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Socio-cultural aspects of prompting student reflection in Web-based inquiry learning environments

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Abstract

This paper reports on a qualitative study of students' engagement with a Web-based inquiry environment aimed at prompting student reflection in processes of scientific inquiry. In order to demonstrate how prompts become structuring resources for students' scientific inquiry, detailed analyses of students' interaction processes are conducted. The students' written responses to the reflection prompts indicated a widespread use of a 'copy and paste' strategy. The analyses of student interaction deepen this finding and show that instead of participating in reflection activities, the students make use of these 'copy and paste' strategies in order to come up with 'correct' answers to the prompts. Further, the analyses indicate that the students' employment of these strategies can be seen as a response to what can be termed the institutional practices of schooling embedded within the design of the prompts. These findings are discussed and explored in accordance with findings from previous studies on prompting students' reflection in Web-based inquiry environments. The study demonstrates the value of a socio-cultural perspective for gaining a deeper understanding of students' engagement with Web-based learning environments. Such a perspective can give valuable insight into how to (re)design prompts, and how prompts can be productive parts of students' learning.

Keywords

interaction analysis, prompting student reflection, socio-cultural theory, Web-based inquiry learning environments.

Introduction

This paper reports on a study of students' engagement with a collaborative Web-based inquiry environment aimed at supporting student reflection during scientific inquiry. Within the learning sciences there seems to be a fair consensus that reflection has a positive impact on students' acquisition of knowledge, as well as on their inquiry skills (Brown *et al.* 1983). Over the past few decades, several Web-based computer tools have been developed with the aim of engaging and scaffolding students in scientific inquiry (de Jong 2006; Linn & Eylon 2006). A common feature for many of these Web-based inquiry environments is the built-in tools aimed at supporting specific aspects of students' inquiry processes, which include sense making, process management, articulation and reflection (Quintana *et al.* 2004; de Jong 2006). In the research literature, such tools have been referred to as 'scaffolds' (Quintana *et al.* 2004), 'support tools' (Manlove *et al.* 2006) or 'prompts' (Davis & Linn 2000; Davis 2004). Research on students' employment with prompts in Web-based learning environments shows divergent findings. Common findings are that students often tend to ignore prompts,

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or that students do not benefit from the support that the prompts are intended to give. Additionally, there are few studies that demonstrate positive effects of prompts with regards to student performance (Aleven *et al.* 2003; Clarebout & Elen 2006).

In order to gain a deeper understanding of these discouraging findings, a socio-cultural approach is taken (Vygotsky 1978; Wertsch 1991). In this paper, the empirical focus is on secondary school students' interaction while engaging with gene technology in the Web-based inquiry learning environment 'Viten.no', the Norwegian counterpart of the KIE/WISE learning environments.[1] A central feature in 'Viten.no' is the prompts designed to support students in their process of reflecting on the scientific concepts by means of content-related questions. Seen from a socio-cultural perspective, Web-based learning environments such as 'Viten.no' can be regarded as a cultural artefact (Cole 1996) storing *opportunities* to engage with embedded *knowledge* and *social practices* developed over generations. This knowledge and these practices are what students potentially interact with when they employ artefacts and perform different types of activities (Säljö 2000). The interesting aspect then becomes the exploration of if and how the students make use of these opportunities for action during their engagement with the learning environment. In order to discuss this issue, the following research questions are addressed:

- *What opportunities for action are embedded within the Web-based learning environment 'Viten.no', and how do these opportunities for action become structuring resources in the students' participation in scientific inquiry?*
  1. *in non-prompting situations?*
  2. *in prompting situations?*

Research on the effects of prompting student reflection in Web-based inquiry learning environments

Several studies have deepened our understanding about the role of prompt tools in computer-based learning environments. Review studies regarding students' 'help seeking' (Aleven *et al.* 2003) and 'tool use' (Clarebout & Elen 2006) in computer-based environments within various knowledge domains show that there are divergent findings with regards to the effects of prompts on student performance. Common findings are low use frequencies, especially when it comes to students with lower prior knowledge (Wood & Wood 1999), or even that students often ignore on-demand prompts (Oliver & Hannafin 2000; Wood 2001). Other discouraging findings are insufficient use patterns such as in cases where students receive prompts containing supplementary information. Here, they tend to produce less explanations and justifications than those who do not receive such prompts (Renkl 2002), or when engaging with levelled hints, the students tend to go directly to the last hint level, which comes close to giving away the right answer (Aleven & Koedinger 2000). However, the research literature on help seeking and tool use also give indications that when students actually use prompts as intended, their performances are often substantially improved (Aleven *et al.* 2003; Clarebout & Elen 2006).

Within the field of scientific inquiry learning, several studies have explored the effects of supporting students' sense making and reflection by means of prompts in Web-based inquiry environments (Quintana *et al.* 2004; de Jong 2006). Most of these are experimental studies with a cognitive or socio-cognitive orientation. Some of these studies have documented positive effects on students' acquisition of scientific knowledge and inquiry skills.

In one study, White and Frederiksen (1998) focus on the effect of prompts seen in relation to 'high-achieving' and 'low-achieving' students. The study shows that students who regularly responded to reflective assessment prompts developed a higher acquisition of conceptual knowledge, as well as inquiry skills. The overall conclusion of the study is that prompting reflection is effective for all students, but that 'low-achieving' students can benefit especially from these types of prompts (White & Frederiksen 1998, p. 51). Lin and Lehman (1999) focus on the effects of prompts with regard to the *transfer of learning*. The students that were prompted to give reasons and justifications scored significantly higher than the other groups in terms of their ability to solve contextually dissimilar problems. Yet other studies show the positive effects of *integrating reflection prompts* with other types of prompts, such as prompts that give students interpretative or experimental support in their inquiry learning processes (Reid *et al.* 2003; Zhang *et al.* 2004). In a non-experimental study, Sandoval and Reiser (2004) focus on the effect of prompts in relation to students' *reflection in peer dis-*

cussions. The prompts enabled the students to perform epistemically oriented monitoring of their working process, plan activities and reflect on scientific explanations and pieces of evidence.

Davis (2003, 2004) contrasts the effects of two types of reflection prompts, 'generic prompts' and 'directed prompts', designed within the Knowledge Integration Environment (KIE). Generic prompts are generic in that sense that they do not provide instructions for what to elaborate on. In contrast, directed prompts give students hints about what to elaborate on. Firstly, Davis found that the students in the generic prompt condition developed more 'coherent understandings' of science than the students who received directed prompts. Secondly, the students more often reflected 'unproductively' in response to the directed prompts compared to the generic prompts (Davis 2003, p. 129).[2] Overall, this means that the more open-ended generic prompts were considered to have a greater effect than directed prompts.

Based on the findings and experiences described in the studies reviewed, some interesting points can be made. The first concerns the divergent findings related to students' employment of prompts within computer-based learning environments in general. Several studies document discouraging findings in regards to low use frequency, insufficient use patterns and that students often do not benefit from the support given by the prompts. However, there are also studies that document positive effects of prompting students' reflection in Web-based inquiry environments. The second point concerns the design of the reflection prompts that have documented a positive effect. One common feature of the reflection prompts that have demonstrated positive effects is that they aim to support students' acquisition of scientific knowledge and inquiry skills by means of prompting them to engage in *activities* characterized by explicit articulation and elaboration. A third point to be made concerns what type of effects prompts have demonstrated to have on students' performances. A common finding is that prompting students to reflect has a positive effect, particularly on students' inquiry performances, but also to some extent on students' acquisition of scientific knowledge. This finding corresponds with studies on other types of prompts, which also show that they are more effective for enhancing students' acquisition of inquiry skills than of scientific knowledge (van Joolingen *et al.* 2007).

A final point concerns the need for more detailed analyses in order to understand the positive or negative effects of students' engagement with Web-based learning environments, as well as *how* students actually engage with the prompts. Davis, for one, calls for studies that include classroom observations and detailed analyses in order explore whether the reasons for the differences in effects are to be found within the specific prompt designs, the educational context or the characteristics of individuals (Davis 2004).

A socio-cultural perspective on students' engagement with Web-based inquiry learning environments

Seen from a socio-cultural perspective, an important part of human conduct and learning processes is the employment of various types of material tools. Tools can be seen as cultural artefacts (Cole 1996) that store *knowledge* and *social practices* developed over generations. This knowledge and these practices are what we interact with when we employ the artefacts and perform different types of activities (Säljö 2000). In viewing Web-based inquiry environments such as 'Viten.no' as cultural artefacts, it is possible to see that these types of environments embed concepts and knowledge from a particular knowledge domain, as well as types of social practices. Considering the *knowledge aspect* of Web-based inquiry environments, we find that centuries of research, discoveries and scientific discussions are embedded within them by means of different types of textual and visual representations. Seen from this perspective, Web-based inquiry environments provide potential opportunities for students to interact with specific knowledge domains and scientific discourses.

Considering the *social practices aspect*, at least two types of social practices are embedded in the design of Web-based inquiry learning environments. The *practices of scientific inquiry* are one type of embedded social practice. This means that ideal epistemic activities characterizing scientific inquiry performed by researchers are embedded in the design of the Web-based learning environment. This is expressed, for example, in that students are encouraged to engage with the scientific content by performing activities such as hypothesis generation, evaluating evidence and constructing explanations. A second type of social practice that is embedded within Web-based inquiry environments is *institutional practices*. What characterizes Web-based inquiry learning environments is that they are not only tools for performing scientific inquiry as such, but also tools designed with the intention of teaching students *how* to engage in scientific inquiry in a particular institutional setting: school science. Consequently, Web-based inquiry environments, as educational environments in general, embed residues of more or less explicit institutional practices reflecting specific ways of organizing, for example, instruction, learning activities and assessment. The embedded institutional practices can be expressed in many different ways such as, for example, by means of written instructions on how to carry out a specific task or procedure, tools that enable the students to test their own skills or conceptual understanding or tools that enable the teacher to supervise and comment on the students' work. The more or less explicitly embedded institutional practices can be, and often are, at odds with the ideal practices of scientific inquiry (Chinn & Malhotra 2002). Dealing with and responding to these possible contradictive practices is consequently a central aspect of students' engagement with these types of environments.

Even if Web-based learning resources store knowledge and residues of social practices, students do not necessarily employ the learning resources as intended by the designers or teachers. The meanings and functions of artefacts are (re)constructed in action. They can be used, invoked and referred to, or misunderstood, disregarded and ignored. This is to say that participants never know or manage the 'full' meanings or potential of a tool – this would be unattainable. Instead, this is negotiable among participants, and many concerns affect the criteria for treating interpretations or the use of tools as appropriate in a given setting (Wertsch 1991). Consequently, reflection prompts – as well as scientific concepts – are to be conceived as polysemic entities, and students will often have different opinions about how to understand and employ them in their work (Furberg & Arnseth 2009). In line with a sociocultural perspective, I argue that students' talk and interaction while engaging with Web-based learning environments constitute a possible entrance for understanding how they actually make sense of and employ prompts as structuring resources in their learning processes. During interaction, participants constantly make meanings and interpretations of situations, events and actions visible and observable to other participants, as well as for us as analysts (Linell 1998; Mercer 2004).

The Web-based inquiry environment 'Viten.no'

'Viten.no'[3] consists of programs devoted to different science topics, one of which is gene technology. In 2006, 'Viten.no' had more than 2500 registered teachers and 70 000 students. The gene technology program, which is at the centre of this study, introduces students to basic topics within genetics, as well as ethical aspects of gene modification. Students have access to texts, a structured set of links to relevant sites, drag-and-drop tasks, animations and multiple-choice tests. Examples of main topics actualized in the gene technology program include 'cell construction', 'the genetic code' and 'protein synthesis'.

The prompts (referred to in 'Viten.no' as 'notes'), designed to elicit reflection on central aspects of the scientific content, are emphasized as an important feature of the 'Viten.no' environment (Jorde *et al.* 2003). To my knowledge, the theoretical learning principles and the design principles forming the basis of the prompts in 'Viten.no' are not directly addressed or extensively discussed in published studies or reports. However, a number of studies and reports stress that 'Viten.no' environments are generally based on the Knowledge Integration Framework, such as the KIE/WISE environments developed by Marcia Linn and her colleagues (Jorde *et al.* 2003; Linn *et al.* 2004a). A common feature of the prompts in light of the reviewed studies above is that they are *process-oriented*. However, the prompts in the 'Viten.no' gene technology program can be regarded as *content-oriented*. This implies that the prompts do not explicitly deal with the procedural aspects of scientific inquiry. After each main topic's introduction, students are exposed to pop-up prompts containing open-ended questions about the topic with which they have just engaged. The students are asked to write their responses in a designated column in the pop-up window, and the responses are then saved in a so-called 'workbook'. The teacher has online access to the students' workbooks and can evaluate and add comments to the students' written contributions.

Research design

Setting and participants

The empirical data were produced during a school project about gene technology in the fall of 2004. The project was carried out in 15 school lessons over the course of 2 weeks.[4] The participants were two secondary school classes of 10th grade students, aged 15–16 years, with 25 students in each class. The central resource for introducing students to the gene technology curriculum was the Web-based learning environment 'Viten.no'. The teacher was in charge of planning and carrying out the project. The project was divided into two periods. During the first week, the students worked in dyads with basic genetics in 'Viten.no' in the school's library and computer room. In the second week, the students worked in groups of four, preparing for and carrying out a plenum classroom debate related to ethical perspectives on the genetic modification of food.

Data and analysis

Transcribed video recordings of four student dyads' interaction while engaging with the Web-based environment 'Viten.no' constitute the main data material in this study. The video recordings used in this study comprise 20 h of transcribed interactional data. Additionally, the students' written responses to the prompts in 'Viten.no' represent important supplementing contextual data for the analyses of the students' interaction. The interactions analysed in this study were produced during six lessons where the students engaged with basic genetics in 'Viten.no'.

The analyses of the students' interaction were conducted in two steps. The initial analysis of all the interactional data produced in the four target groups made it possible to identify general patterns of how the students engaged with the learning environment within (1) non-prompting and (2) prompting situations. In order to explore and understand these practices in more depth, *three* selected extracts of students' interaction are analysed in detail in the following. Two of the extracts are taken from one student dyad's interaction where the first is from a non-prompting situation and the second from a prompting situation. Additionally, I analyse one extract taken from another student dyad's interaction in a prompting situation. These extracts are primarily selected for two reasons. First, they display *typical patterns* of students' engagement with the 'Viten.no' environment. Second, they make it possible to explore and understand *how* the Web-based environment, including the embedded prompts, becomes a structuring resource in students' learning processes.

I have been concerned with examining the students' 'accounts', where accounts are seen as specific forms of linguistic devices that interlocutors use to deal with issues, arguments or actions that somehow require explanations, clarifications or justifications (Scott & Lyman 1968; Mäkitalo 2003). By focusing on students' accounts, the attention is on the students' concerns – what they treat as relevant – as well as how they try to deal with these concerns in their talk. In addition to a detailed examination of specific extracts of interaction, ethnographic information about the institutional setting has been used as a background resource for understanding what was going on. Examination of the material as a whole provided a context for a more detailed analysis of selected extracts.

Results

The examination of the students' written responses to the prompts in 'Viten.no' revealed that most of the responses had one common feature: they were short, non-argumentative, declarative formulations with a strong resemblance to formulations and text passages in 'Viten.no'. Seeing the students' use of what can be termed as a 'copy and paste' strategy in a context where the prompts are aimed at engaging and supporting students' reflection, it seems reasonable to conclude that the prompts do not live up to the intention. Put another way, the students' responses do not show signs that the prompts are used as opportunities for participating in reflection. Going through the video recordings of the students' interaction while engaging with the Web-based environment, in search of episodes containing elaborations, explanations or justifications, it turned out that several episodes characterized by such accounts could be identified. However, there seemed to be one common feature for most of these episodes: they took place in situations where the students did *not* engage with prompts.

In order to explain and understand the discouraging finding of the 'copy and paste' strategy, detailed analyses of three extracts from students' *interactional* *processes* while engaging with the Web-based inquiry environment are conducted. First, two selected extracts from one student dyad's interaction during a non-prompting and a prompting situation are analysed. Next, one extract from a second student dyad's interaction during a prompting situation is analysed.

Student interaction in a non-prompting situation[5]

In the episode shown in Fig 2, Ingrid and Elisa sit in front of a computer engaged with the introduction to protein synthesis, one of the main topics in the program about gene technology. Protein synthesis is the cellular process whereby different types of protein are produced. This process implies that a copy of a gene is made within the cell nucleus from DNA, and this copy is called RNA. RNA is often referred to as the recipe for the proteins. The section dealing with protein synthesis in 'Viten.no' is illustrated by a step-by-step animation depicting the phases in protein synthesis. The screenshots in Fig 1 are taken from the animation with which the students engage.

Just before this extract, the students come across the concept 'RNA'. They think about the concept, and decide to try to find out what RNA is. They agree to look at animation depicting the process of protein synthesis, and see if this can help them to understand more about RNA. The extract in Fig 2 opens with Ingrid reading aloud from the text along with the first step in the animation.

In the first part of the extract (lines 1–9), where the students go through the animation step-by-step, they talk their way through what they see and read. Along the way, they verify their own as well as the other's understanding by reading the text aloud and discussing aspects of it or concepts, giving explanatory accounts. By jumping in and out of reading the explanations and pausing between each step in the animation, the students slow the process down, taking their time to reflect on what they have introduced to as well as relating what they see and read to their primary concern: making sense of the concept of RNA. This step-by-step procedure continues until the students actually see the RNA being constructed in the animation. Based on this, it is possible to claim that the students actively and explicitly use the animations, the text and the built-in pauses in the animation as an opportunity to reflect on and construct a shared understanding of the concepts to which they are being introduced.

As we see in the second part of the extract (lines 10–22), after the students have gone through the step-by-step animation, they start recapping and reflecting on what they have seen and read. Now they no longer look at the animation; instead, they use a depiction of DNA splitting as a resource (see screenshot 3 in Fig 1).

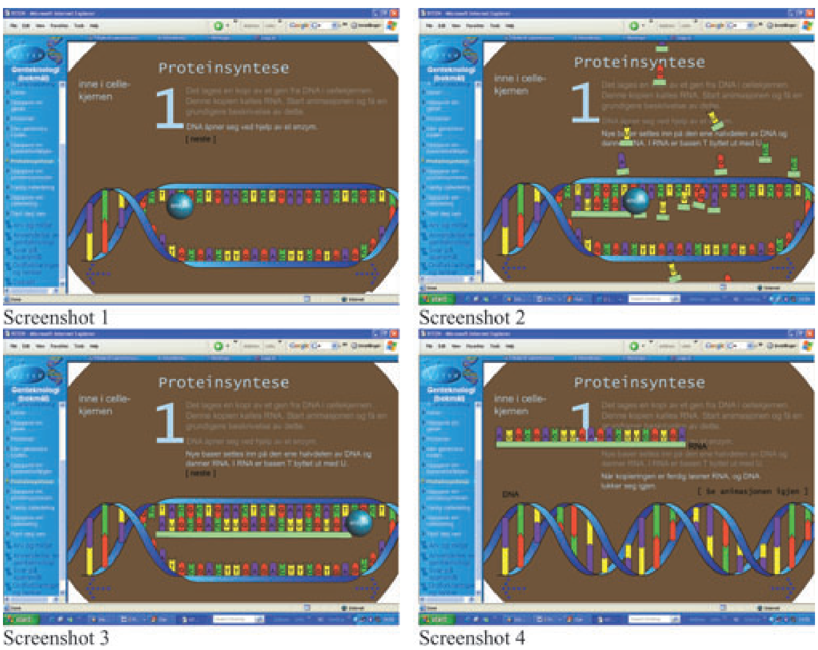

Fig 1 Screenshots from the animated depiction of protein synthesis in 'Viten.no'.

1.	Ingrid:	A gene is a part of DNA. (2) What is a gene? A gene is a part of DNA. (2) [looking at the screen] It's a specific protein. Ah: Yes. Did you get it? [Looks at Elisa]
2.	Elisa:	Uh: (.) Yes
3.	Ingrid:	Yea. Then a copy of a gene is made, which is a specific protein (.) [Looks at Elisa]
4.	Elisa:	Uh hm: [affirmative]
5.	Ingrid:	Uh:: from the DNA in the cell nucleus (.)
6.	Elisa:	which is called RNA. Start the animation to see a more detailed description of this. [Ingrid starts the next step of the protein synthesis animation depicting an enzyme splitting the DNA]
7.	Elisa:	DNA opens up with the help of an enzyme. Gosh, wait (2)
8.	Ingrid:	[Clicks on the next step in the animation] Yes, okay. New bases are placed [Looking intensely at the screen] (2)
9.	Elisa:	at one of the halves of DNA and make up RNA [see screenshot 3 in figure xxx].
10.	Ingrid:	=Oh: ye:s
11.	Elisa	What?
12.	Ingrid:	It becomes a copy of the DNA in a way
13.	Elisa:	Uh hm:: [affirmative]
14.	Ingrid:	So, when it opens with help of an enzyme, then that one opens [points to the enzyme splitting the DNA strand (screenshot 3) and gesticulates and visualises the splitting with her fingers]
15.	Elisa:	=Okay, so these two are originally connected [points to the split DNA threads] then it opens like this, then there is made a
16.	Ingrid:	=It's like this, here [points at the un-split DNA strand], and then it's made a copy of this, here [points at the RNA].
17.	Elisa:	=With the help of an enzyme
18.	Ingrid:	=Yea
19.	Elisa:	And in RNA the base T is replaced with U [Points at the RNA-thread on the screen]
20.	Ingrid:	Yea
21.	Elisa:	Okay, so it's the copy only with a U instead?
22.	Ingrid:	Yea, that's RNA

Fig 2 Data extract: students' employment of 'Viten.no' during a non-prompting situation.

Ultimately, they agree that they have managed to come up with an explanation for the concept of RNA (lines 21 and 22). As before, their account is characterized by giving supplementary extending responses to each other's statements. They constantly jump in, finishing each other's sentences and showing explicitly that they have picked up on and included each other's accounts. The students' method of referring to the illustration – pointing at specific parts of the DNA model and their gestures that imitate the enzyme splitting the DNA – show how they manage to employ the Web environment as an important resource in making sense of the RNA concept. By taking not only the students' verbal interaction into account, but also their embodied argumentation, we see that they manage to construct an increasingly detailed and complex argument about an essential cellular process. Over the course of the conversation given in this extract, two distinctive features come to light. Firstly, the Web environment helps the students to reflect and formulate relevant questions related to the scientific concepts. Secondly, the Web environment becomes an important resource for the students in their search for explanations and answers to their questions.

With the different aspects of cultural artefacts as a backdrop, some essential points can be identified concerning the students' interaction and their way of engaging with the Web environment. As the analysis shows, it is evident that Ingrid and Elisa interact with the knowledge embedded within the Web environment. In other words, they use the opportunity to interact with and reflect on scientific knowledge, and this becomes a resource in their meaning-making process. In their employment of the artefact, the students become capable of (re)constructing and verbalizing a complex scientific argumentation about genes, copies of DNA and proteins. Another point to be made is that the students use the opportunity to engage in reflection, which

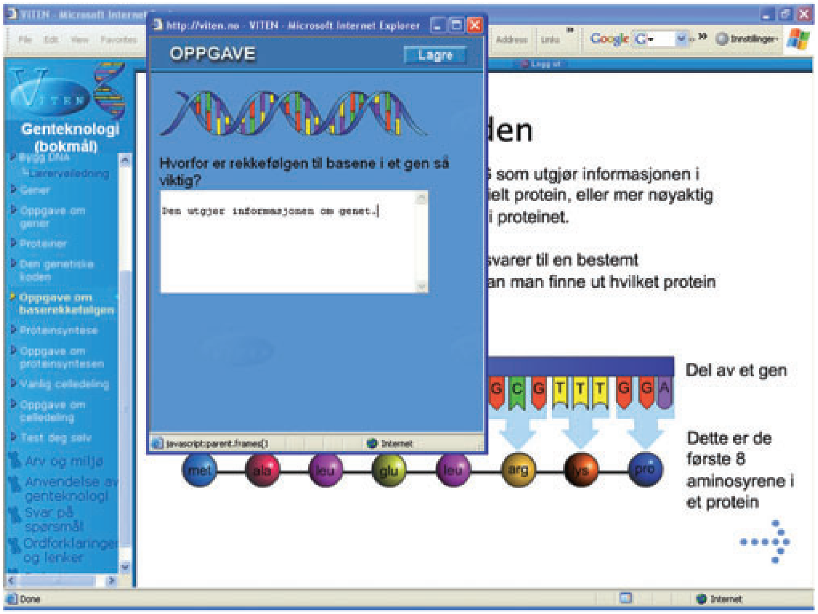

Fig 3 Screenshot showing the pop-up window prompting a conceptually related question.

is a central aspect of the practice of scientific inquiry. This is what they do when exploring the content and depictions in the learning environment, picking up and pursuing words and concepts that they do not understand and constructing shared accounts by joint elaboration. From this perspective, it is possible to say that the extract above exemplifies how the Web-based learning environment in this situation becomes an important resource for participating in practices of scientific inquiry.

Engaging with reflection prompts – two examples

In the following episode, the students have just finished working their way through an introduction to one of the main topics in ‘Viten.no’. They click on the prompt tag in the ‘Viten.no’ menu and a pop-up window appears, covering one-third of the last web page they visited (see Fig 3). The pop-up window prompts the question, ‘Why is the order of the bases in a gene significant?’

The extract in Fig 4 starts with Elisa reading the prompted question aloud.

At the opening of the extract (lines 1–9), the students are trying to come up with an answer to the prompted question without revisiting web pages containing the information they need. Their humorously resigned body language – leaning back, pauses in talking while looking at each other and giggling – indicate a shared understanding that they should have been able to answer the prompted question without revisiting the web pages. In addition, the students’ ways of using hesitant utterances, pauses between turn-taking and incomplete sentences indicate that they found it hard to formulate an answer to the prompted question about the significance of the order of the bases. After some unsuccessful attempts, Ingrid takes action (line 10). She closes the prompt window, and the background web page reappears. The web page contains text about and depictions of the genetic code. Both of the students lean towards the screen and look at it intensely. After a few seconds of individual reading, they start formulating an answer to the prompted question collectively (lines 10–17). Ingrid suggests that they should write ‘Because it forms the information about the gene’ (line 16). Elisa immediately agrees with Ingrid’s suggestion (line 17). The episode ends with Ingrid writing the answer into the designated textbox in the pop-up window. They save their answer and continue to the next main topic in ‘Viten.no’.

This extract is interesting for two particular reasons. First, it is interesting because it demonstrates a typical student practice of responding to the prompts in ‘Viten.no’ by means of a ‘copy and paste’ strategy. Second, it gives some indications of why the students end up choosing this strategy. These indications are

1.	Elisa:	`Why is the order of the bases in a gene significant?` (.) [Looks at Ingrid]
2.	Ingrid:	(.) [Looks at Elisa] It forms -- (.)
3.	Elisa:	Um:: well -- (3)
4.	Ingrid:	Ah:: [Looking at Elisa and smiles]
5.	Elisa:	Ah:: [Looking at Ingrid and smiles]
6.	Ingrid:	Why is -- [giggles and leans back]
7.	Elisa:	Um: haven't we just - (2) no
8.	Ingrid:	`Why is the order of the bases in a gene significant?`
9.	Elisa:	Yes (2)
10.	Ingrid:	Wait [Closes the pop-up window, and the background webpage re-appears] (.) [Both of them lean towards the screen]
11.	Elisa:	Because -- [Looking at the screen]
12.	Ingrid:	=It forms the information in the ge- it's- it's what forms -- (.) [Looking at the screen]
13.	Elisa:	Yea, characteristics. So ami--
14.	Ingrid:	Um: It is the order
15.	Elisa:	=Because it is amino -- (.)
16.	Ingrid:	Because it forms the information about the gene [Straightens up, looks at Elisa]
17.	Elisa:	=<u>Yea</u>
18.	Ingrid:	[Clicks back to the pop-up window containing the question they are about to answer] We're not cheating?
19.	Elisa:	[Giggles and shrugs her shoulders]
20.	Ingrid:	[Reads aloud what she is typing] <It forms the information about the gene> (.) HA (3)
21.	Elisa:	Save
22.	Ingrid:	Uh hm::

Fig 4 Data extract: example 1 of students' employment with prompts in 'Viten.no'.

most explicitly expressed in the sequence where Ingrid asks, 'We're not cheating?', and Elisa responds by giggling and shrugging her shoulders (lines 18–19). Seeing Ingrid's use of the word 'cheating' in context of their initial hesitation to revisit potential relevant web pages in 'Viten.no' makes it reasonable to assume that Ingrid draws a parallel between the prompting situation and a test and assessment situation.

Before elaborating more on this issue, I will analyse an extract from another student dyad's engagement with a prompt. In the extract in Figure 5, the two students, Laura and Sarah, engage with the prompted question, 'All the cells in your body contain the same genes. So, why is a skin cell different from a nerve cell?'. They have placed the prompt popup window in a position that allows them write their response while viewing a relevant web page in 'Viten.no'.

In this extract, Sarah and Laura try to formulate an answer to the prompted question while looking at a relevant webpage. After some attempts at phrasing and rephrasing, the students settle on a slightly edited version of parts of the text that appears on the webpage. Two interesting points can be drawn from this extract. First, the extract confirms the students' common practice of responding to the prompted questions by means of a 'copy and paste' strategy. Second, the extract indicates that these students also interpreted the prompts as means for testing and assessing them, and shows how they adjust their way of engaging with the prompts accordingly. This second point is most explicitly displayed by Laura's statement in line 2, when she comments, '[W]e can't just write exactly the same as it says there, that would be silly'. By saying this, Laura implicitly refers to what seems to be an established institutional norm within their setting: it is not acceptable practice to 'crib' text when responding to questions. If we look at lines 6 and 7, we see how the students adjust their response in accordance to the norm invoked: they change some of the words and use the indefinite instead of the definite plural of the word 'cell types' (line 10).

What can explain the students' method of paralleling prompting situations to testing and assessment situations? One contributing factor might be the character of the prompts. Testing is a well-known institutional practice in educational settings. A traditional, yet customary,

1.	Sarah:	[Looking at the screen] They are different because they have (.) different kind of --
2.	Laura:	[Looking at the screen] Because different genes (.) have been active in the different cells – [turns towards Sarah] we can't just write exactly the same as it says there, that would be silly
3.	Sarah:	Uhm:: (2) Because active and different genes have --
4.	Laura:	[stops typing, looks at Sarah and giggles]
5.	Sarah:	[starts giggling]
6.	Laura:	Ah: swapping the order of words are you? [starts typing] ?active? [articulates typing]
7.	Sarah:	It says the same just that we swap some of the words. If that will work?
8.	Laura:	[Typing] (5) Like this?
9.	Sarah:	Yea, we'll have to settle for that, I think
10.	Laura:	Yes, and I'll write 'cell types' instead of 'the cell types' [reflects the use of indefinite contra definite plural]
11.	Sarah	Yes, at least it will be a bit different
12.	Laura:	Yea
13.	Sarah:	Save

Fig 5 Data extract: example 2 of students' engagement with prompts in 'Viten.no'.

way of measuring students' understanding and knowledge acquisition is by means of their responses to content-related questions similar to the prompted questions in 'Viten.no', often without the use of teaching aids. Another contributing factor might be the design of the prompting features as such. The fact that the students' written responses constitute the only documented 'evidence' of the students' work in 'Viten.no', and that the teacher only has online access to these particular responses, might be a contributing factor to the students' comprehension of the prompts as means for testing and assessing them, and consequently influencing their way of engaging with the prompts. From this perspective, it is possible to say that in order to make sense of the prompts and how to deal with them, the students invoke what can be seen as established institutional practices, norms and expectations characterizing traditional tests and assessment situations. As a result, their main concern becomes finding a *correct answer* to the prompted question. The students' main concern in this prompting setting is not to participate in 'reflection' or other scientific inquiry-related activities. Instead, their main concern turns to finding an appropriate answer in accordance with the established institutional norms.

Discussion and concluding remarks

I opened this paper by posing a guiding question central to my search for a deeper understanding of the socio-cultural aspects of prompting students' reflection in Web-based environments: *What opportunities for action are embedded in the Web-based learning environment 'Viten.no', and how do these opportunities for action become structuring resources in the students' participation in scientific inquiry?* In order to answer this question, I studied the students' engagement with the Web-based learning environment in (1) non-prompting and (2) prompting situations. In the following discussion, four analytical points are discussed.

The *first point* concerns the institutional aspect of students' engagement with Web-based environments. The analyses of the students' accounts while engaged with the 'Viten.no' environment showed that they employed the Web-based inquiry environment differently as a structuring resource within the two types of settings. In the non-prompting situation, the students' use of the text and depictions within 'Viten.no' constitute important resources for reflecting on and making sense of the scientific concepts. In the prompting situations, however, the students' engagement with the Web environment changed. In exploring, explaining and reflecting on the scientific concepts, the students' orientation turns towards making sense of what is expected from them, and how they can adjust their responses to these expectations. How can these changes in the students' engagement be accounted for? 'Viten.no' is designed with the purpose of engaging with the practice of scientific inquiry within the setting of school science. As a cultural artefact (Cole 1996; Säljö 2000), a learning environment like 'Viten.no' also comes with embedded institutional practices such as ways of organizing instruction, tests and assessment. In this sense, the interesting aspect is how the students interpret and choose to make use of these opportunities for action during their engagement with the learning environment. From this perspective, it is possible to say that, in non-prompting settings, the students used the embedded opportunities to engage with scientific knowledge, as well as engaging with activities related to practices of scientific inquiry. In the prompting situations, however, their orientation was primarily directed towards what can be seen as the embedded traditional institutional practices: practices of testing and assessment. Another interesting aspect of the analysis is that it clearly demonstrates how embedded institutional practices can be, and often are, at odds with the ideal practices of scientific inquiry (Chinn & Malhotra 2002). As the analyses of the students' interaction show, dealing with and responding to these possibly contradictory practices becomes a central aspect of students' engagement with these types of environments.

A *second* point is that an analytical focus on students' interaction while engaging with the learning environment also makes it possible to discuss implications for the design of prompts. The prompts in 'Viten.no' can be characterized as *content-oriented*. The students are not provided with any information on how to approach the content-specific questions, and there are no explicit references to the procedures of scientific inquiry. Without any guiding principles about how to deal with the content-related questions, it is up to the students to figure out how to respond to the questions. Combining this with the fact that the teacher has online access to the students' responses to the prompts, it is understandable that the students are attuned towards what they think is expected of them, and adjust their responses accordingly. Taking into account the findings from previous studies on the positive effects of prompting students' reflection, one important aspect emerges. As argued, the prompts in these studies have one particular feature in common: they are all designed with the intention of prompting students' reflection by explicating *the procedural aspects* of 'doing reflection' (White & Frederiksen 1998; Lin & Lehman 1999; Davis 2003; Zhang *et al.* 2004). In other words, the prompts are process-oriented, rather than content-oriented as they are in 'Viten.no'. Because the procedures of conducting scientific inquiry are not explicated, the students are left to their own devices in discovering how to engage with the prompts. In addition, Davis' (2003) finding that 'generic' prompts seem to be more effective than 'directed' prompts suggests that prompts such as those found in 'Viten.no' might benefit from being less specific.

A *third* point concerns the importance of teacher intervention in settings where Web-based inquiry environments have a central role. As argued earlier, even if Web-based learning resources store the knowledge and residues of social practices, students do not necessarily employ the learning resources as intended by the designers or teachers. The most well-designed Web-based environment does not come with a one-size-fits-all-design. The meanings and functions of artefacts are (re)constructed and made sense of in action (Wertsch 1991). Teacher interventions in these types of settings must not be restricted to guiding students in their process of making sense of scientific concepts. Of equal importance is procedurally oriented guidance, as well as guiding students in their process of engaging with and making sense of the Web-based learning environment. This includes explicating institutional practices, norms and expectations.

The final point to be made concerns the importance of detailed analyses that scrutinize the interactional aspects of students' engagement with Web-based inquiry learning environments in general, and prompts in particular. Findings from a variety of studies have improved our understanding of the *effects* of different types of prompts. However, when it comes to understanding the opportunities generated by Web-based inquiry environments, as well as how these opportunities for action become structuring resources for students' participation in scientific inquiry, detailed analyses of students' interaction while engaging with Web-based learning environments are required. Students' engagement with scientific knowledge and scientific inquiry takes place within a context where institutional demands, expectations and norms are embedded (Furberg & Ludvigsen 2008). This study demonstrates that the socio-cultural perspective can enhance our understanding of the positive or negative effects of students' engagement with Web-based learning environments. Such a perspective can give valuable insight into how to design prompts, and how these prompts can be a productive part of students' inquiry learning processes.

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Notes

[1]KIE (Knowledge Integration Environments) and WISE (Web-based Inquiry Science Environments) have been developed by Marcia Linn and her colleagues. See Linn *et al.* (2004a) and Slotta (2004) for an extensive description of these environments.

[2]'Productive', in a KIE setting, refers to a 'knowledge integration' processes characterized by the following: students manage to expand their repertoire of ideas, distinguish between ideas, make links between ideas and identify weaknesses in their current knowledge (Davis 2003; Linn *et al.* 2004b).

[3]http://Viten.no/

[4]The national curriculum for Norwegian schools emphasizes that 20% of all school activity should be project work-oriented. Correspondingly, many schools organize interdisciplinary projects carried out intensively over 1 or 2 weeks. This project on gene technology is an example of this type of project.

[5]**Transcript notation:**

[ ]	Text in square brackets represents clarifying information
⌈⌊	Simultaneous/overlapping talk
=	Indicates the break and subsequent continuation of a single utterance
?	Rising intonation
:	Indicates prolongation of a sound
Underlined:	Emphasis in talk
(.)	Short pause in the speech
-	Single dash in the middle of a word denotes that the speaker interrupts herself
–	Double dash at the end of an utterance indicates that the speaker's utterance is incomplete
CAPITALS:	Loud speak
Italics	Context descriptions
<text>	Indicates that the enclosed speech was delivered more slowly than usual for the speaker
Courier New:	Students' reading from the screen is typed in Courier New

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