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Knowledge connected – trajectories of knowledge building

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Introduction

Developments within the 'knowledge society', especially due to technological innovation, have intensified interest in the relationship between different contexts of learning, between what is often termed as 'formal', that is institutional settings like schooling, and 'informal', everything outside of schools, learning domains (Livingstone, 2002, Sefton-Green, 2004). However, there is very little research internationally with a specific focus on such transitions. As Wortham (2005) has shown, such a broader outline also informs us about the ways we study learners as part of school practices, in how social identification and academic learning are intertwined and not separate entities in what he describes as 'learning identity'.

Even though our main interest in this paper is on trajectories in formal school activities as part of project work, we will also raise a more general discussion about broader sets of connecting knowledge between different contexts and activity systems. We believe it is important to get a better understanding of the trajectories of knowledge building along different time-scales and across different contexts.

As such, there are two aims to this paper. One is of a more general and theoretical nature, the other as a more focused and empirically based study. Concerning the first aim we ask the question of how we might study the flow of knowledge creation along different time-scales. Concerning the second aim we focus on the students and ask the question of how different 'forms of knowledge building' is connected. These two aims are interconnected, but might also be treated as separate discussions raising different challenges for a knowledge building perspective.[1]

How does knowledge gained in one contexts 'travel' to other situations and contexts? In this paper we will limit this discussion to one project within project work in school. Our research question is framed as; how students in one class proceed in their

[1] In this paper we still need to work on showing the interconnection between the theoretical and the empirical parts.

knowledge building over time using different resources and expressing their reasoning in different ways. The main focus is on the students 'forms of talk' (Mercer & Wegerif, 1999) and their use of Knowledge Forum as a resource in the different phases of their project work.

Ways of connecting knowledge

We draw on the socio-cultural tradition of studying literacy cultures, exploring 'literacy events' especially those which have offered ethnographic accounts of literacy practices (Barton & Hamilton, 1998). As such we believe there is a need to explore further traditional conceptions of what has been referred to, pointing back to Vygotsky (1978), as 'spontaneous and scientific concepts'; of how these aspects of knowledge building are intertwined. This is also seen in recent interest in what we mean by informal learning, for example work done on informal science learning (Bell, Lewenstein, Shouse & Feder, 2009), and how such 'funds of knowledge' (Gonzalez, Moll & Amanti, 2005) influence formal ways of learning science.

We can extrapolate four key themes running through a vast literature: (1) the attention to the nature and *multiple contexts of learning,* including physical contexts (Bekerman, Burbles & Silberman-Keller, 2006); (2) *studies of the discourses of learning*, the attention to language registers and specialised usage; (3) the relation of *tools* (mental, technological and including, language) which learners mobilise and in some case master and appropriate to support and further develop (Wertsch, 1998); and (4) the attention to *social networks* within whose ebb and flow learners position themselves and are positioned. Describing these four core principles will allow us to compare and contrast learning over time.

Barton & Hamilton, (1998) uses an ethnographic approach to create a rich description of the uses of literacy within individuals' lives (using a case study approach), to analyze what they call 'local literacies'; that is how literacy processes are deployed within a micro-community and how the uses of literacy both constitute and are constructed by this local frame. Whilst it might be possible to view this study as a form of social capital, understanding an aggregated use of literacy as social interaction, it also suggests how approaches to learning a literacy offer a way into assessing the texture of a community and the ways that access to literacy support individual trajectories through this 'ecology' (Barton, 2007). Within a community of learners people take part in several smaller networks that also weaves together as larger networks. In line with Street (2003) and others it then becomes important to focus on literacy events, as framed by certain activities and contexts, and broader literacy practices across different contexts in the way 'reading' and 'writing' is performed. We believe similar perspectives are valid for how people relate to science and use such knowledge across different settings.

A key construct in this field is the notion of learner identity (Wortham, 2005). Although identity is a disputed term, especially across disciplines (Cote & Levine 2002), recent interest in the idea of learning lives, formulated in respect of adult learners in the UK (http://www.tlrp.org/proj/phase111/biesta.htm), offers a way of exploring how the formation of pedagogic relationships around the self expands the focus on literacy practices to enable us to consider questions of transfer and effectiveness. The recent work of Jay Lemke, (2007) has fore-grounded the co-

construction of learner-identity (by the self and context) as way of moving on socio-cultural insights into literacy and also his former work on science education (1990).

Also the work of Lemke on 'time-scales' (2000) is of great relevance for the study of learning across different contexts. Evolving from social semiotics, Lemke uses the concept of 'time-scale' to make us aware of how actions and events on one timescale, as in a classroom activity, come to add up to more than just a series of isolated happenings. The point is to understand different timescales that students are involved in and how they relate to each other.

Trajectories of participation and the quality of talk

Participation trajectories represent another approach to studies of learning over time and across locations. As a perspective it is closely linked to identity as a "*capacity for particular forms of action and hence a capacity to interpret and use environmental affordances to support action*" (Edwards & Mackenzie, 2008: 165). As such it is prevalent to study people as participants in different trajectories and across social practices with an awareness of the contextual affordances for action. One example is the work of Anne Edwards and Lin Mackenzie on interventions aimed at preventing social exclusion among adults in the UK. They argue for a "*detailed analysis of the formation, disruption, reformation and support of trajectories of participation in the opportunities for action provided*" (Edwards & Mackenzie, 2008: 287). They operate with a situated notion of learning where mind and action is produced in participation in sets of practices. Linking back to the concept of identity, the discursive practices learners are involved in produce specific forms of subjectivities within those settings. Further we might explore how participants are not merely situated in spaces and times, but rather actively networking learning resources across space-time in the course of their activity (Leander, Phillips & Taylor, 2010: 8).

Similar issues have been raised by researchers at the LIFE-centre in the US (www.life-slc.org/). In their focus on learning science in informal environments, Bell and colleagues (2009) present different 'strands' of science learning broadening perspectives of how young people are engaged in science issues. By using an ethnographic approach studying families they show how science specific issues are part of their everyday life practices. This is done by studying young people as part of participation trajectories and how this relates to school based science education.

Language enables us to interact in many different ways, and this is reflected in the variety of registers and genres of language. Language was described by L.S.Vygotsky (1978) as a 'cultural tool', which enables us to construct and maintain social life. Others, such as Gordon Wells (1999), have suggested that it is more appropriate to describe it as a 'cultural toolkit', because of the range of functional forms that any language takes. But, as Mercer, Wegerif, Dawes, Sams and Fernandez (2007) have pointed out, even that image is inadequate in one sense, as a language does not simply exist as a fixed set of tools for communicating; it provides the resources from which specific communicative tools can be made.

Our approach builds on the work by Neil Mercer, Rupert Wegerif and others in the UK about the quality of talk in and dialogic approaches to classroom interactions, in what they call 'forms of talk' (Mercer & Wegerif, 1999). We use the term 'forms of knowledge building' to express similar ides about how students use language and

different semiotic resources in the process of working on a project at school. Our interest is especially on the challenges of establishing what Mercer & Wegerif (1999) describe as 'exploratory talk'.

> Exploratory talk is that in which partners engage critically but constructively with each other's ideas. Relevant information is offered for joint consideration. Proposals may be challenged and counter-challenged, but if so reasons are given and alternatives are offered. Agreement is sought as a basis for joint progress. Knowledge is made publicly accountable and reasoning is visible in the talk. (Mercer, 2000, p. 98).

Mercer and Wegerif (1999) describe certain conditions, based on their 'Thinking Together' project, which would be favourable for the emergence of exploratory talk in joint educational activities (at the computer and elsewhere). Our investigations suggested that the following conditions were important:

(i) partners must *have* to talk to do the task, so their conversation is not merely an incidental accompaniment;
(ii) activity should be designed to encourage co-operation, rather than competition, between partners.
(iii) partners should have a good, shared understanding of the point and purpose of the activity;
(iv) partners should have some 'meta-awareness' of how talk can be used for sharing ideas and solving problems effectively.

In their work they also put an emphasis on computers as a focus for joint activity among students. Based on empirical studies they have developed three types of talk (Mercer & Wegerif, 1999: 85):

- Disputaional talk; which is characterised by disagreement and individualised decision making, and short exchanges consisting of assertions and challenges or counter-assertions.
- Cumulative talk; in which speakers build positively but uncritically on what the other has said. Students use talk to construct a 'common knowledge' by accumulation. Cumulative discourse is characterised by repetitions, confirmations and elaborations.
- Exploratory talk; in which students engage critically but constructively with each other's ideas. Statements and suggestions are offered for joint consideration, which is then challenged and counter-challenged. Knowledge is made more publicly accountable and reasoning is more visible in the talk.

Methodology

In several studies of knowledge creation within and between different contexts of learning, an ethnographic approach to language and literacy research has been used (Heath & Street, 2008). Primarily because such research has an awareness to the field of study and the implied complexities in the social practices people are involved. One example is 'interactional ethnography' developed by Judith Green and colleagues in their studies of literacy as "*visible in the actions members take, what they are oriented towards, for what they hold each other accountable, what they accept or reject as preferred responses of others, and how they engage with, interpret and construct text*" (Castanheira, Crawford, Dixon & Green, 2001: 353). Such an approach needs to be attuned to a cultural awareness of how young people are part of different participation trajectories and certain schooled practices.

Similar ideas have been expressed in more biographical and case based approaches, as seen in the detailed analysis of one school done by Jan Nespor (1997) and the in-depth analysis of a few students during a school year by Stanton Wortham (2006). This work is less on classrooms as such but more about the webs of social relations that embed schools in neighbourhoods and communities, even though classroom research also opens up multiple 'voices' (Wertsch, 1991) and discourses about trajectories of participation and different social practices and literacy events (Bloome et al. 2005).

The data presented in this paper are of a more case-based nature. We use a case from one class at an upper secondary school in Norway to show some trajectories of knowledge building on shorter time-scales (2000), which add up to longer time-scales which are not studied here.

In our research we have both a researcher – researcher and a researcher – teacher collaboration. Bente Klevenberg is the teacher in the class being studied. She has also been a researcher on her own activities. Ola Erstad has done an independent study during the same period. The methods used for this study were observations done in the classroom following students all through the project, audio recordings of interactions among students in smaller groups of four in each group, logs written by the students as requested by the teacher at the outset of the project, at the end of each session and at the end of the project period, and also the postings on Knowledge Forum, which was a collaborative space between Norwegian and Spanish students using the platform set up in Barcelona.

Data

The data is part of a larger research project studying inquiry-based learning approaches among students. In our study at one school we followed one class over a period of two weeks, which was the duration of a specific project on the theme 'Global warming'. In the project the students are using Knowledge Forum. Part of the project is a collaboration with a school in Barcelona, Spain, on the same project theme and also using Knowledge Forum.

As indicated in the points mentioned above the main focus of this paper is on the trajectory or time-scale that the students move through as part of their knowledge building activities. As such we want to present developments through the whole period of the project, which consists of different phases that the students move through. The empirical question is how knowledge building is connected between the different phases of the project and the different forms of knowledge building represented by a trigger film, logs for reflection, discussions in groups and postings on Knowledge Forum.

The phases of the project are divided into:

- Phase 1: A trigger film, 'An Inconvenient Truth'. The students and teacher are discussing the film and deciding on certain research themes and questions different groups of students wants to work on during the project period.
- Phase 2: Students discuss the research question and seek for information, especially using the Internet.

- Phase 3: Students post notes on Knowledge Forum and comment on the notes of the other groups, creating a collective understanding of the theme 'Global warming'.
- Phase 4: Students connecting with students at a school in Barcelona, Spain, working on the same theme. They ask questions and comment on the postings from the groups working on similar issues, all in English.
- Phase 5: A video conference between the students in Oslo and Barcelona.

We want to focus on one group of students in the class consisting of 4 students (2 boys and 2 girls). One of the girls was sick the first couple of sessions and do not really connect to the group work afterwards. The data relates to three different sources during the project period:

Type of data	Description
Logs written by the students.	These logs are written throughout the project and also as reflections afterwards.
Notes and posting on Knowledge Forum.	The different elaborations and reasoning by students.
Interactional discussions among students.	By using video and audio recording we get access to the flow of discussion among the students over time.

Reflection logs on expectations

During the initial phase of the project the teacher asked the students to write individual logs about their expectations and first impressions of the project. This also had the function of starting some reflection work about such a project among the students that would be followed up later on.

As supplementary information in understanding the students' point of departure, there were some reservations among the students about participating in this project. The reason they gave was a concern that they would loose valuable time to follow the curriculum more closely. They thought the project work would take too much time and they would not have enough time left to cover the rest of the curriculum in science education at this grade level. Some students also complained to their parents, that contacted the head master at the school with the consequence that the teacher was called for a meeting to explain. The teacher defended her reasons for doing the project. This reservation among the students framed in their traditional conceptions of student roles and knowledge acquisition is important in understanding the process these students went through in this project.

One interest in the project among the students was obviously the chance to collaborate with students in Barcelona. Of the four students we focus on in this project three of them write that [2]:

> Boy 1: I expect it will be fun to work with the Spanish students. I look forward to read the views they have about the climate problems, compared to what we have heard. I expect to get a lot of information by listening to the Spanish students. Media

[2] The last girl was sick when the students wrote their reflection logs in the beginning of the project.

> in their country have probably approached the climate issue in a different way, and it will be educational to be able to listen to different views.
> Boy 2: I expect that the project with Barcelona leads me to get more knowledge about the theme global warming in general, and that I get insight in what people in another part of the world think about the theme, as mentioned because they might have other views about the theme than us here in Norway.
> Girl 1: People in other countries might have another focus on climate problems than us, and it will be exiting to listen to their view.

Their main expectation is towards exchange of information and views about the project theme of global warming and climate change. What they emphasise is how the views of the Spanish students connect with their own. Related to our interest in 'knowledge connected' it is interesting to see that these three students are all interested in the more general issue of climate change and how opinions are formed by media and public discourses, and how they might improve their own knowledge. In this sense they also have a collective understanding of how they might learn from others, especially students from another country and culture.

Knowledge gained from media discourses has a major impact on students' views and opinions. It has a more important function than just representing a backdrop for formal learning in the sense that they position themselves as learners through their everyday knowledge and that this knowledge also guide their learning trajectories further on; how new information relate to their existing insight in specific area. The issue of climate change is especially interesting in this sense since it is covered by a lot of debate in the media and among the population since it has an impact on peoples' lives in a direct way.

Seeing the film 'An Inconvenient Truth' with Al Gore was an important trigger for formulating research questions among the different groups. Each group chose one specific issue to concentrate on, and then contribute in the overall discussion on Knowledge Forum. After seeing the film each group of four students were asked to formulate one theory they wanted to explore further and put this on Knowledge Forum. The present group chose to focus on the implications of climate change on the Gulf Stream. The intention of the teacher was to narrow down a collaborative 'object' by writing 'My theory' based on their previous knowledge about the issue, and then specify and elaborate on this further. As two of the students wrote in their logs after the project had started:

> Boy 2: In our group we started by writing a theory about the Gulf Stream based on the knowledge we had from before. To a large extent this was based on the film we had seen, «An Inconvenient Truth» by Al Gore, that propose that a cool down of the ice in Greenland might result in a new ice age in the North because the Golf Stream will end. When we wrote the theory we soon found out that our knowledge was limited, and that we needed to get answers on many small questions through this project to get insight in the theme.
> Girl 2: Very good to discuss and to elaborate on theories in this way. When the group discuss views and what the theory is, there is a lot we find out that we need to know more about.

They liked the initial discussion in the group and easily decided on an issue they all found interesting. The process of writing up their preconceptions about the issue also led them to understanding their lack of knowledge about the issue.

Interaction data on collective knowledge building and explorative talk
After deciding on the issue of 'Global warming and the Gulf Stream' the students started to formulate research questions. In the beginning they concentrate on formulations of different questions, if they should have one or several research questions and about translations from Norwegian to English, since what is put on Knowledge Forum has to be in English in order to communicate with the Spanish students. The two boys and one of the girls are writing on their laptops and at the same time discussing what to put into their notes on 'My theory' and 'I would like to know'.

Boy 2: 'Consequences' (writing on the note), is that right?
Boy 1: Yeah.
Boy 2: 'These consequences may decide' (writing), then..
Girl 2: 'May follow'.
Boy 2: 'And which consequences will eventually follow'.
Girl 1: 'Eventually', that is more like at the end, like.
Boy 1: Yeah, that is sort of wrong.
Boy 2: Yeah, of course.
Girl 1: You can rather write; 'what will follow'.
Boy 2: But we do not know.
Boy 1: Shall we run a word correction program just to make sure we have everything correct?
Girl 1: Well I do not think the Spanish students or she (the teacher) will make sure it is right.
Boy 2: Ok, we'll write 'will may follow'.
Boy 1: What? 'will may'? You know that you wrote 'will may'?
Girl 1: Well I was told to write 'will may'. He he. I do what I am told.
Boy 2: No write, 'may follow'. Ok, then we publish it.
Boy 1: I think that is really interesting.
Girl 1: Me too, I think it is really exiting.

This is in contrast to what they write in the reflection logs above, where they express an insight in the issue and different views and opinions. In this interaction they are not directed towards exploring the content and building knowledge. Rather they divide assignments and work on translating from Norwegian to English.

Then they move into a phase of gathering information, primarily from the Internet. They work individually, even though they sit next to each other. Now and then they inform the others in the group about what they find without really initiating dialogue.

One of the boys (boy 1) in the group takes charge of the process at one point, starting to guide the others and give them instructions about what to look for. He also defines what is relevant and interesting in what the others find of information.

In discussing how to divide the work and how to link the different themes the students develop some exploratory suggestions building on the discussions in the group. Especially one of the boys (boy 1) create a reasoning that triggers further trajectories of exploration for all in the group, about the impact of a cooling down of the Golf Stream.

Boy 1: Some could look at the melt down.
Boy 2: I can find information about the Stream.
Boy 1: One person can find information about how much ice there was in 1960 and how much ice there is today, right?
Girl 1: Yes we can do that.
Boy 1: On Greenland. Because then we can find out how much has melted. And that is probably very interesting.
Girl 1: And compare with Greenland like.
Boy 1: But Greenland is very important.
Girl 1: Ok.
Boy 2: But …
Girl 1: What shall I take? Just give me something.
Boy 2: I can take about the Stream. Where it goes and what it is about the stream.
Boy 1: Yes, can't you find out what drives the stream? To make sure that it is cold and warmth that makes it.
Girl 1: And we can find out if it is the Atlantic or the North Sea.
Boy 1: Check everywhere where it goes, then. Which countries it goes to and things like that. It will probably also have the consequence that the countries that are very warm will keep the warm water which makes it warmer there.
Boy 2: Will it?
Boy 1: Don't you think so? Because it took away warm water.
Girl 1: Shall we write up some new questions then?
Boy 2: Well, we saw when the Golf Stream ended then the cold came, they had drawn as clouds that came in, and that went over Southern Europe.
Boy 1: Yeah, it spreads. But we can check that.
Girl 1: But can't we find some new questions linked to this. 'What drives the Stream', was that your question?
Boy 1: Yes, what drives the stream.

This discussion is then expressed in their description of their work on Knowledge Forum.

The Gulf Stream
av Girl 1
Sist endret: 2009, Jan 23 (13:17:12)
av Girl 1

La meva teoria

Our theory is that global warming will cause a meltdown of the ice on Greenland. Melting water will lead to a cool down of the Atlantic Ocean. The Gulf stream will change, because the difference between hot and cold water will no longer be as big as before. The Gulf stream which provides the western-Europe with heat, will stop. In worst case scenario this may lead to a new ice age in western-Europe.

Ocean currents
av Boy 2
Sist endret: 2009, Jan 23 (15:07:00)
av Boy 2

Ocean currents are caused by the wind. The wind makes the water move in the wind

direction, and in this case, the current is caused by the westerly winds in the northern part of this basin. As the current flows northward from the low-latitude areas of the basin, the water cools, and increases in density. When the water increases its density, it sinks to the bottom of the ocean. The cold water flows slowly down along the coast of western Europe and Africa to complete the loop.

Source: http://www.its-about-time.com/pdfs/oall.pdf

Then the teacher comes by and suggest that they can log into a site with research results (www.forskning.no) where they can find relevant and easy accessible information and research results. Then the students go on to define who will pursue on which research questions. Then the girl in the group (girl 2 was not present that day) goes on to make a suggestion;

Girl 1: Well, both can explore how much ice there is on Greenland. And you can look at another place, and then we can compare of there is a connection or difference. If we find the same numbers.
Boy 1: I think it has something to do with when it is Summer and Winter.
Boy 2: Well you do not know that. It says here that they did not know what it was.
Girl 1: There are many hypotheses.
Boy 2: It says here that it starts in the Gulf of Mexico.
Boy 1: Oh yeah, it starts there, right. Well we could also read some of the other notes that the others have put out. Maybe they have some information that we can use.

As seen in these extracts the interaction among the students is partly disputaional talk and partly cumulative talk. The students share information and propose certain directions of their work. They are in an initial phase and there are yet no examples of any critical discussions about subject matter.

A couple of days later the students start to concentrate on what to put on Knowledge Forum. This leads to a more explorative dialogue in the group about the information they have found.

Girl 1: Have you found out if it is in the Atlantic or the North Sea?
Boy 2: I am trying to find out about that right now.
Girl 1: Well it is a bit all over.
Boy 2: No, it goes from South-America, up in the Gulf of Mexico and across the Atlantic, and then, yeah…
Girl 1: Ok. When you put something on Knowledge Forum you have to build on my note that I have put out already.
Girl 2: Well, how shall we do that then?
Girl 1: On 'approach to the problem', you just push and build on even though it is not me.
Girl 2: Ok, so then I just write the information I have found.
Girl 1: What? Shall we not put together first?
Boy 2: No we put out each others and see how it goes?
Girl 1: Is it not better to put it together and publish it as one instead of putting out four more?
Boy 2: What?
Girl 1: Well now we have put out 'approach to the problem' and our theory. And now we find new information. We have to publish that too, but should we not put it together and then …
Boy 2: Yes, We do not bother to put out four different.
Boy 1: Of course we should, that is the point.
Girl 1: No, we should write a small text. We should not write, like, wild.
Boy 1: Yes, that is the point.

Girl 1: No I do not think so.
Boy 2: Ask then.
Boy 1: We should put on each so she can see who have done what.
Girl 1: Oh yeah? We have to ask her then.

After clearing that with the teacher they go on to discuss different questions while searching on the Internet at the same time.

Girl 1: Well, have you found out something about, is it the cold and warm currents, since it is cold and warm water, is it that which makes the streams?
Boy 2: That the cold water sinks. When the warm water gets cooled down it sinks.
Girl 1: Ok, so when the ice on Greenland melts, then that melted water will be cold and that will cool down the Gulf Stream, and then it will stop because it has no warm water.
Boy 1: 'The stream is driven day by day by the wind', it says here.
Boy 2: Does it say that?
Boy 1: Yes. On www.forskning.no.
Girl 1: No it is driven by both the sea stream and wind. It is both.
Boy 1: Ok. But it has something to do with high pressure and low pressure also.
Girl 1: High and low pressure?
Boy 1: Yes it has something to do with that.
Girl 1: Well I though that… Does it really matter if it is cold or warm water then?
Boy 1: That is what XX (boy 2) tries to find about right now.

Then they sit and work in silence for about one minute searching on the Internet until one of the boys says;

Boy 1: Yeah, I think it is that the wind drives the warm water up, right. And then, it says here that it is cooled down and that it is the reason it sinks down. And also that it has a lot of salt. And then it says here 'And therefore it goes back'. Maybe it is because all the time new water is coming up and then it is pressured away.
Girl 1: That is why it is more salt.
Boy 2: But I do not know if it is the wind. Does it say there that it is the wind that drives the scurrent, because that is a bit strange?
Girl 1: It is both. But that is just something I think.
Boy 2: Because the direction of the wind can be different from the direction of the current. But I will read some more about that.

After another 5 minutes they go on to discuss some new information they have found.

Boy 1: It has something to do with fresh water. That stops it. It says here that when more fresh water comes it will stop the Gulf Stream
Girl 2: yes it is because when water evaporates, because it is warm, but the salt does not evaporate. So it becomes heavier, at the same as it is colder.
Boy 1: Yes, but here they use that as a reason for saying that it does not stop because the warm water in the south, but, what you probably meant was that it has not so much to do with the temperature, but that it is fresh water.
Boy 2: Yes, but why does it evaporate further North?
Boy 1: Well here he does not talk about evaporation. Well, yes he talks about evaporation in the South. But first he talks about that if there is global warming it will become warmer and then the fresh water will go down, and this might lead the Gulf Stream to stop because of the fresh water. But I do not quite understand why it stops because of the fresh water.
Boy 2: Well there is a constant flow of fresh water all the time.

Boy 1: yes, but then it comes more fresh water from the glaciers and such. And yes, that leads to, then most probably the salt water will not fall down, right?
Boy 2: Yes then it stops and all becomes heavy, like.
Girl 1: But there is more salt up North because it is left there.
Boy 2: Yes, the salt water goes down then, and then it goes back again. But that means it has to evaporate up North. But there is no reason why it should evaporate up North.
Boy 1: No, it has not so much to do with evaporation then.
Girl 1: Yes, the salt will stay.
Boy 1: Yes, it falls down. It does not take the salt with it.
Girl 1: Yes, but that is why… You know what I mean (to boy 2)?
Boy 2: Yes.
Boy 1: What?
Girl 1: Water evaporates all the time, right?
Boy 1: Yes.
Girl 1: When it evaporates, it leaves behind salt. The salt does not evaporate. That is why it has to be more evaporation in the North and there is most salt in the North.
Boy 1: But it does not have to be because of that the salt is left behind.
Girl 1: I do not know. What other reasons are there?
Boy 1: But there cannot be more evaporation in the North.
Girl 1: No, but there are more salt in the North, therefore we say that there should be more evaporation.
Boy 1: It probably has something to do with the thing that cold water cannot hold on to the salt.
Girl 1: It was Al Gore who said that there is more salt the further North you go.
Boy 1: But we do not know that it evaporates.
Boy 2: But it is the wind that makes the waves. (Then reads from his screen) 'The surface currents are caused by the wind'. 'Surface currents', I do not know …
Boy 1: Well, that is what drives that thing up to go forward. And there was something that it is so heavy or something when it goes back.
Boy 2: (Reads again.) 'The forces of the wind on the water also moves the water forward to create the current.'
Girl 1: Why do you search on English?
Boy 2: Because it is written in English. I do not translate what is written here.
Girl 1: But why do you not search on Norwegian?
Boy 2: Because there is more info on English.

Then another period of about five minutes where they work individually finding information.

Boy 2: Ok, listen. The surface currents are driven by wind, and then it reaches the North, and it gets cooled down …
Girl 1: Cooled down by what?
Boy 1: Because it is colder up there.
Girl 1: Yeah, I just need to know.
Boy 2: And that makes it get higher density, and that is not the case further South. But further North, its like, some freezes to ice, of the water, and then the ice consist of less salt, and then there is more salt in the water, so it increases in density, and then it sinks down and then it goes back. So mainly it is the wind that drives the currents.
Girl 1: So what is that we mentioned in our theory?
Boy 2: Yes it is because warm water has less density. So that has something to do with it sinking again.
Boy 1: So when it gets colder it will sink because it has more density so it is heavier.
Girl 1: Well, will it go back then?

Boy 2: Yes, then it goes back to where the warm water comes from, so there will be circulation.
Girl 1: Yes, but if the ice on Greenland melts then the water will be even more cooled down.
Boy 1: Yes, but it has something to do with fresh water. Because then there will be a lot of water that does not have any salt and then there will be less density. Do you understand? Because the salt is distributed with more water, and there will be less density in the water.
Girl 1: And then it will stop?
Boy 1: Well, this guy says it will stop, but it will slow down at least.
Boy 2: Well the water is very cold also, so it might have something to say.
Girl 1: I read that it will stop the Golf current because it will become so cold.
Boy 2: So shall I write this into the site?

Then they start to write their findings into Knowledge Forum at the same time as they read aloud from the sites they search on the Internet. Looking at the notes on Knowledge Forum we see some expression of their discussion, but not their more explorative reasoning. What is new here, though, is the connection to the students in Barcelona.

Question
av Spanish girl
Sist endret: 2009, Feb 05 (16:39:21)
av Spanish girl

Necessito entendre

Hey!, we are X, Y and Z but we don't understand very well your aguments. We tried to look at your sources, but they are in norwegian, so we can't read them. It would be a great detail of you if you could put some similar sources in english.

Thank's!

http://www.forskning.no/Artikler/2002/november/1037968101.74 in english by google translator.
av Girl 1, Boy 1, Boy 2
Sist endret: 2009, Feb 12 (15:36:16)
av Boy 1

Earlier fears that the Gulf Stream is weakened and disappears is probably greatly exaggerated. New research from the research project RegClim shows that the Gulf Stream will remain stable over the next 100 years.

- Formerly there were many scientists who claimed that the Gulf Stream would disappear completely. There is much that proves that the strength of the stream will vary in this century, but the mean will not change in any great degree, "says Professor Helge Drange at the Bjerknes Center and the Nansen Center.

Drange believe it must be possible that heat transport in the Gulf Stream will be weakened. Measurements indicate that the Gulf Stream stopped completely in the periods under previous ice ages. Calculations show that the climate along the Norwegian coast can be five to ten degrees colder if the Gulf Stream collapses or does not reach up to our latitude.

- But it is unlikely that it will stop within the next hundred years. Even the models that calculate the greatest weakening of the Gulf Stream, the warmer climate in our regions. The global warming will more than offset the possible regional cooling due to a weakened Gulf

Stream.

A Norwegian branch

Gulf Stream describes in everyday speech, the flow of surface water in the North Atlantic from the Gulf of Mexico, across the Atlantic, and with one branch in the Norwegian Sea.

- Power operated from day to day by the wind. When the warm salt-bearing surface waters cool in the Nordic seas during the winter, it drops down to the sea floor and forms the bottom water in the oceans. Salt water is therefore driven back as the depth and bunnvann. Thus the scope for transport of the more heated surface from the Caribbean, "explains Professor Drange.

This vertical revolution of water is one of the reasons that it is small is all the way into the Barents Sea and in Svalbard.

- It is important to calculate the extent to which global warming affects the vertical revolution, and thus the heat transport in the Gulf Stream, "said Drange.

Large reduction

Temperatures in the depths of the Norwegian Sea from the veather ship Polar Front suggests that the strength of the dyphavssirkulasjonen in the Norwegian Sea has decreased by 25 percent during the past 50 years. This may also indicate that the Gulf Stream has been weakened over the same period of time.

Without the Gulf Stream had what was covered by ice in the north probably gone down to the Faroe Islands. It is, as far south as what was covered by ice is north of the Americas and Siberia. But because of global warming, is what was covered by ice in the Arctic now in the process of retiring.

The arctic what was covered by ice in March to the left. What was covered by ice in August to the right. Light blue shows the current situation. The white shows a possible situation in 2080. (ill RegClim)
Boat through the Arctic in 2050

- The most sober models open for ships that sail from Scandinavia, north through the Northeast Passage in the Arctic and over to Alaska in the summer of 2050, says Drange. But many polls suggest that it is possible to sail through the Arctic before the time.

A process that can help to weaken the Gulf Stream is the supply of fresh water on the surface of the sea in Norwegian waters in the north from precipitation, rivers and issmelting. Increased supply of fresh water because of global warming will in isolation lead to a weakened Gulf Stream.

The new results from RegClim shows, however, small changes in the Gulf Stream by increased greenhouse effect. A warmer globe, will in fact lead to more evaporation in the southern tropical regions. Thus, this water becomes more saline, and a part of this water will flow northward, and thereby offsetting the effect of increased fresh water supply in northern regions, outside the Norwegian coast.

This is not the best English. We hope that you understand it. Please write if you do not understand.

How will the global warming affect the Gulf stream?
av Spanish boy
Sist endret: 2009, Feb 04 (13:11:13)
av Spanish boy

Nøkkelord: Ice age ice-age ages ice-ages iced melt down gel glaç edat de gel i'm cool 23

Hey! We are X, Y and Z and we would say to you that we're very interested in what you said. We think that your theory is well done: if the global warming doesn't stop in a few period of time, the ice of Greenland will melt down and it will be a serious problem for the Gulf Stream.
You said that before the Gulf Stream get stoped there will be an Ice Age, and we will talk about it. So, for information about the Ice Ages or for giving us some useful details you can look at our explanation.

http://kforum.xtec.cat/note?DB=comconeixer&NoteID=262982&ViewID=210118

ce-ages
av Spanish Girl
Sist endret: 2009, Feb 04 (13:07:36)
av Spanish girl

Hi! where are X, Y and Z, and we have a theory about Ice-ages.

As far as we are concernded, we would be able to say, without chance of mistaking, that ice-ages are long periods of time in which a huge extension of the whole Earth is covered by ice. In consequence, every single living form is threatended to meet its end. Due to ice ages, species are forced to evolve in order to be able to face new dangers unknown unti that moment. Moreover, this phenomenon decreases the temperature average and increases the difficulty to find foo. In conclusion, we think that ice-ages are a fatal challenge that show which ones are the strongest by staying alive.

Our new theory about the Gulf Stream
av Boy 2, Girl 1, Boy 1, Girl 2
Sist endret: 2009, Mar 12 (14:36:49)
av Boy 1

Síntesi avançada

We now know that the Gulfstream is mainly driven by winds. The circulation depends on the differnce in density caused by the salt. The combination of salt and cold water increases the waters density and makes the cold and salty water sink, returning back against the equator along the bottom.

There are many theories for and against the gulf stream to stop. This makes it hard to come to a conclution. Even though the Gulf stream stops, it is hard to tell how it will affect western-Europe.

This connection between the Norwegian and Spanish students is more about sharing information and making their positions.

Reflection logs on the process

In their reflection logs after the project has ended the students write about their experiences.

Approaching information

In their reflections the students in this group indicate what triggered their learning process in this project.

When we worked on finding 'new information', I found a lot I did not know from before, and adjusted some things I was uncertain about. (Boy 1)

The research question was one of the main reasons that I learned so much. Because we had a question that consisted of so much information we also got a lot of information we could discuss and learn from. (Girl 1)

In 'my theory' we mainly took Al Gore's film as a starting point, and what it presented concerning the Gulf current. (Boy 1)

As Boy 1 mention they adjusted their former knowledge after searching the research within this field. The trigger film was important as a staring point in formulating their theory and their critical stance to the findings presented. As the girl also mention, working on the research question was an important point in their work.

On knowledge building

Working on their issue, the students collaborated and discussed different perspectives and ways of understanding the issue. However, when they looked into the notes from the other groups they worked more individually.

When we were building on the others theme we worked a lot by ourselves. We read other texts, and were critical to what they wrote. (Boy 1)

During the last phase 'building on our own and others themes', we answered the questions and the comments that had come to us as best we could. After that we looked at other themes, and formulated questions to things we thought were interesting, unclear or lacking. During this phase I learned a lot about the others themes, because I got enough time to read up on them. (Boy 2)

My group received a number of good questions about our theme, and about what we had written. I got a number of comments on the note about what sea currents are and how they move, because I think the note could have been difficult to understand, because this is a difficult theme, and because there were some difficult words. (Boy 2)

They were positive to knowledge building as a method in the way they comment on other postings and the questions and comments they receive themselves. They seem to learn from this in the sense that discussing in this way make them understand the issues the other groups are working on and also how they themselves express their knowledge for the others to read and understand.

Views on the issue

In their evaluation of their own learning process, expressed in these reflection logs after the project had ended, they are quite explicit in what they have gained from this project.

I have changed views about the Gulf current and Greenland. I have not made a specific opinion about what is right or wrong. I believe the CO2 level has increased, but I am still a bit uncertain about how much that is manmade, and if the consequences are as large as many seems to think. Today I for example found 'proof' that some of the things Gore said was wrong. Researchers disagree (even though Gore say they do not). I can therefore not say that I have changed my opinion. (Boy 1)

The film might have contributed to reinforce my opinions about pollution that create global warming. (Boy 2)

The conclusion has to be that I have learned a great deal, not only about the theme, but also to be critical. Al Gore has a theory, the theory that we built our theory on. Our theory we cannot be sure is right. Since there has been a lot for and against on this issue we agreed that there should not be a set answer on what will happen. Personally I believe that the Gulf current will stop immediately. (Girl 1)

Looking back on our opinions we see that it is all wrong, and badly thought through. If the Gulf current had only been directed by changes in temperature, the cold water from Greenland would only reinforce the currents. (Boy 1)

I have changed my opinion a bit, but I am still very doubtful. Because there is so much disagreement there is quite a lot that became even more unclear than it was. This is because I realy did not know so much about it before. Before the project started I did not really have any opinion about global warming. I guess I had come to the conclusion that, yes, it is there but what can I do about that issue? (Girl 1)

As the girl mentions above they have not only learned a great deal about the issue they were working on, but also 'to be critical', and what that means in a process of argumentation and knowledge building. Also the impression that they have changed opinions concerning their preconceptions on the issue.

Discussion

Two main issues have been explored above. One is about how knowledge is connected, the other about trajectories of knowledge building. In order to study these issues we have used different sets of data.

First, it is the issue of how students connect between different knowledge domains and information sources in their knowledge building strategy. The students in this study obviously make connection between their everyday conceptions of global warming, mainly based on following debates in the media, and the contextualization (van Oers, 1998) of this issue within science education in schools. This is seen in their logs in the beginning of the project, where they present some of their ideas and opinions. The theme itself relates directly to the knowledge gained outside of school. However, they soon discover their lack of substantial knowledge on the issue they are working. Further on in the project the connection is then done between their ideas and opinions and the views of different researchers. Further, their opinions and findings about global warming and the effect on the Gulf Stream is connected to the opinions

and questions from the Spanish students on Knowledge Forum. The trigger film 'An Inconvenient Truth' was important in formulating ideas connecting their own opinions on the issue and the research findings presented in the film. Of course the students also have to connect the information they find from different sources, which trigger their discussions in the group.

Second, the trajectories of knowledge building raised in this paper are shown in the interconnections between the different phases of the project and the different data sets presented. It is the dynamic and the flow between the different phases that create the potential for knowledge building. Without studying the interaction between the students in discussing their findings it is difficult to evaluate their postings of notes on Knowledge Forum.

In studying the trajectories and flow of knowledge building among the students we have seen that they are very engaged in the issue they are working on. In the class as a whole it was also interesting to notice that their very critical remarks and attitudes towards the project and working on Knowledge Forum in the beginning changed a lot during this period based on their experiences and an understanding of what they gained of knowledge and insight on the issue during this period, as seen in their logs and comments after the project had ended.

As shown in the extracts above from one of the groups in the class, the students struggled in reaching what Mercer and Wegerif (1999) describe as 'exploratory talk'. Most of the time they are doing 'disputational' and 'cumulative' talk. They find information on the Internet, which they share with the others and discuss with some short assertions and counter-assertions, and then post on Kowledge Forum. Some of these postings they get feedback and questions from other students in the class. We also see that they build positively but uncritically on the comments of the others in the group. The students struggle to interpret the different factors that influence the Gulf Stream and how global warming might influence these factors in different ways. It is only during one long sequence that we see that they engage more critically and constructively with each other's ideas, where reasoning is more visible in the talk. That is after they have been working for some time on the different research data and different perspectives on global warming and the Gulf Stream. After critically examining different perspectives together they explore they foundation of what is considered reasonable without reaching a conclusion. This is formulated as a description in a note on Knowledge Forum that the Spanish students respond to and which create further exploration and argumentation among the Norwegian students.

This process of different 'forms of talk' might also be described as different 'forms of knowledge building' based on these trajectories and flows in the way students are working, using different resources and ways of expressing their ideas and opinions (logs, discussions and posting on KF). Knowledge Forum is important in the way it forces the students to think through their formulation of a research question, which is an important starting point in the project, also in the way they have to use English to formulate their theory and findings. The interaction with the Spanish students triggered was positive and gave the students an extra impact in such a project, since they were living in a different environment where global warming was interpreted and presented in the public discourse in a different way than the Norwegian students.

In relation to issues of assessment and 21st Century competencies, the logs written by the students are of importance. These logs are part of the assignment by the teacher set out in the beginning of the project. For the teacher this represents two important assessment issues. First, by writing these logs the students reflect on their own learning process in a formative way by getting feedback from the teacher, but also that the students comment on each other logs on Knowledge Forum. In this project these logs represented something new for the students, and they express interest in the way they make the students think about learning processes both for themselves and in a collective sense. Second, the teacher gets important information about the processes of the students, of how they have been reasoning and working in the group and problems they have experienced. The teacher can then support the students towards more exploratory talk.

Concluding reflections

This research has larger implication for how we study knowledge building and learning over longer periods of time and across different contexts, studying what Jan Nespor (1994) terms 'knowledge in motion'. Related to 21st Century competencies this raises important considerations about the process of knowledge building and creation among students, over time and also across contexts. As such, it challenges traditional conceptions of formal versus informal ways of learning. Also, implying different approaches towards conceiving assessment that will support knowledge building as life-wide and life-long.

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