Digital Video Tools in the Classroom: Empirical Studies on Constructivist Learning with Audio-visual Media in the Domain of History

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Abstract: This paper presents empirical evidence concerning the application of digital video technologies for creating design-based learning environments for middle school students. In three studies we show how the affordances and constraints of digital video technology can support for students their (a) cognitive (b) action related and (c) socio-cognitive learning processes in the domain of history. We present both quantitative and qualitative data. We also present initial evidence for the role of complementary support by explicit instructional guidance. Results are discussed with regard to practical implications.

Introduction

Audiovisual media provide an important resource for classroom learning. Yet, films and videos are often used in 'suboptimal' ways (Hobbs, 2006). For example, they are shown to classes in a passive, TV-like manner, without clear-cut educational goals and without fostering students' learning activities, dialogue, knowledge construction, or critical thinking. From a psychological perspective, this kind of usage limits the effectiveness of audiovisual materials for learning, and promotes instead a tendency towards superficial cognitive processing (Salomon, 1984) and oversimplification (Spiro, Collins, & Ramchandran, 2007; Spiro, Feltovich, Jacobson, & Coulson, 1991). While this might be only unfortunate in some cases, it can actually be problematic in others, such as in the complex domain of history (Spiro, et al., 2007). In history learning, media sources including historical films, newsreels, TV-products and videos can help to reconstruct historical processes and events (e.g., Wineburg, 1991). Yet, the sources themselves - rather than merely presenting "facts" - are themselves parts and results of the historical processes from which they have originated, and as such they reflect certain perspectives (sometimes subtley as in news shows or educational films, sometimes obviously or even deliberately as in propaganda films). Hence, historical films and videos need to be understood by students exactly in this way: as historical "constructs" (Wineburg, 1991).

How can such an understanding be achieved? Educators have suggested domain-specific strategies, such as "de-construction and re-construction" of historical films (Krammer, 2006). Taking a general theoretical stance in his important work on cognitive flexibility, Spiro has suggested using hypermedia technology as a supportive tool for multithematic exploration and processes of active and constructive work with video in ill-structured domains. Likewise, in a similar cognitive-constructivist framework for the use of video in education (Goldman, Pea, Barron, & Derry, 2007), video analysis activities with advanced digital video tools have been acknowledged as supporting "perspectivity" (Goldman, 2004), inquiry, and specific (socio-)cognitive processes of students (Smith & Blankenship, 2001). This advanced category of digital video tools (some of them originally created for professional research purposes) refers to software applications which provide a variety of possibilities for editing, contextualizing or analyzing digital videos (cropping, annotating, commenting, tagging, or integrating hyperlinks). Such functions could be restructured for youthful learners in classrooms so that they could either produce their own videos or remix video contents (as, for example, from YouTube).

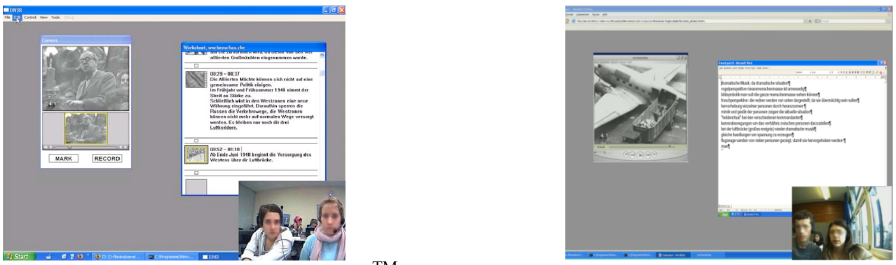

Figure 1. Screenshots of a DIVER™ worksheet (left) and the video player plus text editor condition (right) including video feed of dyads' interactions (bottom right).

In this paper, we present empirical research on the meaningful integration of digital video tools into history education in secondary school. We conducted a series of three empirical studies with 11th grade students in Germany. Our research rests on two assumptions: (1) the assumption that the affordances and constraints of digital video technologies—particularly constructive video tools allowing for annotating, editing (e.g., zooming and cropping), and re-sequencing—have opened up new vistas for making video accessible to constructivist learning in school-based education and beyond (Zahn et al., 2005) and (2) the general assumption that framing such video tools in constructivist design tasks can be effective (Zahn, Krauskopf, Pea & Hesse, in press). We worked with a video tool which has been created specifically to support both cognitive processes and collaborative learning with digital videos (the DIVER/WebDIVER™ system, Pea et al., 2004, see Figure 1). It supports cognitive processes such as focusing attention within a complex and dynamic visual array. It includes a set of specific editing capabilities which enable users to extract, rearrange and comment on scenes or video segments aiming at the support of important visual analytic skills of learners, such as focused observation. The selected and commented items are called *dives*, based on users "diving" into a video by zooming in on scenes and details of the video by controlling a selection frame or "virtual viewfinder". A dive consists of re-orderable "panels", i.e., clips and corresponding comments that are shown in a separate column next to the source video. As a result, sequences and details of a video are not only being cognitively selected, but these video selections and interpretive annotations become new, replayable artifacts that have persistent references as URLs. This is why the system is also considered a *collaborative* tool: These replayable artifacts can be collaboratively produced and shared with others for joint reflection, analysis and discussion ("Guided Noticing"™). In transferring these design rationales underlying the DIVER/WebDIVER™ system or similar tools to the classroom (Zahn et al., 2005), we investigate in our research both the new opportunities and the new challenges arising for students, and ultimately teachers. From our point of view , there are many opportunities to create better conditions for active learning with video materials and relate them to effective processes of knowledge building (Scardamalia & Bereiter, 2006).For instance, students may work creatively with digital videos, which are already available as audio-visual sources online. They can suggest new ways to approach these media and thus enable subsequent users to integrate the reflections of others, which ultimately leads to the development of core competences, such as historical reasoning, advanced expertise (Scardamalia & Bereiter, 2006) or new media literacies (Jenkins, Clinton, Weigel, & Robison, 2006). The challenges include the adequate framing of The main challenge is to frame these collaborative tools with the right tasks to create powerful learning environments, in order to reach the learning goals during classroom- based instruction.

Visual Design to Frame Learning with Digital Video Tools

To investigate both the opportunities and the challenges of using advanced video tools for constructivist learning in history lessons, we apply design approaches to learning, i.e., concepts of learning by creating artifacts (e.g., learning through design, Kafai & Resnick, 1996; learning by design, Kolodner et al., 2003). We consider the design approaches especially suitable in our case, because they call for activity- and project-oriented learning with media. In this process, students can autonomously create something that seems authentic, meaningful and consequential for them, which gives them the opportunity to experience themselves as competent and intrinsically motivated learners (Beichner, 1994). In addition, from a cognitive perspective, a deeper understanding of the complex topic area and video content can be expected: Acting as designers, students are creating a new video-based information structure. This requires them to select, compare and reflect on the content they wish to present and on how to present it, which results in a positive influence on knowledge acquisition for a complex topic, as in writing (Hayes, 1996). Based on the work of Lehrer and Erickson (Erickson & Lehrer, 1998; Lehrer, Erickson, & Connell, 1994), the ideal structure of a design process includes planning, transformation, evaluation and revision. Design projects thus should support the development of general problem solving skills as well as specific skills related to media competence. Learners not only need to plan the information structure they are going to create, they also must creatively integrate different media formats in order to combine them effectively for a sensible form of the information presented. In an attempt to integrate the cognitive models of writing and design with constructionist (constructivist?) perspectives, and in order to apply them to the case of video-based design, we proposed elsewhere a tentative model of collaborative visual design as a process of joint dual space problem solving (Zahn, Krauskopf, Hesse, & Pea, 2009). In this model, we hypothesize visual design to be a collaborative problem solving process involving intensive interactions between video content and form (audience-related goals), in a rhetorical problem space. Based on this model, we shaped our research around the following research questions:

- How do the affordances of advanced digital video tools impact (a) cognitive (b) action related and (c) socio-cognitive processes of students learning a historical topic?
- How do students approach visual design tasks in a real history class?
- When and how can explicit instructional processes optimize the implementation and utilization of digital video technologies?

For the purpose of our empirical research, we developed a prototypic visual design task for German history lessons, where students were asked to rework a video source showing an historical newsreel on the 1948 Berlin blockade. With varying digital video tools at hand, learners elaborated on the video source by integrating additional information provided, with the goal of creating an artifact that could be published online for future (peer-)learners. The task included critical reflection and comments on the historical content as well as on newsreels as a means of propaganda in former times, based on examples from the source video. Whether the affordances of digital video tools used in the context of our creative task would clearly have a positive effect on student understanding in a real history class was an open empirical question. It was also an open question whether the affordances and constraints of different digital video tools differentially influence student learning and if so, whether they would affect specific task elements. In general, we assumed the visual design task and the affordances of digital video tools would have an impact on three levels: (a) the cognitive impact was assessed by multiple choice items tapping historical knowledge and transfer tasks for critical film analysis. We investigated the design products of participants as indicators of (b) action-related outcomes by considering their number of selected scenes and sequences, precision (length of sequence and size of detail), and structuring (deviations from the source video's chronology). Finally, we analyzed the dyads' taped interactions as indicators of (c) socio-cognitive effects by using a coding scheme that captures students' problem solving behaviors (planning, executing, evaluation, revision), collaborative behaviors, and content discussed (the original newsreel-video, the historical events, or their design task). In addition, we analyzed selected case examples of dyads' interactions to provide empirical evidence for the impact of the affordances of the advanced digital tools on collaboration.

The visual design task was tested in a lab-experiment (see Zahn, Pea, Hesse, & Rosen,in press) under controlled conditions to investigate its general effectiveness. Also, the specific effects of the affordances of the digital video tool WebDIVER^{TM}, in contrast to a control condition using "simpler" technology (video-player & text-editor) had to be proven before we took the procedure into studies with high school students in the classroom. The sample of this first study consisted of 24 dyads of psychology students (mean age = 22.2, *SD*= 4.8, 68.8% female). Generally the results revealed high appraisal of the task and significant positive mediating effects of the WebDIVER^{TM} video tool on all three levels of outcomes described above: Dyads supported by WebDIVER^{TM} showed higher factual knowledge and film analysis skills, design products of higher quality, and more communication time devoted to task relevant content (historical context and design decisions). In sum, the results showed that the influence of the video tools extended to the learners' socio-cognitive processes and focused their interactions on the task. Qualitative case analysis provided evidence for direct effects of the video tools on conversations, i.e., tool affordances implicitly guided learners' elaboration on the source video.

Field Study in Class

Following up on the results from this preliminary laboratory study, we took the experimental design into German secondary classrooms. The experimental sessions were conducted in schools spanning over two subsequent 45 minute units using a portable "notebook classroom" we provided for the study. The students were alerted by teachers that our task would be integrated into the current history curriculum. In this study we manipulated two experimental between-subject factors in a two-way factorial design. The first factor (technology) was the digital video tool provided to the students (digital video tool DIVERTM vs. simpler software solution, i.e. video player combined with text-editor). The first factor was chosen to test the ecological validity of the results found in the prior lab experiment on the specific effects of the affordances of the digital video tool WebDIVERTM. By investigating effects of tool affordances, we wanted to address the important issue of whether or not an editing tool originally designed for researchers and educators, when reapplied as a tool for learning in the classroom, would be beneficial for students in comparison to a common (and maybe more familiar) technology. The second factor (metaphor) was the appeal to students' media-related rhetorical concepts –their rhetorical concepts were either in line with or different from the system architecture of the digital video tool). By introducing this second factor, we wanted to tap into the question of explicit instructional support of the complex design task as opposed to the implicit guidance by the digital tools. We based this factor of metaphor on the work of Stahl and Bromme (2004), who investigated students designing hypertexts and reported that, due to the novelty of the medium hypertext, student designers cannot be assumed to have firmly established media-related rhetorical concepts which form a design goal. Therefore, in the first condition we prompted students with a metaphor of "video dives" epitomizing the concept of a medium for selecting ("diving into") visual information. In the second condition we prompted students with a metaphor of "annotated movies" epitomizing the concept of a medium for integrating information elements.

Altogether 234 students from 8 classes in 4 German secondary schools participated. Due to technical problems, data of 24 participants (12 dyads) could not be saved and were not included in the analyses. In the end , data from 111 dyads of students were analyzed (mean age =15.9, *SD*=0.78, 60.9% female). We are aware that our data has a multilevel structure; however, due to the sample size and small number of classes, we based our analyses on the dyadic level. Gender composition of the dyads was equally distributed over the four conditions. Furthermore, experimental groups did not differ with regard to their experiences with digital media, personal computers, or prior knowledge of post-war German history. However, the groups using the DIVER^{TM} tool reported higher initial interest in post-war German history. Thus, all reported analyses were additionally run with interest as covariate without changing the results.

In general, the design task was rated by participants as being interesting in general and proved applicable in the classroom. Also, with regard to cognitive outcomes, all students improved in their factual knowledge of the historical content, measured by a multiple-choice test before (*M*= 45.20% correct, *SD* =15.50) and after the design task (*M*= 65.00% correct, *SD*=8.20), $F(1, 107)=230.83$, $p<.05$, partial $\eta^2= .68$. However, there were no differential effects of the independent variables. The manipulation tapping students' media concepts showed no effects on either outcome variable, nor were there any significant interactions ($F<1$).

With regard to the action-related outcomes, students using the advanced digital video technology (DIVER™) created more sophisticated design products. They selected significantly more scenes and more details within these scenes compared to the control group. Furthermore, the DIVER™ tool increased the number of deviations from the chronological order of the source video when students made the selections, which indicates more autonomous design in the experimental compared to the control condition. Altogether, this indicates that the advanced digital video tool fostered a higher quality of the design products.

In line with these findings, dyads using the DIVER™ tool seem to have acted more autonomously during collaboration: In order to analyze the socio-cognitive impact of the affordances of digital video tools on collaborative design, the interactions of a random subsample (*N*=14 dyads) were coded for (a) content of collaborative talk and (b) problem solving behavior. 20% of the videos were coded by a second rater and according to Asendorpf and Wallbott (1979) we computed Cronbach's α for ratio scales (here the aggregated time of students spent on the different activities) as the agreement measure. Overall, high inter-rater reliability was found, all αs > .81.

The proportions of content discussed during the design task, relative to overall collaboration time, show a beneficial influence of the advanced technology. Dyads working with DIVER™ discussed the historical content more substantially (*M*=14.22% of time, *SD*=7.37) and their actual design task (*M*=16.45%, *SD*=5.96), than did dyads in the control condition (*M*=5.33%, *SD*=6.56), $F(1, 107)=6.42$, $p< .05$, partial $\eta^2= .39$, respectively (*M*=7.23%, *SD*=6.55) $F(1, 107)= 7.78$, $p< .05$, partial $\eta^2= .44$. In contrast, students working with the less sophisticated video player and text-editor showed a tendency to discuss the source video itself more (*M*=18.64%, *SD*=8.36) than did students using DIVER™ (*M*=3.49%, *SD*=18.03), $F(1, 107)=3.37$, $p< .10$, partial $\eta^2= .25$. Overall, this indicates that the affordances of the advanced digital video tool influenced the dyads' collaboration on a socio-cognitive level and may have fostered task-relevant discussion about historical content and design.

Students' general problem-solving behavior, however, was influenced neither by the design tools nor the prompted metaphors. All dyads directly engaged in executing the task (80.5% in general) and devoted less than 4% of their time to planning and evaluation. Analyses revealed a tendency for students to request help less often when using DIVER™ (1.63% time working on task, *SD*= 2.13) than in the control condition (*M*=5.32%, *SD*= 4.04), $F(1, 10)= 4.21$, $p<.10$, partial $\eta^2= .26$). We interpret this as an indicator for a stronger implicit guidance of the advanced digital tool in situations when a task is not explained step by step but determined by the goal. The coding of the video interactions also showed that overall "other" activities of learning dyads made up less than 5% of the time on task. These activities included off-task behavior, such as chatting (*M*=3.90%, *SD*=3.58) and problems concerning the technology (*M*=3.67%, *SD*=2.82) and did not differ between the four conditions, all *F*s < 1, ns. Therefore, any differences in students' learning behaviors cannot be attributed to differences in the difficulty of operating the two technologies.

However, especially taking into account the limited time that students could spend on the design task, the quantitative indicators for learning outcomes document effects, *not* processes. In order to provide evidence windows to substantiate our assumptions (see above: advanced digital video tools may support collaboration on a socio-cognitive level), we conducted additional case analyses focusing on giving what Barron (2003) calls a "localized account" on how the dyads integrated technology affordances in their conversations for their design-related interactions. Such evidence was already found in the prior laboratory study (Zahn et al., in press), where we identified processes of "guided noticing" (Pea, 2006), which emerged as interactional patterns in dyads elaborating on a newsreel with WebDIVER™. In the present paper, we provide evidence for similar findings under the conditions of the real "noisy" classroom setting. We compare two exemplary episodes for processes in two dyads working with either DIVER™ (see Table 1) or the simpler technology of the control condition (see Table 2). These dyads performed similarly well on the task and the post-tests. The episodes illustrate how the students from each dyad collaboratively work on the *same* scene in the historical newsreel video, but with *different* orientations: Dyad 1 (Students A and B working with DIVER™) discusses a design problem thereby elaborating on historical content, while dyad 2 (Students C and D working with a video player combined with a text-editor) discusses descriptive features of the source video while also sticking to its chronology.

In dyad 1, during most of the episode the two students skim through the dive panels they had created earlier, which results in several cycles of "guided noticing" (Pea, 2006). The transcript provided in Table 1 illustrates how A guides attention to a previously selected picture. The joint attention of students A and B is also implicitly guided by the technology's affordances: In the beginning of the episode (lines 1-9) the students seek a picture as a focus of their joint attention and select it for their design product (while deleting another prior selection). In the middle of the episode the question of student B about a necessary design decision (where to assign the caption “Air Lift”, line 11), initiates a short discussion (lines 12-16), which ultimately leads to meaning-making about what “Air Lift” means (line 12) and what “Candy Bombers” are (lines 14-16). In other words: understanding of the historic event (the aim of supplying the population separate from the planes as a means of reaching this aim and their name “Candy Bombers”) results from a simple question (line 11), which resulted from the necessity to write and place a caption. This provides an example of how the tool’s affordance impacts socio-cognitive processes, joint meaning-making and the establishment of common ground, finally leading to creating a design product. There is an additional factor suggested by the excerpt presented here: While the dyad diverges from the central goal in this episode—specifying what is meant by the term Air Lift—the dive panels created earlier repeatedly guide joint attention back on this goal. Students A and B finally record the different ideas emerging during their conversation, in other words, they arrive at closure, manifested in their design product as a replayable artifact.

Table 1: Exemplary Episode of Dyad 1 (Working with DIVER™)

Timestamp 00:13:27			
Line	**Student**	**Utterance**	**Actions and written comments**
1	A	Where is the picture? There it is.	B scrolls up to the specified dive
2	B	Yes. …	
3	A	What’s that?	
4	B	That‘s … [inaudible] … write “Air Lift”	
5	A	I would leave that the way it is.	
6	B	What is that?	
7	A	Yes, that is a good picture. … But you can delete the one below.	A refers to a selected detail of an image showing a group of men carrying bags of supplies
8	B	Too bad, actually.	B deletes the indicated image
9	B	Um … (verbalizes while typing) Supplies provided by the Allied Forces?	B selects a dive showing two men unloading a truck with supplies and types “Supplies provided by the Allied Forces”
10	A	Mmhmm	
11	B	And where do we write “Air Lift”?	
12	A	Well, Air Lift means the supply with … carried out by the airplanes.	
13	B	But it has to be mentioned somewhere.	
14	A	Well no. … Because everything is about the Air Lift … Nee! … Well, or we add “Candy Bomber” to a picture of a plane.	
15	B	Were they all named like that?	Screens through the selection
16	A	Well no, but this is what they were called … well, colloquially.	
17	B	All of them, really?	
			A selects a dive of a still showing a group of airplanes on the ground.
18	A	Yes. …	
19	A	Ah … I thought you had deleted that.	
20	B	I did.	
21	A	Ah, you it is not possible to go down here like this. What is that? … people … That one, we can also delete.	A deletes a dive
Timestamp 15:53 – 16:09		*Experimenter announces that everybody should write their final comments and prepare to proceed to the following tasks.*	

In comparison, as can be seen in Table 2, the conversation of dyad 2 is focused on describing the source video’s surface features instead of dealing with design issues and the historical content. The episode starts with C guiding D’s attention to the music on the audio track (line 1). After an initial affirmative reaction (line 2), D draws the joint attention away from the music towards the pictures, and states that the airplanes are shown from different camera angles (line 2). C writes down this discovery and continues D's initiation of a deeper interpretation (lines 4-6), which D incorporates in the written comment (line 5). Next, D focuses their discussion on the word choice (lines 10-12), draws the focus away from interpretation back to the observable surface level (line 6), and C corrects his former writing. They then return to the issue of the music (line 8) with which they started out, and they describe the accompanying video images (lines 9-11). Continuing to refer to the music accompanying the final scene, D suggests an interpretation (line 14), yet C objects. In sum, while the two students from dyad 2 initiate meaning-making twice in this episode, they do not succeed in achieving true common ground or finally in recording the ideas that emerged during their conversation. In other words, the dyad does not arrive at agreed-upon meanings to be manifested in their design product. Furthermore, they do not elaborate on content or design, but their discussions remains on a descriptive level with a strong orientation towards the surface features of the original source video. This is in line with the quantitative findings reported above (proportions of content discussed during the design task). Moreover, with regard to the socio-cognitive effects of the control condition technology, we found another aspect. As suggested by this excerpt of this dyad's conversation, the technology affords the students to *proceed according to the chronology* of the source video. This contrasts with the conversation of dyad 1, in which the students skimmed through the source video *following an idea*.

Table 2: Exemplary Episode of Dyad 2 (Working with Video Player combined with Text Editor)

Timestamp 00:20:29			
Line	**Student**	**Utterance**	**Actions and written comments**
1	C	Military marches.	C stops the video
2	D	Mhm [affirmative] Let's write that the planes are being shown from many different angles [incomprehensible] concentrate	C starts to type "planes are shown from many different angles"
3	D	Now you typed perp. [laughs]	C corrects the typing error perp. to pers.
4	D	„in order to" ..., come on, say something	
5	C	„in order to ... make people concentrate on them"	C continues to type "in order to make people"
6	D	Yes … „in order to highlight them" is better.	C changes the comment into "in order to highlight them."
7	C	An what do we write here?	
8	D	„military marches"	C types "military marches"
9	C	"while …" do you get that?	
10	D	Yes, I do. Do you see that? There [incomprehensible] are being distributed.	D points to the monitor. C starts to type "while supplies are being distributed"
11	C	"while [incomprehensible] are being distributed"	
12	D	[incomprehensible] Oh, crap! [incomprehensible] No, no, it does not work somehow. How embarrassing. What's happening? You are clicking correctly, aren't you?	C is struggling with positioning the cursor at the word that needs to be corrected They continue to watch the video to the end
13	D	"Joyful music, because the supply with food is ensured."	D moves the head in the rhythm of the music.
14	C	No, that's crap.	
15	D	So, what do you wanna write? „because [incomprehensible]"?	C types "Freudenmusik" [joyful music]
Timestamp 00:25:12		*Experimenter announces that everybody should write their final comments and prepare to proceed to the following tasks.*	

In conclusion, the results indicate that the digital video tools as "collaborative" tools supported students' understanding of historical sources in *different* ways during the visual design task.

Discussion

Taken together, our quantitative and qualitative results indicate that advanced digital video technologies applied to classroom learning can be useful in supporting the socio-cognitive processes of student dyads performing complex visual design tasks in the history domain. The findings suggest, when explicit instructional guidance is limited, technological affordances and constraints can implicitly guide and support students' task-related and socio-cognitive activities. We found indications that the implicit instructional support of specific tools constitutes an important complement for learning with design tasks. However, students focused on applying the different technologies, but spent little time on planning and evaluation during task completion. This latter finding might explain why using instructional metaphors did not prove to be salient enough when combined with different digital video tools on students' learning: Metaphors are important during planning. When planning is limited, metaphors have limited impacts on design and learning.

The results of this field study are in line with the earlier findings from the lab study (Zahn, et al., in press), where the affordances of the advanced digital video tool impacted the quality of participants' design activities and extended to learning outcomes and learners' socio-cognitive processes focusing their discussions in very similar ways. Thus, we conclude that the effects of implicit guidance by technological affordances and constraints may constitute an important factor in computer-supported learning that needs to be considered with regard to educational goals and possible instructional strategies. Affordances and constraints of advanced technologies already in use can be seen as potentially supportive to implicit instructional aspects. Studying them means providing valuable information for effective integration in the classroom. However, explicit instructional aspects need to be considered, too, during learning with digital video. This is especially true when addressing issues such as optimizing learners' problem solving within the joint problem space of a complex visual design task, and successful integration of these tasks into instruction for a whole classroom. Further research is needed into these issues. In an initial step to look further into the role of explicit instructional support, we went back to a more controlled environment by inviting 201 students from 9 school classes to our research lab. In this study we manipulated two between-subjects factors: The first factor was the instructional support of either the design problem or the collaborative aspects of the task, which was derived from the theoretical model of design as problem solving. At the beginning of the collaboration phase, students were either prompted to consider the future audience of their design product and to make clear the main messages they wished to convey with their reworking of the source video (support of design), or they were asked to write down rules to ensure good communication within their dyad and to think about how to divide the task into sub-tasks and how to distribute these among them (support of collaboration). For the second factor, we manipulated the video tools, by contrasting two web-based applications: WebDIVER™ and Asterpix (http://www.asterpix.com). This manipulation was based on our considerations that we had found different technological systems to differ on a generic level in enabling users to acquire different cognitive skills (Zahn, et al., 2005): Some digital video technologies focus on integrating associated information, like the Asterpix system. Others focus more on observation and analysis, like WebDIVER™. We were especially interested in whether the specific socio-cognitive functions of the two prototypic tools would differentially influence student learning on the three levels described above (cognitive impact, action-related outcomes, socio-cognitive effect). Furthermore, we wanted to investigate whether our explicit instructions fostered students' planning behavior, and, indirectly, other important sub-processes of our model. Finally, we wanted to learn more about the interaction between the instructions and the tool-specific affordances, in order to provide more evidence for the need to frame digital video tools when integrating them into classroom instruction. Results from this study indicate significant effects for explicit instructional support, as well as the interaction with implicit guidance by the tools' affordances.

Taken together, such results provide initial evidence for the importance of instructional framing of visual design tasks. With our research we hope to deepen our understanding of how to foster students' video-related learning activities, dialogue, knowledge construction, or critical thinking when working with historical sources. We hope, too, to pave the way for constructivist approaches to using audiovisual media in the classroom.

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