taken-for-granted. By engaging in play the students transcend the rules of the given classroom tasks and create a situation that meets their needs and interests (cf. Andrée, Lager-Nyqvist & Wickman, 2012).

Example 3: Measuring if a person is fat

In the data there is one incident when a group of girls work with the task to discuss what they know about fat and, as a part of that discussion, introduce and develop a test for measuring if a person is over-weight. The girls call this an ‘over-weighting test’ (in Swedish *överviktningstest*). In all, the group of Lisa, Anna, Karin and Fanny discuss ‘what they know about fat’ for about fifteen minutes. The four girls contribute in various extents with facts and personal experiences. Fat appears to be a meaningful topic for discussion in relation to their personal lives even though it is also a discussion in a school-setting in relation to a distinct task.

The girls begin their discussion talking about fat making people obese, fat being disgusting and how much fat they eat. Fanny then claims that she has to eat a lot of fat *since* she is fat.

- Fanny: I eat you know, do I eat a lot of fat? Yes I have to do that since I am fat
Lisa: No, of course you don't otherwise you would be really fat
Anna: And it is over-weight you know Fanny, then you wouldn't be able to do this here.
You would like only be able to do this here [see figure 4a]
Fanny: I can't
Anna: Up here [see figure 4b]
Fanny: I can't, it's not possible
Anna: Yes, you wouldn't be able to, it would be like about, like this. Like this if you were
over-weight
Karin: Like this I think [see figure 4c]
Lisa: No, like this
Anna: Mm
Lisa: No, like this
Anna: Look, if you cannot reach around then you are over-weight
Karin: Is it exactly up here you should
Anna: Yes if you don't have small fingers. Dwarf. Dwarfs
Lisa: But Anna, is it not like here?
Anna: No, it is up here ((inaudible))
Lisa: Here, exactly. Above the bones

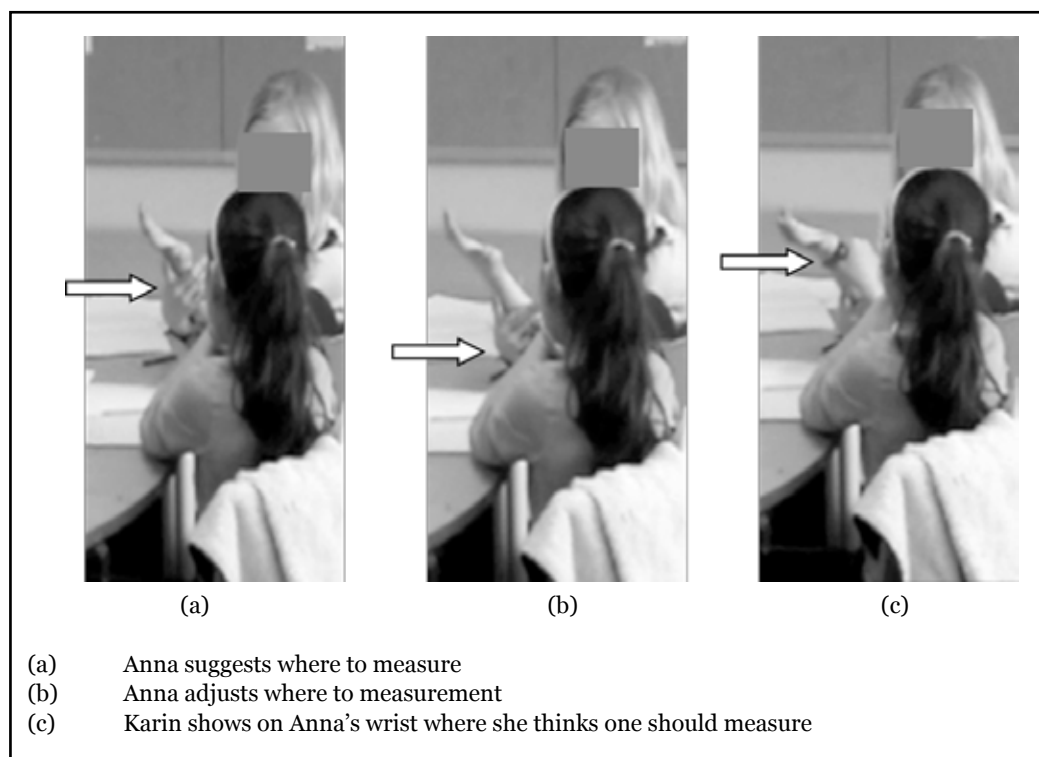


Figure 4a-c. Suggesting a test to measuring if Fanny is over-weight.

The question engaging Fanny, Lisa and Anna is if Fanny should be classified as a fat person. Fanny concludes that she has to eat a lot of fat since she is fat. Lisa objects to Fanny's statement and Anna supports Lisa by introducing a measure that may avoid classifying Fanny as fat. Anna introduces the test by saying that Fanny wouldn't be able to reach around her wrist with her fingers (figure 4a). The girls then continue to discuss where to actually perform the test, on the wrist or higher up on the forearm close to the elbow. Anna, Karin and Lisa have different suggestions as to where to measure – all which seem to include Fanny in a category of over-weight persons. Anna then introduces an exception; the test is not valid if you have 'small fingers'. The questions the girls deal with is if Fanny is to be considered fat, how they may determine if a person is fat and under what conditions a test of persons being fat or not is valid.

After a while the teacher comes to interrupt the girls and tells them to get started with the tests of different nutrients:

- Teacher: Hey girls, now I want you to get started. All of you at this table have to get started now
Anna: We're talking about that if you don't reach around here then you are over-weight
Teacher: Really
Anna: Yes
Teacher: Is it such a test
Anna: Yes it is, it's an over-weightingtest [in Swedish överviktningstest] or what it's called. We're a bit over-weight
Lisa: One mustn't ask particularly fat people you know

When the teacher says that she wants them to get started, she emphasizes the completion of the tests as a main task of the lesson (rather than continuing the discussion on what they know about fat). Anna responds to the teacher that they are talking about being over-weight, implicitly saying that they are on task. The teacher then acknowledges their test as a test: "Is it such a test"? Lisa concludes that you mustn't ask particularly fat people and that one should not ask people that have short fingers. Thus, negotiating a code of ethics and implicitly stating that a classification of a person as fat may harm the individual.

Figure 5 illustrates what motives are realized through the girls' invention of the 'over-weighting test' to determine whether or not Fanny is fat. This example, of how a classroom task and personal lived experiences may be used to engage in an activity oriented to social relations, constitutes a unique moment in the IBSE classroom practices. The expressed interest for measuring if a person is fat may be understood in relation to the discussion being situated in a school science practice where measurement is a central issue. With the test the girls produce an objective measure of whether a person, they themselves or someone else, may be considered fat. The mediating resources are the task given and an idea of objective testing. The rules enacted in the discussion are to remain within the boundaries of the task, to discuss what they know about fat, but transform it in relation to a goal of distinguishing fat from non-fat people. Another rule constituted is the expressed ethics of developing a test that will not falsely classify a person as fat and not to perform the test on a person who may be assumed to be tested positively (i.e. short people and 'particularly fat people'). In terms of division of labor, we see that Lisa, Karin and Anna engage in how to perform the measurement whereas Fanny positions herself as a person to be measured. In this example the teacher does not engage in the action of determining whether a person is fat or not. In sum, the girls' engagement may be understood as a moment of realizing an activity of establishing social status or social relations.

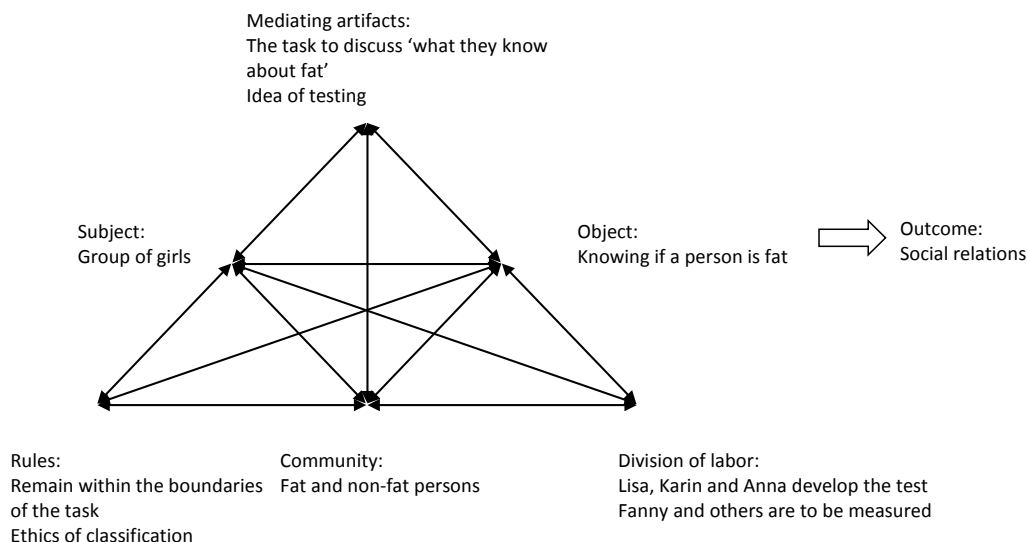


Figure 5. Drawing on personal funds of knowledge to establish if a person is fat.

DISCUSSION AND CONCLUSIONS

In this article we have looked at IBSE classroom practices incorporating ideas of 'learning science from experience' in a Swedish school setting. We focused on instances where students draw on diverse funds of knowledge in working with inquiry tasks and conceptualized what funds of knowledge students made use of in relation to the different activities they engage in. Our analysis shows that students may draw on quite different funds of knowledge. The questioning of the test-result of fat in milk gained meaning in relation to an object of producing a correct protocol and may be understood as a moment of formal education activity. In other words, the students were not so much engaged in measuring if there was fat in milk as they were in producing a correct protocol. Here, the students drew on what they knew about fat in milk to produce a protocol of 'what food contains fat' rather than a protocol of 'what tests are positive'. The boys who collectively imagined that they might get a positive result on the test of fat in water pointed, through their joint action, to the issue of the test as a test of what was already obvious to them (there is no fat in water). Finally, the action of the girls, who engaged in measuring if Fanny was fat, gained meaning in relation to an object of determining if someone is fat and may be understood as a moment of negotiating social relations.

If we hope for science education to help students developing capabilities for using science to better understand the world, a key for teachers is to create a framework of learning tasks within which variations of students' motives and motivations (objects of activity) may be expressed (Chaiklin, 1999). It is necessary to develop science teachers' action patterns, or action possibilities, to become sensitive to a variation of objects of activity constituted through classroom work. In IBSE, such action patterns might involve making use of the conflicts acknowledged by the students, as e.g. the conflict between test results and what the students already knew about fat in milk. Hence, making possible an elaboration of students' understanding of limits of science measuring practices. In such practice, the test of fat in milk could be used an opportunity to learn about construct validity. The way the students dealt with writing the protocol could also be problematized in light of ideas of fair testing and research ethics. Raising these issues in classroom practice would open opportunities for recognizing diverse funds of knowledge and developing students' motives for engaging in science learning. However, recognizing conflicts and tensions may be easier to say than do. Berg, Löfgren & Eriksson (2007) argues that there is a dilemma in primary science teaching practices of making science interesting on

the one hand, and introducing students to scientific practice on the other. They show in their study of primary Chemistry teaching that right or wrong results were not dealt with in the classroom, and that all student claims were treated as 'right'. Such a practice of non-recognition of conflicts inevitably has as a consequence that neither test-results, nor students' experiences are taken seriously.

The question of how students are enabled to draw on diverse funds of knowledge in IBSE classroom practice is an issue of authenticity: To what extent are students actually given opportunities to engage in authentic investigations i.e. in producing some new knowledge? We need to ask under what conditions would e.g. a test of fat in milk be of epistemic value, i.e. producing new knowledge. Would it be possible to redesign the test of fat in milk as an authentic test? The current design of the task to measure *if* there is fat in milk, in fact, becomes a way to disqualify students as knowledgeable and communicates a message that what happens in the science classroom has little to do with the world outside (this may be understood as a process of alienation of students cf. Beach, 1999). The three girls do initiate a personally relevant open-ended investigation of how to measure if a person is fat. On the one hand, this question is a high-stakes ethical question in a teacher's perspective. On the other hand, to bring forth ethical and social considerations of 'objective testing' is a central issue of science curricula.

In conclusion, we have pointed to possibilities of expanding and acknowledging students' funds of knowledge when working with investigations in the science classroom. As the students in Moje et al.'s (2004) study, who were unwilling to draw on everyday funds of knowledge publicly in classrooms, the students in our study most often did not draw on personal funds of knowledge, except in the investigation of fat. However, the teachers in these classes did not actively invite such funds when conducting or discussing investigations. Students' personal funds of knowledge were explicitly dealt with during the first two commissions and then left behind as of no relevance to the investigative work. When a teacher actively does invite personal funds in discussions, reading, writing and investigations as in the study of Calabrese-Barton and Tan (2009) we may expect students to actively and openly draw on diverse funds of knowledge in classroom work. By valuing and legitimizing students' funds of knowledge as related to and applicable to work in the science classroom we may create conditions for classroom work to become developmental and also less alienating. However, further research is needed that examine how personal funds of knowledge may be mediated in science classroom practice.

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