Computer literacy and inquiry learning: when geeks learn less

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Abstract
A low level of computer literacy has often been hypothesized as constituting a disadvantage in knowledge acquisition. However, within the field of computer-supported inquiry learning systematic investigations of these purported relations have not been conducted. This classroom study investigates the role of computer literacy (procedural computer-related knowledge, self-confidence in using the computer, and familiarity with computers) as a learning prerequisite for knowledge acquisition, and analyses the learners’ patterns of media use as processes that might explain this role. Thirty-seven students from two final classes of a secondary school worked in pairs on the project ‘How far does light go?’ in the Web-based Inquiry Science Environment. Findings did indicate significant relations of neither procedural computer-related knowledge nor self-confidence in using the computer to knowledge acquisition. However, students with greater familiarity with computers acquired significantly less knowledge. In the light of the patterns of media use, these findings might be explained by different navigation styles adopted by students with high and low familiarity with computers: students with high familiarity with computers exhibit more shallow processing strategies (‘browsing’) which are less functional for learning.

Keywords
collaborative learning, computer literacy, digital divide, web-based inquiry learning, knowledge gap hypothesis, patterns of media use.

Introduction
In computer-supported inquiry learning environments, students adopt the roles of scientists, engage in scientific inquiry and thereby construct knowledge by themselves. An important part of computer-supported inquiry learning environments is computer technology: it serves as a medium for the presentation of theories and evidence, for scaffolding the inquiry activities, and as a repository where students can store their intermediate results and knowledge of the domain. These computer-supported inquiry learning environments are open in the sense that the learners have large degrees of freedom to navigate and find their way through the environment. Accordingly, competence in interacting with computer technology can be considered as crucial for the learning outcomes. At several points in the history of electronic media, the question as to whether there might be disadvantages for some users has been raised (see Bonfadelli 1994). Also, with respect to recent digital media, such concerns have been frequently discussed at a general level: An intensely debated issue has been that of a digital divide between people who have access to and use digital media and people who do not (see, e.g. Attewell 2001; Murdock 2002). Beyond access and use, there is the idea of a so-called second-level digital divide, that is, that differences in digital literacy, in particular online skills,
might be the relevant inequalities (Hargittai 2002; cf. also Carvin 2000; Warschauer 2002). In the course of this discussion, it was argued that an inherent disadvantage is not so much constituted by a low level of access to and use of digital media compared with groups with a higher level but rather by their possible consequences, such as differences in inclusion and participation in societal developments, the availability of information or services and the acquisition of knowledge by means of digital media (Marr 2004). One assumption concerning such disadvantages is the so-called knowledge gap hypothesis. This hypothesis implies that members of the society with a lower level of education – as one aspect of socio-economic status – acquire knowledge from media more slowly than people with a higher level of education (Tichenor et al. 1970; cf. also Ettema & Kline 1977; Gaziano 1983; Bonfadelli 1994). This assumption has been investigated empirically, especially with respect to print media (Tichenor et al. 1970) and television (cf. Gaziano 1983), but more recently also with respect to digital media (Bofadelli 2002).

Although these questions concerning disadvantages associated with lower computer literacy have been discussed quite intensively on a general level, they have not been subject to systematic investigation within the context of computer-supported inquiry learning. Therefore, research is needed that helps to explore the hypothesized relations between learning prerequisites associated with computer use and knowledge acquisition in the field of computer-based inquiry learning.

Inquiry activities and the role of media in computer-supported inquiry learning

The educational goals of computer-supported inquiry learning environments include – among other objectives, such as acquiring argumentative and inquiry skills – the acquisition of domain-specific knowledge. These kinds of knowledge acquisition and change are brought about by scientific activities of the students as differentiated in different versions of the inquiry cycle (e.g. de Jong & van Joolingen 1998; Schwartz et al. 1999; van Joolingen et al. 2005). These activities comprise the transformative processes of hypothesis generation, experiment design and data interpretation, as well as regulatory processes, such as planning, monitoring and evaluation (de Jong & van Joolingen 1998; van Joolingen et al. 2005; de Jong 2006). However, quite often, students experience problems in performing these inquiry activities, such as not being able to create their own hypotheses on the basis of data gathered, conducting inconclusive experiments, misencoding experimental data or unsystematic planning and monitoring of their inquiries (de Jong & van Joolingen 1998; van Joolingen et al. 2005). In computer-supported inquiry learning, this finding might be attributable to the much-appreciated openness of many learning environments (cf. Mayer 2004) that is often regarded as a core feature of inquiry. Typically, in a computer-supported learning environment, science-related information is presented in texts, pictures, films, animations, and the like. Learners often can select from these media elements and navigate through the inquiry learning environment in a self-regulated way. Furthermore, students are provided with tools for documenting data and conclusions, such as text editors, spreadsheets, mapping tools or discussion boards are provided. It seems clear from an empirical perspective, that some instructional guidance is crucial for the success of learners in these environments (Kirschner et al. 2006).

Computer literacy, patterns of media use and knowledge acquisition

According to the line of reasoning presented above, students with lower digital literacy might be disadvantaged in acquiring knowledge in these environments in comparison to ‘geeks’, which might result in an increasing gap with respect to knowledge. What are important aspects of digital literacy that are likely to moderate the effects of inquiry learning?

‘Digital literacy’ can be defined as comprising a ‘variety of complex […] skills, which users need in order to function effectively in digital environments’ (Eshet-Alkalai 2004, p. 93). With respect to computers, which constitute the digital environment in computer-supported inquiry learning, several aspects of literacy can be distinguished. According to Richter et al. (2001), computer literacy comprises declarative and procedural computer-related knowledge, familiarity with computers and self-confidence in using the computer: (i) Declarative computer-related knowledge is constituted by general knowledge on common computer applications and the possibilities and
functionalities of computers, as well as acquaintance with abbreviations in the field. (ii) Procedural computer-related knowledge comprises the skills required to use a computer, such as specific know-how related to common applications such as word processors or file managers, and general routines that apply to many programs. (iii) Familiarity with computers is a subjective estimation of one’s competence in dealing with different kinds of computer applications. (iv) Self-confidence in using the computer can be characterized by a lack of doubts about one’s competence in dealing with computers (Richter et al. 2001).

Of these dimensions, particularly procedural computer-related knowledge, familiarity with computers and self-confidence in using the computer might be associated with differences in opportunity to acquire knowledge during computer-supported inquiry learning: procedural computer-related knowledge reflects the aspect of online skills required to deal with features of computer-supported inquiry learning environments such as pop-up windows, drag and drop functionality and embedded, replayable movies in order to gather information and document one’s findings textually and visually. Self-confidence in using the computer can be assumed to influence learning, as computer and Internet self-efficacy have been found to be related to Internet usage (LaRose et al. 2001) and to task performance (Thompson et al. 2002). Familiarity with computers might be a result of frequent use of computer technology and therefore be related to competent and confident use of the features of inquiry learning environments. Accordingly, procedural computer-related knowledge, familiarity with computers and self-confidence in using the computer can be hypothesized to be related to knowledge acquisition in computer-supported inquiry learning. This assumption is expected to hold for all kinds of inquiry learning environments with varying emphasis, depending on the degree of structure of the environment, and needs to be examined.

The potential influence of these aspects of computer literacy is expected to be mediated by differences in how people use the media from which they are supposed to acquire knowledge (Attewell 2001). It can be noticed as a point of criticism that research in this field has not put enough emphasis on analyses of the patterns of media use by which the hypothesized relation of digital literacy to knowledge acquisition might be mediated. This is required to provide a coherent explanation as to how computer literacy might affect knowledge acquisition. The media elements (text pages, movies, pictures, text boxes, graphical tools) in computer-supported inquiry learning can be roughly divided into elements for receptive use, that is, for gathering information about the domain that is the topic of inquiry, and elements for productive use, that is, for documenting one’s finding by means of external representations that constitute ‘tangible’ results in the learning environment. The use of both kinds of elements should induce the elaboration of the content, as both tasks require the activation of knowledge acquired earlier. During the interaction with elements for receptive use, students have to access knowledge in long-term memory to make sense of the content presented in these elements (e.g. Kintsch 1998), whereas when dealing with elements for productive use, knowledge from long-term memory is used to generate an external representation. Therefore, it can be assumed that both types of elements are important for knowledge acquisition during inquiry learning: externally representing one’s interpretation of a piece of evidence in a media element for productive use, for example, a causal mapping tool, can be an important activity that triggers elaboration. However, for this kind of cognitive processing to occur, the learners also need to extract the relevant information from media elements for receptive use before. Accordingly, a balanced use of the respective media elements in the learners’ patterns of media use should be necessary.

To conclude, so far inquiry learning has been considered from rather optimistic perspectives that emphasize the potential of digital media for the presentation of authentic contexts for inquiry, as well as the scaffolding of specific inquiry activities. However, quite often computer literacy is claimed to be an important factor as far as knowledge acquisition in computer-based learning is concerned. For the reasons given above, procedural computer knowledge, familiarity with computers and self-confidence in using the computer are the aspects of computer literacy that can be seen as being of particular interest in computer-supported inquiry learning. Nonetheless, these hypothesized assumptions have received hardly any attention in empirical research on computer-based learning scenarios and computer-supported inquiry learning in particular.
Research questions

Our research questions were the following:

1. What are the differences between students at different levels of computer literacy with respect to the acquisition of knowledge in a computer-supported inquiry environment?

It is expected that higher computer literacy – more specifically: greater procedural computer-related knowledge, higher familiarity with computers and higher self-confidence in using computers – might be associated with greater acquisition of knowledge.

2. What are the differences between students at different levels of computer literacy with respect to the patterns of media use in a computer-supported inquiry environment, and to what extent might they explain differences in knowledge acquisition?

We expected that students at different levels of computer literacy differ with respect to the patterns of media use in the computer-based learning environment processes. However, due to the early stage of research on this issue, we had no specific expectations with respect to this question.

Method

Participants

Thirty-seven students (17 girls and 20 boys, 16–20 years old) from two final classes of a secondary school participated in the study. The students worked in dyads that were formed at random. In part, dyads had to be regrouped on the second day of the study due to both dropouts and the arrival of new participants, which is a typical problem in classroom research and also explains the uneven total number of participants (e.g. one person that participated on both days may have worked with two different partners who participated only on 1 day). However, learners from dyads who were not identical on both days were excluded from the analysis, which resulted in 16 learners who were included in the analysis.

Design

We took the individual students as the units of analysis. These were classified by median splits according to their degree of procedural computer knowledge (Median = 2.50), familiarity with computers (Median = 0.43) and self-confidence in using the computer (Median = 0.56). This led to three one-factorial designs with two levels of the respective computer literacy dimension. Additionally, the correlations between the computer literacy scales and knowledge acquisition were analysed in order to use the complete information available in the data for testing the monotony of the relation of computer literacy to the acquisition of knowledge over the whole range of computer literacy found in the sample.

Learning environment

During the learning phase, the students collaborated in dyads using one laptop computer. They worked through a shortened German version of the Web-based Inquiry Science Environment (WISE) project ‘How far does light go?’ (Bell 2004). In this project, learners are asked to choose one of two competing hypotheses. The Light-Dies-Out hypothesis claims that light dies out and stops as it travels further from its source and that the distance at which it dies out is different for different light sources. The Light-Goes-Forever hypothesis states that all light goes forever until it is absorbed. After their initial decision, the students are faced with pieces of evidence, receive hints for their interpretation, discuss which of the two hypotheses the evidence supports, take notes and classify the evidence according to the hypothesis it supports, using the graphical SenseMaker tool (Bell 2004). This tool allows the students to group pieces of evidence according to the hypotheses they support by drag and drop manipulation. Finally, the students can review their notes and select their strongest arguments.

Instruments and dependent variables

For the measurement of digital literacy we used three scales from the ‘Computer Literacy Inventory’ (INCOBI; Naumann et al. 2001; Richter et al. 2001) because this instrument is empirically validated and relies on objective knowledge tests rather than
self-report data for competence aspects. The scales used were (i) ‘procedural computer(-related) knowledge’; (ii) a slightly modified version of the ‘familiarity with computers’ scale; and (iii) ‘self-confidence in using the computer’.

The procedural computer-related knowledge scale consisted of 12 multiple-choice items with five options (including ‘I don’t know’). In each of these items, a typical situation when working with a computer is described, and it is asked how one would deal with it, for example: ‘Your mouse does not work any longer and you want to exit the program currently in use. What do you do?’ One of the four options to choose from is the following: ‘I exit the program by pressing, “CTRL” + “END”.’ Alternatively, the program can be closed by pressing “ALT” + “F3”. The scores for this scale could range from 1 to 12.

The familiarity with computers scale comprised seven items related to computers in general and particular types of software that might be relevant in computer-supported inquiry learning. These items shared the item stem ‘I am familiar with the use of . . .’, which was completed, for example, by ‘computers in general’ or ‘Internet/WWW’. The answering format was a 5-point Likert scale ranging from ‘far above average’ to ‘far below average’. Possible scores for this scale range from −2 to +2.

The scale for self-confidence in using the computer consisted of 11 items related to perceived problems when working with computers, which had to be rated on 5-point Likert scales ranging from ‘applies’ to ‘does not apply’. Here is an example item: ‘When working with the computer, I easily get frustrated by problems that come up (caused by the computer).’ The scores of this scale could range from −2 to +2.

The internal consistency (Cronbach’s alpha) of the familiarity with computers scale was good (α = 0.83). For the self-confidence in using the computer scale (α = 0.62) and the procedural computer knowledge scale (α = 0.60) it was sufficient.

Domain-specific knowledge was measured by a translated and modified version of a test developed specifically for the WISE project used in this study (Bell 2004). Identical versions were used in the pre- and post-tests. This test comprised six multiple-choice items and three items with a free answering format. The multiple-choice items cover information from the learning environment, for example: ‘Telescopes can be used to observe things, such as the moon. Which of the following explanations best describes how a telescope works?’ There are two to four options in each multiple-choice item. In the current example one is the following: ‘A telescope gets you closer to the moon.’ The items with a free answering format ask for reasons for the answers on the multiple-choice items. The students’ responses were coded for the mastery of correct information and the absence of misconceptions, such as the assumption that light can be ‘absorbed’ by ‘other light’. The point scores could range from 0 to 12. The internal consistencies were α = 0.59 in the pre-test and α = 0.77 in the post-test.

Data sources for the patterns of media use in the learning environment were screen and audio recordings of the students’ activities. These recordings were created by software that captured movies of the contents that were displayed on the computer screen during the learning phase and the students’ talk in front of the computer. The material was broken into segments with a fixed length of 10 s, to which a coding scheme (see below) was applied. The WISE project used in this study consists of 116 ‘steps’ constituted by the different elements of the learning environment (HTML pages, dialogue boxes, pop-up windows, etc.) that are presented to the students in a pre-structured order. In this order identical elements such as the SenseMaker tool reappear several times. These elements were classified according to their function as elements for reception and elements for production. For each of the 10 s segments, the WISE element currently displayed was identified and coded numerically according to its position in the series of 116 elements. The whole process was analysed. Two coders coded about one half of the material each. About 10% of the process data were coded by both of the coders for the calculation of their agreement on the different dimensions. The agreement of the coders for the patterns of media use was sufficient (P = 75%; Cohen’s kappa = 0.75). Two types of graphical representations of the students’ patterns of media use were constructed from these codings: The first type displays the students’ paths through the sequence of elements of the learning environment (graph for path through the learning environment; with time on the horizontal and element as well as section of the WISE project on the vertical axis), whereas the second type shows the students’ use of types of media elements in the learning environment (graph for the use of types of
learning environment elements; with time on the horizontal and element type with respect to its function on the vertical axis). These graphs allowed us to explore possible explanations for the relations of dimensions of computer literacy to the acquisition of knowledge.

In addition, selected pieces of discourse were transcribed in order to substantiate tentative explanations for the relations of computer literacy to knowledge acquisition on the basis of the students’ inquiry activities and patterns of media use.

**Procedure**

The study stretched over two blocks of science lessons on consecutive days in each of the two classes in which we conducted the study. On the first day, students were grouped into pairs. Then they completed a questionnaire on demographical variables and tests of digital literacy and domain-specific prior knowledge. After an introduction to the learning environment by their teacher, they could work through the environment for about 40 min until the end of the lesson. On the second day, students began by working in the learning environment for about 1 h and 20 min. Afterwards, they prepared individually for the final classroom debate, which then followed. Finally, they completed a questionnaire consisting of motivational variables and the test of domain-specific knowledge.

**Statistical analyses**

The small sample size prevented the use of post-test residuals from predictions based on the pre-test as a measure of knowledge acquisition. Therefore we had to rely on simple pre-test–post-test differences, which, under the conditions of this study, can be considered as sufficiently accurate measures of change (Petermann 1978, p. 35 f.). The unit of analysis were the single students. From each dyad, both members were included in the analysis. The α-level was set to 5% for all statistical tests.

**Results**

**Research question 1: relation of computer literacy to the acquisition of knowledge**

As indicated above, the students were classified as either high or low with respect to procedural computer knowledge, familiarity with computers and self-confidence in using the computer by means of median splits in order to compare the two respective groups according to their knowledge acquisition. The results concerning the relation of computer literacy to the acquisition of knowledge are presented in Table 1. As indicated above, we also report correlations between these computer literacy scales and knowledge acquisition.

Surprisingly, students with lower procedural computer-related knowledge gained numerically more with respect to knowledge acquisition. However, this difference was not significant ($t_{14} = 1.26$, n.s.). The same applies to the corresponding negative correlation between procedural computer-related knowledge and knowledge acquisition ($r = -0.41$, n.s.).

Also students with lower familiarity with computers acquired more knowledge than students with higher

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**Table 1.** Relation of the students’ computer literacy to their acquisition of domain-specific knowledge. The scores could range from 0 to 12. The last column contains the correlations between the computer literacy dimensions and the pre-test–post-test difference.

<table>
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<tr>
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<th>Pre-test</th>
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<td>Mean</td>
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<tr>
<td><strong>Procedural computer-related knowledge</strong></td>
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<tr>
<td>Low</td>
<td>4.50</td>
<td>2.33</td>
<td>6.25</td>
<td>3.20</td>
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<tr>
<td>High</td>
<td>5.38</td>
<td>1.19</td>
<td>5.63</td>
<td>2.26</td>
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<td><strong>Familiarity with computers</strong></td>
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<tr>
<td>Low</td>
<td>5.00</td>
<td>2.16</td>
<td>7.57</td>
<td>2.15</td>
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<tr>
<td>High</td>
<td>4.63</td>
<td>1.60</td>
<td>4.38</td>
<td>2.45</td>
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<tr>
<td><strong>Self-confidence in using the computer</strong></td>
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<tr>
<td>Low</td>
<td>4.25</td>
<td>1.83</td>
<td>5.50</td>
<td>1.93</td>
</tr>
<tr>
<td>High</td>
<td>5.63</td>
<td>1.69</td>
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*P < 0.05.
familiarity with computers. The decrease in knowledge in the high familiarity with computers group is not significant and might be due to measurement error. This difference was significant \( t_{13} = 2.60, P < 0.05 \). Also the corresponding negative correlation was significant \( r = -0.54, P < 0.05 \).

Students with lower self-confidence in using the computer gained more than students with higher self-confidence in using the computer. However, this difference was not significant \( t_{14} = 0.40, \text{n.s.} \), nor was the corresponding correlation \( r = -0.14, \text{n.s.} \).

**Research question 2: relation of computer literacy to patterns of media use that might explain differences in knowledge acquisition**

Can differences concerning the students’ patterns of media use help explain the unexpected detrimental relation of higher familiarity with computers to the acquisition of knowledge? Figures 1 and 2 present two graphical overviews of the paths two dyads took through the learning environment, displayed in two different kinds of graphs for each dyad, as described in the methods section. The dyads were selected to match the pattern of findings presented above: The first dyad is a clear case of high familiarity with computers with low knowledge acquisition, whereas the second dyad is a clear case of low familiarity with computers with high knowledge acquisition.

Figure 1 shows the pattern of media use of a dyad both members of which have a high familiarity with computers (dyad 1).

The rather continuous graph for the path through the learning environment without too many ‘outliers’ shows (after a moderate start) a rather high and increasing ‘slope’ which indicates the velocity with which the students move through the elements. The diagram also shows that, after some amount of time (about 45 min), the duration of areas with ‘horizontal’ progression becomes shorter. This indicates that the students spend

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**Fig 1** Pattern of media use of a dyad with high familiarity with computers (dyad 1). In both graphs, the horizontal axis displays learning time. The vertical axis of graph (a) represents the 116 separate elements of the learning environment in their pre-structured order, divided into its six thematic sections by the horizontal lines. The vertical axis of graph (b) displays the types of media elements of the learning environment according to their function. For example, from 0:24:50 to 0:35:20 these students view the note window that constitutes the 15th WISE element, which is an element for production.
less time on certain activities associated with the elements of the learning environment, which is likely to prevent them from deep elaboration during these interactions. As can be seen from the graph for the use of types of learning environment elements, with about two larger exceptions, during these phases only elements for productive use receive attention for longer periods of time. At the same time, the graph for the path through the learning environment shows that phases in which they continuously progress diagonally become more frequent. This indicates that they tend to click through the elements at a rather high pace, which does not give them the opportunity to sufficiently elaborate, for example, on evidence or hints. The horizontal areas towards the end of the learning session – from about 1:20:00 onward – result mainly from a page that collects all of the students’ work in the learning environments, which is displayed for a considerable amount of time without further changes by the students, and technical problems that also account for the somewhat more confused picture towards the end.

This explanation pointing towards rather shallow processing of the material in this dyad can further be substantiated by the discourse of this dyad. The following excerpt from the transcript shows how these students deal with windows asking them to discuss the competing theories. The names of the students in the transcripts have been changed.

Howard: Just click ‘okay’, then it goes away, you don’t have to write anything there. Just click ‘okay’.
Hugh: And what do we do now?
Howard: Okay, we’ve already discussed this. It goes away, too, you can’t write anything there.
Hugh: Yes, there’s no text.
Howard: Okay, we’ve already discussed this. It goes away, too, you can’t write anything there.
Hugh: Yes, there’s no text.
Howard: Yes. So, on to the next section.
Hugh: Okay.

In contrast, Fig 2 shows the graphs of a dyad with low familiarity with computers (dyad 2). At first glance, in this case the graph for the path through the learning environment appears much more scattered, which reflects activities of going back and forth in order to re-inspect some instructions, hints or...
pieces of evidence, and relate them to the actual tasks, which can be regarded as an indicator of cognitive elaboration. Additionally, the overall ‘slope’ of this graph is far lower, indicating a lower pace of progress through the elements of the learning environment, providing them with the opportunity to elaborate the content of the single elements. Also phases of ‘horizontal progression’, which result from greater amounts of time spent with single elements, continue to appear until the end and become even more perspicuous (with the phase from about 1:20:00–1:35:00 resulting from problems the students experience with the selection page).

The main difference compared with the other dyad is that horizontal areas appear also on elements for receptive use, not only on elements for productive use, such as notepad elements, as can be seen from the graph for the use of types of learning environment elements. At the same time, in this dyad, there are shorter areas of diagonally upward progression in the graph for the path through the learning environment, in which the students browse quickly through a sequence of elements.

The following excerpt from the transcript of this dyad with low familiarity with computers substantiates the assumption that the graph appears more scattered because these students jump around in order to re-inspect pieces of evidence they need to elaborate the material. It also shows how keen this dyad is on elaborating elements for receptive use, in this case a merely textually presented piece of evidence:

Lisa: Perhaps they mean by ‘light dies out’, you see, that it shines for a while and eventually simply goes out. The whole, complete one.
Lauren: You mean the stars, right?
Lisa: Just the light in general, because there is the light-dies-out and the light-goes-forever . . .
Lauren: Yes.
Lisa: . . . and is eventually reserved [sic!]. By ‘light dies out’, you know: that it goes out completely then, like a candle when you blow it out.
Lauren: Yes, it’s simply as if . . .
Lisa: . . . and not, that they mean that the tropi . . . that is, if you light a candle in the dark, there is this circle where it gives bright . . .
Lauren: Yes.
Lisa: . . . and then comes the dark. That they don’t mean that it dies out there . . .
Lauren: Yes.
Lisa: . . . but that it dies out altogether.
Lauren: Yes, that there’s no light at all any longer.
Lisa: Because then we have to go back again. [Pause] How great [ironically], we were a little bit too intelligent.

[Pause: they return to a different WISE element containing a piece of evidence in a photograph]
Lisa: But they all die out [. . .]. So this is stupid, too.

So dyad 1 (high familiarity with computers) seems to rush through the environment and just elaborate while interacting with elements for productive use, whereas dyad 2 (low familiarity with computers) complies with the requirements of the learning environment, discusses also elements for receptive use, and even goes back in the environment in order to re-inspect and elaborate on elements of the environment that were displayed earlier.

Discussion

Our results can be summed up as follows: With respect to the relation of computer literacy to the acquisition of knowledge, we had hypothesized that higher computer literacy, in particular greater procedural computer-related knowledge, higher familiarity with computers and higher self-confidence in using computers, would be associated with greater acquisition of knowledge. This assumption could not be confirmed. Surprisingly, instead, students who were less familiar with computers acquired more domain-specific knowledge. Therefore, our study does not provide evidence for the hypothesis of a second-level digital divide in the field of inquiry learning between people with high and low levels of computer skills (cf. Hargittai 2002; see also Carvin 2000; Warschauer 2002), at least in the expected direction.

In contrast, the results of the study suggest that greater familiarity with computers can be related to less functional behaviour in the use of computers for the purpose of knowledge acquisition, as indicated by the exploratory analyses related to research question 2. Apparently, the dyad with higher familiarity with computers spent less time on the single elements for receptive use, which gave them little opportunity to elaborate on the information provided in these elements. The tendency towards shallow processing (browsing) contrasts with the balanced time allocation to elements for receptive and elements for productive use, which is displayed by the dyad with low familiarity with computers. One explanation for this could be that the high familiarity with computers dyad mistakenly transfers strategies of browsing the web in search of information or entertainment.
These findings contribute to our understanding of computer-supported inquiry learning in several ways: first, the study provides some evidence that inquiry learning can have differential results depending on the level of learning prerequisites. Second, it appears that lower computer literacy need not always constitute a disadvantage. The demands that computer-supported inquiry learning environments put on the learners’ computer literacy do not seem to be a barrier for most students. Rather, some affordances of the learning environment might seduce some learners with higher computer literacy to transfer less functional Internet browsing behaviour accompanied by insufficient cognitive elaboration to inquiry learning. Third, the validity of the differentiated measurement of aspects of computer literacy receives some support from the straightforward pattern of relations between the aspects of computer literacy and knowledge acquisition. Finally, we would like to emphasize that the patterns of media use that are influenced by the learners’ computer literacy have to be differentiated from the students’ inquiry activities that are linked to the cognitive processes of inquiry learning, such as hypothesis generation, experiment design and data interpretation, as well as planning, monitoring and evaluation (de Jong & van Joolingen 1998; van Joolingen et al. 2005). What is difficult for learners about computer-supported inquiry learning might not be the media-based environment, but rather the strategies the learners’ need to apply to conduct their inquiry, although aspects of media use might interfere with these processes.

However, we also would like to point out several limitations of the study presented. This study was a rather small-scale field study. Accordingly, it cannot provide definite answers for the questions under investigation. We also do not claim validity of our findings for inquiry learning environments that are less systematically structured that the WISE project used in this study with its proposed sequence of media elements (Linn et al. 2003). Furthermore, the duration of the learners’ inquiry project was only two consecutive days. Accordingly, this study does not warrant broad generalizations over long-term effects of computer literacy in computer-supported inquiry learning. This issue should be addressed in future research. Another important limitation is the fact that it was impossible in this study to investigate the role of collaboration with respect to computer literacy: In dyads with heterogeneous computer literacy, collaboration might compensate for less favourable prior competencies of one of the partners. However, as the main result of this study demonstrates, it has to be kept in mind that a lower competence level need not be a less favourable starting point for learning. Questions concerning the role of collaboration in computer-supported inquiry learning were addressed in other studies (e.g. Kollar et al. 2005).

Our findings raise the question as to how students at different levels of computer literacy can be supported to engage in cognitive activities that are functional for inquiry learning when interacting with all kinds of media elements that may be present in a computer-supported inquiry learning environment. One concept that appears to be a promising basis to more systematically integrate computer-supported small group collaborative inquiry learning into the overall classroom activity, are classroom scripts. These can be regarded as culturally shared conceptions of good classroom instruction (Stigler et al. 1999; Prenzel et al. 2002; Seidel et al. 2002). By creating and implementing a classroom script that distributes functional inquiry activities (de Jong & van Joolingen 1998; van Joolingen et al. 2005) over the classroom plenum, small groups and individual students, a collective enterprise of inquiry could be formed that integrates and fosters the individual learners’ efforts. This (i) brings the teacher back into the conductor role; and (ii) suggests a new perspective on different, interacting levels of structure, guidance and regulation (the individual, the group and the class) that has been subsumed under the term of ‘orchestration’ (Fischer & Dillenbourg 2006).

References


