Categorisation in Knowledge building

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CATEGORISATION IN KNOWLEDGE BUILDING

Task specific argumentation in a co-located CSCL environment

Abstract. In this paper we explore how students talk and reason when they were exposed to a set of categories taken from scientific discourse. The scientific categories are built into a web-based discussion forum (Fle) as part of a pedagogical and technological design. The scientific categories are based on the concepts of the progressive inquiry model for knowledge building. Socio-cultural theory with a focus on concepts like categories and prompting is our theoretical framework. In the DoCTA NSS project we have used the progressive inquiry model to explore how the students use categories to collaboratively build new understanding of a specific knowledge domain. Based on the theoretical framework and an empirical example, we argue that the progressive inquiry model – in its conceptual form - is too rationalistic for student knowledge building. We found that student knowledge building is task-specific and local oriented, rather than aimed at conceptual artifacts.

INTRODUCTION

Design experiments in different knowledge domains have been directed at how the learning environment could be designed to promote conceptual development beyond procedures and rules (Brown, 1992; Anderson, Holland, & Palincsar, 1997; Greeno & Goldman, 1998; Abbas et al, 2001). In many of these studies the authors have been able to show positive results, but they have also identified some shortcomings, such as fact-finding patterns (Hakkarainen & Palonen, 2002). An important finding is that students need to be prompted to articulate their conceptual understanding. The need for teacher intervention for creating conditions for the conceptual talk is also well documented (Hakkarainen, Lipponen & Järvelä, 2002).

One important aspect of prompting that we explore in this paper is to use categories as "guiding principles" for the understanding-making process. Computer systems provide means for implementing such guiding principles, for example as different kinds of "sentence openers" built-into the ICT.

Design experiments can be seen as an intervention in the educational practice; since the researchers in collaboration with teachers, try to change the way the students work. These shifts often presuppose a change in participation structures and how agency and division of labour are distributed between the teacher and the students. One aspect of this change is epistemological. By epistemological change we mean how the teachers and students think about the knowledge construction process. Their perception of this process has impact on what kind of participation structures will develop in the educational setting (Stenning, et al. in press; Hakkarainen, Lipponen and Järvelä, 2001).

From a socio-cultural perspective on learning the notion of activity is seen as the

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basic concept for design and analysis. The participants in an activity are connected to each other by their involvement in talk and action with the teacher and their fellow students. The activity is mediated by the use of scaffolds inscribed in the computational environment. One scaffold we explore in this paper is prompting categories. The goal of the paper is to understand the relationship between students' activities when solving specific tasks and their use of categories during the problem solving.

We address the following research questions in this paper:

- What impact did the categories have on collaboration and problem solving?
- What meanings did the students attribute to the categories?

The research context where we explore these questions is design experiment with 9 graders in Oslo and Bergen, in Norway. The knowledge domain is biotechnology, with emphasise on ethical issues.

This paper is organized as follows. In the first section we will give a brief overview of the theoretical position we take regarding the relationship between learning activities, how we can understand the use of categories, and we discuss the progressive inquiry model proposed by Hakkarainen, Lipponen and Järvelä (2001). In the second section we describe the learning environment and the design experiment. In the empirical part we give a few examples on how the students perceived and used the categories. Finally, in the discussion we elaborate our findings and theoretical position.

SOCIOCULTURAL PERSPECTIVE ON PROMPTING, CATEGORISATION AND KNOWLEDGE BUILDING

Categories are important assets in all human activity, and learning how to classify events, things and activities is part of the process of creating social order (Sacks, 1992; Garfinkel, 1967; for recent review see Mäkitalo 2002, Mäkitalo and Säljö, 2002). By sorting things out we are able to cope with complexity and maintain a measure of social order in our private and professional lives (Bowker & Star, 1999). This is a historical process initiated by individuals in specific activities (e.g. personal concerns), but when generalized categories may serve as governing parts of institutional activities (e.g. laws).

In this paper we address a specific aspect of categorization, namely prompting categories. In computational learning environments it is possible to build-in these as "sentence openers" or scaffolds in the computational environment, which the students then can use in their interaction with the learning environment.

There are different approaches to understanding categorization. One of the approaches is to see the categories as external representations, a topic which has also been studied in the cognitive sciences (Zhang, 1997). However, the main focus of cognitive science is related to how individuals use and develop mental representations. On the other hand, working with external representations is prominent among CSCL researchers. For example, Suthers and Hundhausen (2002)

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have extended the cognitive perspective by looking at the use of external representations in collaborative activities. However, often the cognitive processes remain as the unit of analysis, leaving social and institutional aspects unaccounted. Our interest is how students understand and use categories in problem solving and collaboration, as an activity situated in a social practice. Categories in educational settings don't come as empty vessels (as the name may imply), but are loaded with history and politics (Suchman, 1994; Mäkitalo and Säljö, 2002). Categories have evolved over time and can seen as part of what Bowker and Star (1999) labels categorical work. Categorization is therefore not neutral. Categories become real to the extent they get used by people in specific activities.

Progressive inquiry and knowledge building

Our understanding of progressive inquiry and knowledge building has taken as staring point the Future Learning Environment 2 (FLE2) (Muukkonen et al., 1999), an online discussion forum with built-in posting categories implemented according to the progressive inquiry (PI) model. The progressive inquiry model includes the following aspects of inquiry: Identifying (initially fuzzy) questions, producing personal working theories, collaboratively evaluating and redirecting the inquiry, searching for deepening knowledge by consulting more capable peers and teachers, finding reference information in online resources, generating subordinate and refined questions and producing elaborated explanations and shared theories for the whole learning community.

Hakkarainen, Lipponen and Järvelä (2001) argue there are two primary sources for the PI model: philosophy of science and cognitive science, or in their own words "the knowledge seeking inquiry starts from an agent's cognitive or epistemic goal that arise out of his or her dissatisfaction with the present state of knowledge." (p. 131). There are clear differences between the notion of knowledge in the philosophy of science and in the cognitive sciences, especially in that the former tend to *objectify* knowledge whereas the latter tend to *personalize* it (i.e. as internal mental states). However, they do have in common a focus on problem solving, i.e. that a problem and its associated set of questions drive a knowledge building process aiming at answering the problem. This includes finding new and innovating questions to reframe a problem and to restart the knowledge building process when it reaches temporary impasses.

From a cognitive science perspective the relevance of questioning is to establish a *goal* for a problem solving process. This implies that the learner's cognitive goals are the driving force in the knowledge seeking process. When knowledge seeking is driven by questions, different ways to answer becomes important and crucial for the quality of the learning process and its outcome. This includes how to problematize (Stenning et al., in press), how to deal with multiple and conflicting information, and how to construct explanations and hypotheses.

By objectification is meant that the basic elements of scientific inquiry (problems, tentative theories, critical evaluations) are publicly available (as external representations) and shared by the members of a research community (Popper, 1972). Sharing is realized by the simple fact that information is publicly available,

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but also (indirectly) in that information is not associated with any individual owner. It is the latter aspect that has been the focus of Popper's approach to scientific knowledge building (Popper, 1968), and he refers to the "ownerless objects" as World 3 objects (Popper, 1972). Examples of World 3 objects are theories published in books and stored in libraries, conference papers in proceedings, and words in a dictionary. These objects have no owners although they may have originated by the efforts of individuals. Bereiter (2002) calls these objects *conceptual artefacts*.

Although the categories of the PI model have its heritage in the scientific schema proposed by Popper, we cannot expect students to manipulate knowledge objects as professional scientist do. Instead, we propose a new concept for student scientific knowledge building, Micro Third World object (MTW[1] for short). An MTW object is a "localized" Popperian World 3 object. Its World 3 characteristic stems from the fact that it is shared (e.g. an external representation) and may originate as a proper World 3 object (i.e. a published resource stored in a public repository). By localized we mean the object is adopted by a community of learners and attributed a meaning not a priori given but locally constructed by small groups. Examples of MTW objects are the problems, theories, and explanations produced by pupils in the science classes we have studied. In the empirical section we give concrete examples.

MTW knowledge is the combination of objectified knowledge stored in public places and the students' use of that knowledge in their social activity of knowledge building. As such they bear resemblance to categorical work (Bower & Star, 1999). Categorical work entwines objective knowledge (shared categories in specific knowledge domains) with social activities and politics (Suchman, 1994). In our "miniature" society we have found tentative evidence of entwining, namely between categories of scientific inquiry and student knowledge building and between objective knowledge (published resources) and negotiated meaning in small groups.

The goal for introducing the progressive inquiry model in our classrooms is to the increase the awareness and focus on the students' abilities to practice 'scientific reasoning', which is necessary in order to develop abstract or theoretical knowledge (Donald, 1991). As we have emphasized previously how to achieve these learning processes is very demanding and hardly part of everyday practice in most educational activity. This is therefore an urgent problem to focus on, both at the practical and the theoretical level.

The knowledge building metaphor could be interpreted as a normative model for how we should organize students' work. However, the normative view is taken from a very different institutional setting as distinct type of activity (scientific reasoning), to a school setting. This transformation is not trivial.

[1] MTW is not only an acronym but also an integration of two words: MTV and WWW (World Wide Web). MTV has set a new standard for TV (fast paced, abrupt juxtaposition) and Internet has created a fertile ground for the proliferation of MTW objects, since it is so easy to locate, copy and reuse information published on the WWW.

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DESIGN OF THE LEARNING ENVIRONMENT

In the DoCTA NSS project (Design and Use of Collaborative Telelearning Artefacts, Natural Science Studios) we have adopted the progressive inquiry model as our main design principle. However, our research goal was not to replicate any of the studies referred to in this tradition (Scardemalia & Bereiter, 1994; Hakkarainen, Lipponen and Järvelä, 2001). Our goal was to explore the design space of this model and to assess its impact on the students' actions and use of categories.

The progressive inquiry model is implemented in FLE2 (Muukkonen, Hakkarainen, & Lakkala, 1999). FLE2 is a groupware system, with tools oriented towards distributed collaboration and knowledge building. The tool most relevant for this study is the knowledge-building forum, which is a discussion board with categories to prefix the postings (Figure 1).

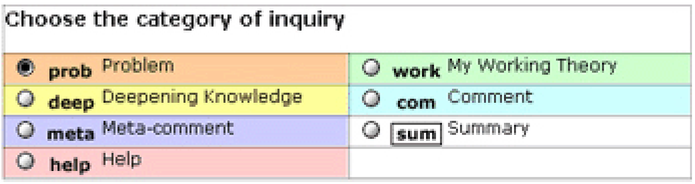

Figure 1. Knowledge building categories in FLE2

The students had to select a category before a message could be posted. The categories are listed on the top of the screen and presented in different colours. In the original system they were written in English (as in Figure 1). In the version of the system we adopted the categories was first translated into Norwegian. The Norwegian equivalent is slightly different for the English version shown in Figure 1 since we split the Deepening Knowledge category into two: Reliable knowledge, and Uncertain knowledge. In the original system there was no distinction between reliable and uncertain knowledge.

In addition to asynchronous discussion with FLE2 the students had access to technology for sharing resources, synchronous discussion, small-scale simulation, and domain-specific Internet resources. The Internet resources were browsed through a search engine called ATEKST. ATEKST is a front end to Norwegian newspaper articles. It was used when the students needed references to back up (support or refute) claims and arguments.

The content of the learning environment was biotechnology, in particular the ethical dimensions of this knowledge domain. The students mainly focused on the ethical dimensions in our design experiment. The students were from grade 9. One group of students was located in Oslo and the other group in Bergen. In this study we analyse the use of categories based on data from one of the co-located settings.

The students were expected to produce a web page about biotechnology as the final outcome. The web page should include information from multiple resources and include the local group's discussions (positions and arguments) as well as the counter positions produced by the collaborating group at the other school.

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Methodological issues in design experiments

The socio-cultural theory on learning gives analytic tools for understanding how students learning activities is 'played' out in interactions with artifacts, here more specifically the use of a set of categories (Jordan & Henderson, 1995). We see the design and the concrete use of specific learning environment as historical unfolding activities. Design experiment is one type of formative intervention in a social practice, with the intension is to create new types of activities for students to take part in. The design is based on a set of abstract principles. We argue that it's important to make a clear distinction between the abstract principles behind the design of a learning environment and how the students actually interact with the environment (Rasmussen, Krange & Ludvigsen, 2002).

In the whole DoCTA NSS study we have collected data by video recordings of classrooms where the students work during the design experiment (two weeks). The activities of two of the group in Oslo and Bergen where recorded more in detail. These groups where followed with two cameras during the design trial. In addition the students where interviewed and we have collected log files of some of the activities in FLE 2. In this paper we base our illustration on the part of the data where the students use the categories as part of their activities. We have transcribed these episodes. We analyse in some detail how the students used the categories.

The analysis could in principal take two pathways, one following the template-based approach that inherits the rationale build into the progressive inquiry model (scientific inquiry), and the approach used in this paper, where we try to find the meaning making in the actual use of the templates. We argue that a drawback of the template-based approach is that we could miss important dimensions of the situated character of the students' learning processes and how the students activities become social accountable (Garfinkel, 1967).

EMPRIRICAL ANALYSES – TASKS, UNDERSTANDING AND CATEGORIZATION

In these analyses we will try to understand how the students actually used the categories during knowledge building, based on moment-by-moment interaction data.[2]

In this excerpt three students have written an argument, which they are going to post in FLE 2. They discuss what category to use for the posting.

1. Student X: I wonder… reliable knowledge (interrupted by student Y)
2. Student Y: No – it's not reliable knowledge
3. Student X: No!!!
4. Student W: Reliable knowledge, sure…
5. Student Y: It's not, It's not reliable knowledge just because he says so (with temper)
6. Student W: Then, it's not reliable knowledge.
7. Student Y: It is different when it's that kind of statement, that's a kind of study."

[2] The enumeration is for organization of this paper. The excerpts are not sequential in the whole data set.

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The first student X suggests one of the categories (reliable knowledge), but the other student Y disagrees and the remaining is a discussion of a relation between a certain segment of text, which they have written and how it should be categorized. In segment 5 and 7 student Y tries to elaborate her argument about why she thinks it's not reliable knowledge. The student's argument is twofold: it is a special kind of statement and it is a study rather than published research. By the use of the categories the student at least to certain extent is able to problematize what kind of status a segment of text have in relation to a problem.

In this next excerpt the students are trying to find relevant information in one of the resources of the newspaper search engine ATEKST.

8. Teacher: How are things going?
9. Student Y: Yes, we are working …., we have already send one reliable knowledge!
10. Teacher: Have you – where did you find the reliable knowledge?
11. Students (all): In the "Atext"
12. Teacher: In "Atext", in which newspaper?
13. Student Y: In Aftenposten
14. Teacher: Are you sure that it's reliable knowledge, when it's written in Aftenposten?
15. Student W: It's was a statement from a physician
16. Student X: I don't know
17. Student Y: What can we take as reliable knowledge then?
18. Teacher: No, I'm only ask, how sure you can be on a newspaper…., is it true when it stands in a newspaper?
19. Student Y: No. "

The talk between the teacher and students is a continuation of the discussion about the status of resources. When the teacher asks about where they have found the information they categorize as reliable knowledge they refer to a search engine, which is connected to a large number of Norwegian newspapers. The teacher asks a question that prompts the students to elaborate about what kind of resources they can rely on. The students answer concretely, but also in a more general way. When the teacher asks whether or not newspaper articles per definition can be said to be reliable resources, the students assume this is not the case. The discussion between the teacher and the students goes on, and they try to sort out how to make sure that the resources they find are trustworthy.

When we take the excerpts into consideration the students generate meaning with respect to the categories in different ways. The categories trigger a discussion about how to understand the relation between text and a certain category. When the students don't agree they are stimulated to elaborate their argumentation. This argumentation makes the relation between their written text and the category more transparent, which creates an important condition for knowledge building. This process makes the students aware of the content for their argumentation.

The teacher's intervention and the talk that follows stimulate the process of problematization. What level of trustworthiness can be attributed to the resources the students find in ATEKST or other resources? The students know that they should be critical to facts or arguments presented in newspapers. The teacher's question serves as an important part of the knowledge building process. His question raises the awareness of the status of resources, so that the students need to articulate their

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opinions of ways of working with the content. When student-student and student-teacher interaction make use of the categories in the way we have described, the activities can be seen as examples of knowledge building processes.

If we see this analysis in relation to previous work (Ludvigsen & Mørch, 2002) we would argue that students have pragmatic orientation to the categories. They don't take the categories for given by the computer system, or the categories used by other students for granted. Nevertheless, they consider them useful, since the categories in use give them prompts, which is part of their scaffolding structure. This pragmatic interpretation could also indicate that the students are more concerned with the overall goal of solving the task, rather than the actual knowledge building process by itself. These finding of mixed patterns is interesting, because they point towards that we have knowledge seeking and fact-finding patterns embedded in students talk, in a complex way.

DISCUSSION AND CONCLUSIONS

The categories used in the FLE2 learning environment could be considered part of a broader scientific discourse. Furthermore, the categories of the progressive inquiry model could be seen as part of categorical work that applies to different disciplines (Bowker & Star, 1999). One the other hand, the use of the categories is connected to the local meaning production in the different scientific disciplines. The categories chosen, such as problem, reliable knowledge and uncertain knowledge, give clear indication that the students are able to establish a participation pattern that belong to knowledge building.

The students' use of the categories could be interpreted as a kind of categorical work (Bowker and Star, 1999). The reasoning of some of the students and the student-teacher interaction show that the students are able to make their reasoning transparent, i.e. to elaborate, problematize and make critical judgments. This is partly connected to the categories themselves and partly to the teachers' intervention in the process. We can say, to a certain extent, the students when collaborating, make use of aspects of the progressive inquiry model (se also Arnseth, Guribye, Ludvigsen & Wasson, 2002). When it comes to scientific discourse (which lies at the heart of the PI model), our findings indicate that the students discourse is not "objective", but local and task-oriented. Exposing the students to categories of a scientific discourse and the advanced vocabulary of this discourse don't make a scientific practice visible to the students. The work that becomes transparent to the students is their own work with the categories.

On the other hand, when the students get socialized to a more demanding work environment, they have opportunities to take part in and get experienced with how scientific knowledge building could take place. The learning environment could under specific conditions create a new type of agency for the students, which imply different division of labour between teacher and students (Boaler and Greeno, 2000; Hakkarainen, Lipponen and Järvelä, 2001). The examples we have shown in this paper give suggestions of types of interactions in which the students have possibilities to develop conceptual knowledge, since they are engaged in a

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conceptual type of talk. Conceptual talk goes beyond the regular classroom talk where the focus often is on task. The conceptual level of discourse is not automatically part task related talk. As argued the teacher intervention is of significant importance for creating a type of talk where the conceptual resources is used at part of the knowledge building activities.

We will argue that the analysis of the moment-by-moment interaction gives indications about how the categories are used, and how the categories helps to support how the students' deal with specific content (Stahl, 2002). However the students' use of the categories is part of their local processes of solving their tasks. It's a great challenge not only to support the working process, but also the how students work with the content. In other studies done by Ludvigsen et al (2002) we have fund that it is very difficult to find ways to supported the content of the students work. As other have shown the teacher is the most critical resource for creating conceptual oriented talk.

Its' important to emphasize even if the students use same of the categories in their work as scientist do, we would argue than we should be careful to make interpretations, which imply that the scientific categories in the progressive inquiry model 'travels' in en unidirectional way. The students work is fare from a research laboratory, so the categorization process, which the students are part of, is generated by the local meaning production in this specific setting. The categories are useful, even if the meaning making process is fare from a more rationalistic model of doing science. The categories make the students aware of the systematic part of the knowledge building process. This is important for developing skills that are sensitive to the differences between types of knowledge involved in problem solving.

The theoretical part has been an argumentation that students learning should be understood as a different type of activity than scientific processes, or internal cognitive processes. The PI inquiry model seems to rationalistic and don't provide us with analytic lenses sensitive to the local meaning production. We understand learning as a highly institutionalised activity, where the social accountability is negotiated in the intersection between long cycles of activities and moment-by-moment interaction (Rasmussen et al, 2002).

Acknowledgements

We want to thank the Network for IT-Research and Competence in Education for funding of the DoCTA NSS project. We are grateful to all the participants in the project for creating inspiring work condition. We also want to thank teachers and students at the schools, which take part in project. Especially we would thank the master students', which have worked with the data we have used in this paper: Anne Brandshøi and Karianne Omdahl.

We would also like to thank InterMedia, University of Oslo for financial support and colleagues in our research group on Net-based learning and the socio-cultural research group in education for valuable discussions.

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