Effects of Computer-Supported Collaboration Script and Incomplete Concept Maps on Web Design Skills in an Online Design-based Learning Environment

Inaugural-Dissertation
zur Erlangung des Doktorgrads der Philosophie
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München

vorgelegt von

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aus

Tanta (Ägypten)

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Declaration

I declare that the thesis hereby submitted for the Ph.D. degree at Ludwig-Maximilians-University Munich is my own work, where I have consulted the published work of others; this is always clearly indicated by special reference.

No part of this thesis has been previously submitted at another University, in Germany or overseas, for any degree or examination.

Walid El-Refai

Munich, March, 2012

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Walid Yousry Abd El-Hai El-Refai

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Introduction

Nowadays, there is an increasing role of the media in everyday life. Media can bring the world into our place. In other words, almost everything about environment, people, places, events, entertainment and so on can be easily available to everyone. Therefore, developing a literate person who has the ability to read, analyze, evaluate, criticize, and produce communications in a variety of media should be a main goal of all educational institutions; particularly college and university education (Aufderheide, 1993). Media literacy can be defined as the knowledge and skills that are needed to critically analyze media and also produce media messages in a wide variety of forms (e.g., print, TV, computers, arts, etc.; Hobbs, 1998).

Designing web content is an important competence of media literacy that becomes essential for individuals, companies, and businesses. According to Sgobbi (2002), web design simply refers to creating pages for the World Wide Web. Skills concerning the design and building of websites become critical competencies for future workplaces, since the Internet penetrates deeply into different aspects of life around the world (Ivory & Megraw, 2005; Natukunda, 2008). However, designing and building websites is a challenging and complex process that can be part of different roles (e.g., web designer, graphics designer, and web manager), and conduct different tasks (e.g., planning web pages, adding and organizing contents, creating hyperlinked documents, and establishing navigation systems). In addition, developing web design skills still receives little attention within higher education (e.g., Duran, Yousman, Kaitlin, & Longshore, 2008). Empirical evidence shows that university students usually graduate in low levels of web design skills (e.g., Hardy, 2005, Templeton, Jones, & Li, 2003; Hulick & Valentine, 2008; Rafaill & Peach, 2001; Shannon, 2008; VanLengen, 2007) and design web contents, and new technology courses have to receive more attention (e.g., Scott 1995). Therefore, it has become imperative for colleges and universities to train their students in web design skills. Moreover, learning specific research-based standards for designing websites (e.g., Harbeck & Sherman, 1999; Koyani, Allison, Bailey, Chaparro, Ivory, & Wheeler, 2003; Powell, 2000) has to be done side by side with learning web design knowledge and skills as a prerequisite skill for the students (Bucy, Lang, Potter, & Grabe, 1999), which in turn may enable them to design and build attractive and effective websites.

The nature of the design process can be described as a form of ill-structured problem that requires the students to acquire the skills of communications, coordination, problem solving, and teamwork as well (Sgobbi, 2002). Therefore, given the complexity of this task, collaborative learning may be a promising instructional approach to acquire web design skills, since through collaboration, complex tasks can be distributed among learners of a group (Roschelle & Teasley, 1995). In this way, collaborative learning may be more convenient for the design process than individual learning, especially when it is well-structured (Harskamp & Ding, 2006).

Design-based learning (DBL) is a type of active learning that has gained widespread attention in the Learning Sciences and could be used for engaging the students in solving ill-structured problems, such as the design process, collaboratively (e.g., Fortus, Dershimer, Krajcik, Marx, & Mamlok-Naaman, 2004; Kolodner, 2002). DBL can be described as a combination between problem-based learning, project-based learning, and inquiry learning, where the students are supposed to work collaboratively through a set of different design processes to achieve design challenges, such as “Design a miniature car that can go from one side of the classroom to the other” (e.g., with the aid of straw, paper, and glue; see Kolodner, 2002) with the aim of learning content knowledge as well as the acquisition of social and communicative, inquiry-related skills (e.g., communication, collaboration and problem-solving skills; see Kolodner, 2002).

Over the last years, several DBL approaches have been developed, such as Learning by Design (LBD; Kolodner, 2002), Design-based Science (DBS; Fortus et al., 2004), and Engineering Competitions (Sadler, Coyle, & Schwartz, 2000). However, each DBL approach has its own characteristics. For example, in Learning by Design, the students work through two cycles of activities that concern investigating and solving the design problem with repeating these activities in each iteration with more focus on the content and increasing level of complexity. In contrast, in Design-based Science (DBS) the learning activities are organized in one iterative cycle with repeating these activities in each iteration on different science content. For instance, through the “Vehicles in Motion” challenge (Kolodner et al., 2003), which is an example of a LBD unit, the students repeat their activities on the same design (miniature vehicle and a balloon-powered propulsion system) with more modifications and improvements for enhancing the vehicle’s performance to go as far and straight as possible. In contrast, in the “How do I Design a Structure for Extreme Environments?” unit (Fortus et al., 2004) which is an example for a DBS unit, the students in each iteration are supposed to engage in different learning cycles concerning weather conditions, technical drawings, different sources of loads, shape and structural integrity, and thermal insulation. Overall, analyzing a number of DBL approaches showed that the design processes can be classified into two main types of processes: (a) Collaborative processes that involve engaging the students to work collaboratively and playing different roles through the design activities and (b) content-related processes that direct the students to learn the content and focus more on scientific concepts in the content.

Moving towards online DBL makes sense especially when the target skill is web design. Computer-Supported Collaborative Learning (CSCL) environments have succeeded before in implementing other student-centered instructional approaches, such as inquiry learning (e.g., using knowledge forum for improving conceptual, metacognitive and collaborative processes in computer-supported collaborative inquiry; Zhao & Chan, 2009) and problem based learning (e.g., using a synchronous and an asynchronous distributed problem-based learning environment to support learners’ motivation and problem-solving; Zumbach, Hillers, & Reimann, 2003). All these approaches involve very similar collaborative and content-related processes to DBL, including suggesting solutions for a problem, exploring ideas, conducting investigations, working collaboratively, discussing, evaluating, and interpreting the results (Jonassen, Peck, & Wilson, 1999; Papert, 1993). The current study investigates if DBL can be successfully transferred to online learning and be used to facilitate the acquisition of web design skills.

According to the nature of DBL, the students are supposed to engage in complex and challenging investigation and learning processes. Furthermore, the students have to learn the content deeply, acquire science concepts and realize the relations between them, and after that connect them with ideas of research and design, and organize their ideas in order to address the challenge (Narayanan, Hmelo, Holton, & Kolodner, 1996; Puntambekar & Kolodner, 1998; Vattam & Kolodner, 2006). In addition, DBL typically requires the students to engage successfully in collaborative learning activities through their investigation. For example, in LBD students have to collaborate in small groups to reach an understanding of the design task at hand, control and conduct design processes and related empirical investigations, and effectively communicate with other learning partners (Kolodner, 2002). There are many studies that have demonstrated that students often do not collaborate well and experience difficulties when supposed to engage in high-level collaboration processes (e.g., Cohen, 1994). If DBL is realized online, these problems may even be amplified. Therefore, additional support during online DBL is needed for the students.

In general, there are two categories of scaffolding that can be used for supporting online DBL (Kollar, Fischer, & Hesse, 2006), (a) social scaffolding, that refers to how interactions can be facilitated to gain knowledge and skills (Vygotsky, 1978), and (b) content scaffolding, that refers to scaffolds which provide learners with conceptual support concerning the contents of the task (Kollar et al., 2006). Giving such support is likely to facilitate learning of content knowledge, as well as the acquisition of social and communicative, inquiry-related skills (e.g., communication, collaboration and problem-solving skills; see Kolodner, 2002). This study focuses basically on examining two types of scaffolds: (a) computer-supported collaboration scripts as social scaffolding and (b) incomplete concept maps as content-related scaffolding.

In theory and research on CSCL, as well as in instructional psychology, collaboration scripts are considered a powerful means to improve processes and outcomes of collaborative learning (e.g., Schoonenboom, 2008; Stegmann, Weinberger, & Fischer, 2007; Weinberger, Stegmann, Fischer, & Mandl, 2007; Weinberger, Stegmann, & Fischer, 2010). For example, Kollar, Fischer, and Slotta (2007) demonstrated that collaboration scripts were able to improve collaboration through structuring the interactive processes between learning partners. Moreover, collaboration scripts are able to facilitate communicative-coordinative processes between the students which may affect positively the communication, and interaction between the students that guide them through complex learning processes (Hoppe, Gaßner, Mühlenbrock, & Tewissen, 2000). With respect to knowledge acquisition, there is evidence that collaboration scripts can affect domain-general knowledge (e.g., on collaboration and interaction; e.g., Stegmann et al., 2007; Weinberger, Stegmann, & Fischer, 2005), but positive effects on domain-specific knowledge are much more rare (Weinberger et al., 2005).

As mentioned before, students in online DBL need to be supported during content-related discourse processes to ensure higher quality of both learning processes and outcomes. One way to address this problem is to use incomplete concept maps that can be described as concept maps that involve missing concepts and relationships. In general, concept maps are visual representations that can structure collaboration, and increase the discussion between the students with respect to the content (Cox & Brna, 1995; Holley & Dansereau, 1984; Jonassen, Beissner, & Yacci, 1993). For example, studies on the use of concept maps and graphic organizers indicate positive effects on content comprehension (Mok, Lung, Cheng, Cheung & Ng, 2006; Romance & Vitale, 2002; Shavelson, Ruiz-Primo, & Wiley, 2005). There is also a positive impact on guiding students in online discourses and interactions (Suthers, 2003), as well as on increasing and facilitating the discussions between students (Jacobson & Levin, 1995), which at the end may lead to content-related knowledge construction. A strength of using concept maps lies on the graphic representation used to visualize and manage domain-specific knowledge necessary for the design task (Tergan & Keller, 2005), which enables the students to understand and remember complex information and abstract concept relationships (Armstrong, 2003), as well as mapping, organizing, structuring and restructuring, elaborating, evaluating, communicating, and using their ideas and thoughts (Cox & Brna, 1995; Holley & Dansereau, 1984; Jonassen et al., 1993). Moreover, providing students with incomplete concept maps can increase activities for seeking missing information, which in turn may positively affect learning outcomes (Baker, 2003). Therefore, in this dissertation, incomplete concept maps will be used, which are supposed to stimulate the students to think more about the concepts and the relationships in the content (Schau, Mattern, Weber, Minnick, & Witt, 1997).

Therefore, the main question of this dissertation is: To what extent can online DBL be facilitated by collaboration scripts and incomplete concept maps?

In **chapter 2**, more focus on media literacy and its importance will be shed and web design skills as important competence of media literacy will be discussed. In addition, the chapter addresses constructive standards for designing websites. Subsequently, web design knowledge and how it can be acquired will be presented. In the last part of this chapter, collaborative learning as a suggested approach for developing web design skills will be linked to design-based learning approaches.

Chapter 3 introduces Design-based Learning (DBL), selected examples of DBL approaches according to specific searching criteria, and the main characteristics of DBL based on selected approaches. In the next part, the chapter addresses CSCL environments and their potentials with respect to online DBL, and how CSCL contexts may enable and facilitate online DBL. In the last part, the main problems that may hinder online DBL will be discussed.

Chapter 4 discusses an overview of the extent to which students need to be supported in an online DBL environment. Based on the types of scaffolding (Kollar et al., 2006), computer-supported collaboration scripts as social scaffolding and incomplete concept maps as content scaffolding will be discussed in details, describing how they can be implemented in online DBL to facilitate and support learners through their design-based discussions.

Chapter 5 outlines the theoretical framework regarding processes, outcomes and facilitation of the acquisition of web design skills in an online DBL environment. In addition, the research questions regarding collaborative and individual learning outcomes related to design and building websites will be formulated.

Chapter 6 introduces the methods of how the study was conducted and how the variables were operationalized. Additionally, the online DBL environment of the study including the learning material will be presented.

Chapter 7 gives an overview of the results. First, the chapter reports the effects of collaboration script and incomplete concept maps on collaborative learning outcomes (content-related discourse quality, collaboration skills shown in a subsequent collaborative transfer task, as well as the quality of published websites). Subsequently, effects of collaboration script and incomplete concept maps on individual learning outcomes (factual knowledge and skills on web design) will be presented. Finally, one case study for each of the four experimental conditions will be presented.

Chapter 8 will discuss, interpret, and compare the findings of the empirical study to prior findings. The findings of the study will then be put into perspective concerning a number of limitations of the study. Furthermore, implications for future research will be outlined.

Media Literacy and Web Design Skills

In recent years, media literacy has become important for everyone (e.g., students, researchers, and the public; Piette & Giroux, 2001). Designing web content is an important component of media literacy. The Internet has increasingly become an integral part of everyday life and is becoming difficult to dispense in different aspects of life (Natukunda, 2008). Moreover, the Internet touches various aspects of the media and has the ability to disseminate information and services widely and rapidly (Ivory & Megraw, 2005). In addition, web design connects various scientific areas (e.g., graphic design, community service, and psychology) to computer science. For example, through the process of web design, students have to be aware of issues that are related to their community (e.g., prices, jobs, and problems), have enough information about different topics in computer science, and appreciate the Internet's value in their life (Baird, 2006).

However, web design is a challenging and complex process that requires learners to build complex websites involving hyperlinked documents, different navigation systems, and social information spaces, as well as to account for the possible needs, purposes, and abilities of different users (Spyridakis, Wei, Barrick, Cuddihy, & Maust, 2005). Furthermore, there is a need for students to acquire special skills of communication, coordination, problem solving, and teamwork that may facilitate the communication and interaction between students during design activities, which might enable them to share experiences, and solve complex design tasks. The students also have to update their technical knowledge in order to become familiar with rapid changes in web tools, information and computer technologies that support Internet and Intranet usage (Kotamraju, 2002; Sgobbi, 2002). Therefore, engaging students in collaborative learning may allow them to effectively use one another's resources and skills, such as asking for information, evaluating ideas, and monitoring work (Chiu, 2008), which in turn may lead to the improvement of students' web design skills.

In this chapter, definitions of media literacy and to what extent media literacy is addressed within higher education will be discussed first. Next, web design skills as an important component of media literacy, constructive standards for designing websites, and types of web design knowledge will be presented. Finally, collaborative learning as an appropriate and suggested approach for design and building websites will be addressed.

Media Literacy

Over the last thirty years, awareness of the importance of media literacy has become more prominent throughout the world (Piette & Giroux, 2001). Students are in need to know and deal with a complex and fast-changing information environment and to prepare themselves for a future workplace and community, which in turn requires giving more focus on media literacy skills as a critical part of education in today's world. Thus, it is important that students receive training in media literacy in order to serve as skillful 21st century graduates (Duran et al., 2008; Scull & Kupersmidt, 2011).

Media and literacy have different meanings to different people, which in turn led to many forms in many different cultural and learning environments among scholars from different disciplines (e.g., media studies, communication, education, and child development; Christ, 2004). However, despite the many conflicting opinions about the definition of media literacy, some general consensus has been reached. One accepted definition considers it to be the competence to both critically analyze media and to create messages in a wide variety of forms (e.g., print, audio, video, and multimedia; Aufderheide, 1993; Hobbs, 1998; Martens, 2010). From this definition, the media literate person should have the ability to think critically about what s/he sees, hears and reads in different media (e.g., books, television, the Internet, and new emerging technology), and also has the ability to create messages using print, audio, video, and multimedia (Lund, 1998). Particularly, media literacy requires developing the individuals' knowledge and skills of (1) media use, which involves finding, selecting, and using it for a variety of purposes (Wulff, 1997), (2) media creation that consists of preproduction (e.g., identifying target audience), production (e.g., creating media and filming), and postproduction (distribution) to communicate information and ideas through multiple audiences (Ascher & Pincus, 1984; Lund, 1998; O'Brien, 2005; Williams & Medoff, 1997), and (3) critical media that involves constructing personal meaning and evaluating media messages and productions such as target audience, used techniques, unstated message, and purpose (Hobbs, 2004; National Communication Association, 1998).

Despite the awareness of media literacy as a field of study which is rapidly growing in importance students typically do not receive sufficient formal training in media literacy as well as instruction in basic media literacy skills and media literacy education, especially in higher education (Aufderheide, 1993; Scull & Kupersmidt, 2011; Silverblatt, Baker, Tyner, & Stuhlman, 2002). In addition, efforts of integrating media literacy into a clear educational policy are still inert and indefinite (Wulff, 1997). Moreover, only a few empirical studies regarding media literacy within higher education have been conducted (Duran et al., 2008) and most of these studies are limited only on media analysis and media use skills. For example, Hindin, Contento and Gussow (2004) focused on analyzing advertisements as one type of media to evaluate whether a media literacy nutrition education curriculum with respect to the effects of television advertisements on children's food choices could influence the behavior, attitudes, and knowledge of Head Start (a program of the United States Department of Health and Human Services that provides comprehensive education, health, nutrition, and parent involvement services to low-income children and their families) parents. Participants were a convenience sample of 35 parents from Head Start programs. Results suggest that a media literacy nutrition education curriculum can be easily developed by dietitians, who can teach parents how to critically analyze many other forms of media (supermarket magazines, brochures, newspapers, websites). Furthermore, Fuller, Damica and Rodgers (2004) addressed body-image issues as related to media images. This study aimed to investigate the effect of an interdisciplinary media literacy intervention curriculum on 4^{th} grade girls in an urban elementary school. The participants were divided into two conditions (experimental and control conditions). A series of lessons that educated the participants on the role of fat in growth and development and media-generated images of women and girls was developed and implemented. The results of this study indicated that the participants in the experimental condition in the intervention were superior to those in the control group with respect to considering and wrestling with the complexities of body size and media representation issues (e.g., understanding of fat, media-generated images of women, and stereotypes of fat characters). The study confirmed also the need for media literacy education as a component in a health curriculum. Regarding media use skills, for example, Jones and Fox (2009), who explored the impact of the Internet on children, families, communities, the workplace schools, health care and civic/political life, provided specific categories of media and Internet use (e.g., entertainment, communication, social media use, and information gathering). Yet the media creation dimension remains an area of concern that has still received little attention especially in higher education and students are least likely to engage in that (Salaway, Katz, Caruso, Kvavik, & Nelson, 2006). Therefore, students in college and university education have to receive sufficient formal training and evidence-based programs or curricula in media literacy that provide more emphasis on developing knowledge and skills of media creation.

Web Design Skills as an Important Component of Media Literacy

In the mid-1990s, web design emerged and was limited to simple and basic components (Kotamraju, 2002). Through the period 2001 – 2010 large coursework and research related to web design was conducted as a result of increasing the users' number of the World Wide Web and the Internet's relationship with computer science and technology (Kotamraju, 1999), which made it easier to simultaneously share information and knowledge between users. Users from different countries can access the same information on the Internet at the same time (Marcus & Gould, 2000; Zorn, 2005).

Websites play an important role in our everyday lives. They are considered the most popular form of interaction and communication medium to enable people to interact and find information through the Internet (Jewanski, 1999). According to the Internet World Stats webpage, more than 20% of all world population already reaches the Internet (Costa, 2008). Numerous everyday activities (e.g., purchases, reservations, activity planning) are now routinely carried out over the Web. In addition, several companies have become dependent on the web as a main resource for their business (Baresi, Di Milano, & Morasca, 2007). Therefore, websites have become critical communication media for society and widely spread in different forms and contents (e.g., digital media, software, and databases; Bellizzi, 2000; Hoque & Lohse, 1999). Thus, every company or organization should have a website to facilitate conveying the information about themselves and their purpose within the business world (Rettig, 1992). In this way, web design may be seen as intrusive (Shyam Sundar, Narayan, Obregon, & Uppal, 1998) and it has become one of the fundamental computer skills in which students need to be successful at college and beyond (Hardy, 2005; Hulick & Valentine, 2008; Wilkinson, 2006; Wolk, 2008).

In general, web design describes the skills of designing pages for the World Wide Web. Accurately, it concerns defining and implementing design to manage and coordinate between all the components (e.g., site layout, style, contents, and functions) of the website (Sgobbi, 2002). In addition, web design also refers to creating websites with focusing on user interfaces that involve the content of the website and the navigation system that users need to access the content of the site (Kotamraju, 2002). Technically, web design implies developing a plan and method to enable the website users to understand and contact easily with the client's messages, as well as to identify technical tools for developing and managing the website and its contents.

On this basis, skills of designing web content are considered an important component of media literacy and they are required in order to prepare the students at different levels for future workplaces (Selber, 2004). However, designing and building websites is a challenging and complex process because websites have become complex distributed systems that involve the web (a way of accessing information over the medium of the Internet) as the interaction means and the Internet (a massive network of networks on which the World Wide Web is based) as the communication infrastructure (Spyridakis, Wei, Barrick, Cuddihy, & Maust, 2005). In this way, web design requires learners to skilfully adapt different roles (e.g., web project manager, system administrator, and graphics designer), work on tasks (e.g., creating hyperlinked documents, establishing navigation systems, and creating account for different users), and update their technical knowledge to keep track of the rapid changes of web tools, applications, information and computer technologies that support Internet and Intranet usage (Kotamraju, 1999; Sgobbi, 2002). In addition, the students must have enough technical background mainly in three aspects: (a) HyperText Markup Language (HTML) authoring, which is a code for structuring web pages and their contents (e.g., text, images, and videos), (b) graphic production, which refers to the process of manipulating digital images, and (c) media development that deals with visual and technical component of the website, such as videos and sounds (Kotamraju, 2002). Due to the complexity of web design process and expected problems associated with this process (e.g., organizing contents of web pages, and establishing navigation and security systems), designing and building websites individually does not guarantee producing high quality websites. Therefore, students need to develop the skills of communication, coordination, problem solving, and teamwork (Sgobbi, 2002). This set of skills is expected to benefit students through sharing experiences associated with web design processes and its accompanied problems with others and exchanging information rapid changes in web tools and computer technologies related to Internet and web design (Kotamraju, 2002).

Despite widespread recognition among educators of the need for web design skills and their attempts to integrate web design into curricula of higher education (e.g., Riley, Kunin, Smith, & Roberts, 1996; U.S. Department of Education and U.S. Department of Commerce, 2003), there is much evidence that the website skills of university students are not very high (e.g., Coolbaugh, 2004; Hardy, 2005; Hulick & Valentine, 2008; Rafaill & Peach, 2001; Shannon, 2008; Templeton et al., 2003; VanLengen, 2007; Wallace & Clariana, 2005) and students at colleges and universities have not enough teaching on web design and new technology (e.g., Scott 1995). Therefore, engaging students at the college and university level in courses that aim to develop their skills to create a well-designed website, learn this new technology, and better prepare them for the future in different fields has become imperative. In addition, the educational institutions have a large responsibility to train and retrain their students to acquire and upgrade their skills especially in the web design area (Owston, 1997).

Constructive Standards for Designing Websites

Although websites play an important role in communication between people and dissemination of information and services more broadly than ever before, there is still evidence that many websites involve weaknesses concerning usability and accessibility (Jackson-Sanborn, Odess-Harnish, & Warren, 2002). The design of websites plays an important role in conveying messages to users. Definitely, the way in which websites are designed and built, in terms of either aesthetics or usability, affect user's communication, usability, and benefit from different resources that are available on the Web. Therefore, website design has to be sufficiently attractive and suit users' requirements, which in turn adds to the importance of creating well-designed websites (Ivory & Megraw, 2005; Weinschenk, Jamar, & Yeo, 1997).

Well-designed websites facilitate a global distribution of products and services and communications around the world. Furthermore, better design will lead to better results, such as specifying target users and their needs (Terry & Mynatt, 2002). Thus, website designers should learn how to attract and keep the users' attention to explore more and be able to retrieve the information that they are looking for. Clearly, attracting the users' attention to the critical elements in a website is considered as a prerequisite skill that has to be acquired by the designers to design effective websites (Bucy et al., 1999). In this way, design and building good websites requires first specifying the target users and goal of the website carefully. Next, a set of standards of design and building good website concerning the elements of the website (e.g., appearance, navigation, frames, interaction to represented data, and links) should be followed and applied (Beyer & Holizblatt, 1998; Misanchuk, Schwier, & Boling, 2000; Schwier & Misanchuk, 1993; Weinschenk et al., 1997).

A lot of literature concerning a user-friendly design of websites exists (e.g., Brinck, Gergle, & Wood, 2001; Comber, 1995; Computer Science and Telecommunications Board, 1997; Flanders & Willis, 1998; Spool, Scanlon, Schroeder, Snyder, & Deangelo, 1999; Van Duyne, Landay, & Hong, 2002). Most of these resources are considered as personal guidelines about designing websites, which are usually vague, voluminous, and conflicting. Therefore, designers often find them difficult to understand and apply (e.g., Borges, Morales, & Rodriguez, 1996; Ivory & Megraw, 2005; Ratner, Grose, & Forsythe, 1996).

Beginning in 1990, different groups and organizations tried to initiate specific contents and style standards for their own members and different style manuals began to become available that provided a set of common research-based standards that most groups were subscribing to. The Yale university center for advanced instructional media provided one important manual (Web Style Guide; Lynch, 2002) that is recommended for use in the educational institutions. This manual involves thorough and accessible standards for designing and building sites that were suggested to be used by developers around the world. All the standards are included in a free online book version of guide.

The Yale's Web Style Guide identified seven categories of standards for designing and building websites for business, educational, or personal use. These categories varied between (1) technical standards (e.g., the homepage name must end with the extension index.html), (2) graphics (e.g., images should be displayed at 100% with photo format as JPEG.), (3) navigation (e.g., there should be the same look on every page that links from the homepage), (4) appearance (e.g., all fonts and headers should be similar), (5) writing mechanics (e.g., punctuation, grammar, and spelling are all correct), (6) intellectual property (e.g., all copyright guidelines must be followed and any extra help is credited), and (7) organization and content (e.g., theme and purpose should be evident on homepage). In addition to having a set of constructive standards for designing and building websites, there is also a need to apply them appropriately to show the websites as transparent as possible for users. Some researchers (e.g., Robert, 2007) believe that each category of the standards should be applied in a manner relative to the other six and should be free of rudeness, such as playing audio or video automatically when one arrives at the site, forcing users to use a particular browser, and having Flash as the only means of navigation (Robert, 2007).

However, there are many studies which show that only few designers could apply the standards of websites effectively (e.g., Chevalier & Ivory, 2003; Ivory, Mankoff, & Le, 2003). In this way, learning specific web design standards that cover all seven categories that were suggested by Yale's Web Style Guide and implementing them effectively in web pages is likely to develop the students' skills to create a well-designed website.

Web Design Knowledge

Two types of knowledge the students should acquire in a good course on web design which are declarative and procedural knowledge. Web design requires students to be involved in inquiry and discussion of complex design tasks, as well as to acquire different knowledge sets (Spyridakis et al., 2005). Therefore, the acquisition of web design knowledge should be facilitated and fostered. In this section, an overview of types of knowledge concerning web design will be given and subsequently, the way such web design knowledge (individual and collaborative knowledge) can be acquired will be addressed.

Through participation in design processes and problem solving activities, students may develop technological knowledge, which can be divided into two types of knowledge: (1) declarative knowledge, which relates to what the students have to know in order to do something. In this way, the declarative knowledge focuses more on the content and the relationships among the concepts in the knowledge, and (2) procedural knowledge, which relates to the activities and how students do something (McCormick, 2004, 1997; Williams, 2000). Declarative and procedural knowledge can be simultaneously activated when students process information and using each one of them depends on the frequency and recency of its prior use (Higgins, 1996). For example, students may think about the characteristics of well-designed websites. At the same time, they may use a particular procedure for searching and identifying related information.

Most cognitive psychologists tried to distinguish these two types of knowledge (e.g., Gagne, 1985; Shuell, 1986; Wall, McClements, Bouffard, Findaly, & Taylor, 1985). This distinction helps to identify methods and strategies that may facilitate students' acquisition of knowledge and skills with less effort and time (Jiamu, 2001).

Declarative knowledge (otherwise referred to in the literature as conceptual knowledge; e.g., Ben-Hur, 2006) is static knowledge stored in memory about facts, concepts, and principles that could be applied in a specific domain (De Jong & Fergusson-Hessler, 1996). In addition, it includes the nature and organization of factual information that is acquired, processed, and used in judgment of individuals (Smith, 1994). More specifically, this type of knowledge refers to the information that a person has to know in order to perform an action that is modified and adopted continuously (Wall et al., 1985). It can be argued that factual knowledge of web design corresponds with declarative knowledge in use. The factual knowledge of web design refers to the acquisition of specific web design concepts and realization of their relations, as well as the connections between such concepts and ideas of design (Vattam & Kolodner, 2006). Thus, declarative knowledge enables students to describe and define concepts, and often receives the most attention in traditional teaching classrooms (Mandl, Gruber, & Renkl, 1994). In traditional classrooms, students are encouraged and supported to acquire declarative knowledge, but other knowledge types are usually ignored (Weinberger, 2003).

Interdependent with, but distinct from declarative knowledge is procedural knowledge. Procedural knowledge is dynamic knowledge that refers to the procedures or operations performed on declarative knowledge. It includes "the sequences of interrelated operations that transform, store, retrieve, or make inferences based on declarative knowledge" (Smith, 1994, p.101). Accordingly, procedural knowledge includes perceptual, cognitive, response initiation, and execution phases, which contribute to adequate performance of an action (Wall et al., 1985). Therefore, procedural knowledge is required to enable learners to understand, analyze and solve problems. From this point, in addition to acquire declarative knowledge, students also need to acquire procedural knowledge to facilitate the acquisition of web design skills, which could be assessed by the actual performance of a skill (Marchion, Wall, & Bedingfield, 1987). In this way, two stages were suggested for learning procedural knowledge. The first is a declarative stage, where facts about the skill are learned and the second is a procedural stage where the knowledge is applied and that way proceduralized (Anderson, 1982).

For example, when a student learns how to design a website, s/he has to learn all about the standards of design and building good websites, how to create a new website, how to customize the settings of the website, how to insert different components into web pages, and how to publish the website. This is a set of factual information the student has to acquire during the declarative stage. Putting those facts into practice will enable the student to gain web design skills (procedural stage).

Collaborative Learning as an Approach to Foster the Acquisition of Web Design Knowledge and Skills

Learning can be described as the acquisition and structuring of knowledge that begins with the acquisition of factual knowledge (Chandrasekaran, 1989). Hence, learning a new skill requires existing knowledge and knowledge structures, which if they do not exist, must first be learned. Knowledge often is described incorrectly as an object of mind. However, knowledge can also be considered as a process and activity state in the task performance (Anderson & Lebiere, 1998). Weinberger (2003) assume that collaborative learning could be a promising way to acquire knowledge on grounds of shared knowledge or when they perform tasks depending on previously acquired knowledge individually.

Collaborative web design knowledge could be acquired when students work collaboratively in different phases of design and building websites to achieve the design task (Fischer & Mandl, 2001). Learners, who construct knowledge together, apply knowledge as a solution for solving complex problems. The groups' performance reveals the use of web design knowledge as a co-construction. Therefore, collaborative learning environments can play an important role in facilitating the acquisition of collaborative web design knowledge (Salomon & Perkins, 1998). Collaborative learning environments can specify to what extent students could work together effectively on designing and building websites.

The individual acquisition of knowledge is considered as the primary goal of any learning environment (Salomon, 1993). Individual learning outcomes were discussed as effects of a specific learning environment by Salomon and Perkins (1998). This concludes that knowledge is acquired and possibly transferred to different situations by the individual (Salomon & Perkins, 1998). However, the lack of spontaneous knowledge transfer is considered as a main problem of learning (Mandl, Gruber, & Renkl, 1994). Therefore, the students need to be supported to transfer web design knowledge from collaborative problem-solving to solve problems in individual situations. In this way, engaging the students in a collaborative learning environment may facilitate the acquisition of collaborative and individual web design knowledge.

Collaborative learning is defined as an activity that allows students to work together on the same problem instead of working on different components of the problem individually (Brandon & Hollingshead, 1999). Collaborative learning is often suggested as an adequate approach for complex and challenging processes such as web design processes (e.g., Lehrer, 1993; Lehrer, Erickson, & Connell, 1994; Liu, 1998; Papastergiou, 2005). On the one hand, the nature of the information age requires qualified individuals who can work in a team to solve complex problems and build knowledge (Kagan, 1994; Tan, Hung, & Scardamalia, 2006). In addition, many higher education students lack essential skills for the modern society such as processing information and operating effectively in ambiguous and unstructured situations. As a result, facilitating thinking, particularly the acquisition of metacognitive and problem solving skills, has become a desirable goal in different stages of education. Therefore, institutions of higher education are beginning to push collaboration as a way to promote critical thinking skills and become more learner-focused, which require changing the nature of the students' role to become more active by learning from each other, solving their problems, and learning about collaboration, as well as shifting the teachers' role from a lecturer to a facilitator who provides resources, monitors progress and encourages students to problem solve (Scardamalia & Bereiter, 1999). Furthermore, teachers have to move from being deliverers of the knowledge, to being facilitators of the learning activity (Cohen, Brody, & Sapon-Shevin, 2004). In addition, the process of designing and building websites itself is considered as an ill-structured problem, which involves working on problems that are complex, ill-defined and open-ended (Seol, Kim, Lee, & Park, 2007; Spyridakis et al., 2005). Through solving ill-structured problems, students have to engage in finding and organizing needed information from various resources, construct representations of their own knowledge, share information and knowledge, communicate and collaborate with others in order to solve the problem (Howard, 2002; Sinnott, 1989; Voss & Post, 1988; Weiss, 2003). Research studies demonstrate that when learners participate in collaborative groups, they are encouraged to share their information and thoughts with others, which in turn leads them to have a chance to reflect on their own learning and understanding, as well as to consider others' perspectives, which may finally aid in clearing up misunderstandings, acquiring knowledge and developing their critical thinking and problem solving skills more than individuals working alone (e.g., Clark, 2000; Hmelo & Ferrari, 1997; Manion & Alexander, 1997).

Collaborative learning refers to the instructional use of small groups in order to maximize students' learning by giving them a chance to work together (Johnson & Johnson, 2004; Kirschner, 2000). Through collaborative learning, students can seek, construct, and develop their knowledge within a meaningful context through interaction with others (Derry & Lesgold, 1996; Doise, 1990; Lave & Wenger, 1991; Wilson, Teslow, & Osman-Jouchoux, 1995). The terms cooperative learning and collaborative learning are often used interchangeably, whereas some researchers would differentiate them, especially according to the amount of structure and facilitator-control designed into the group activity (Bruffee, 1999; Emerson & Mosteller, 2004). In both, the students work together; however, cooperative activities are highly structured and are more teacher-centered (Panitz, 1997). The teacher usually plays a main role in controlling over the group by specifying group's goals, assigning group roles, and supporting groups with all needed material for achieving the task (Panitz, 1996). In addition, cooperative learning is division of labor, where each participant is responsible for specific portion of the problem (Dillenbourg, 1999). On the contrary, collaborative activities are less structured and are more student-centered. The students have more freedom and control over their learning. They determine how they collect data, what they have to learn to achieve the task, and how the final product should be like (Panitz, 1996). Moreover, collaborative learning is considered as a joint work of participants to solve the problem together (Dillenbourg, 1999). In this way, collaborative learning focuses more on the interaction and discussion between the students. Yet, a distinction between the two terms (collaborative and cooperative learning) is not always realized. For instance, Johnson and Johnson (1999) used the term of cooperative learning to refer to processes and interactions, which were labelled by Roschelle and Teasley (1995) as collaborative learning.

Johnson and Johnson (2004) identified five elements that should be available within cooperative learning situations: (a) positive interdependence refers to the student's awareness of the importance of partners in order to be able to accomplish the group's task, (b) individual accountability indicates to the students' responsibility for their own learning and their ability to perform in the presence or absence of partners, (c) promotive interaction means the students have to support each other's learning by helping, sharing, and encouraging efforts to learn, (d) social (team) skills denotes that the students have to conduct the activities effectively as a team, e.g., by communicating with each other and by making decisions, and (e) group processing refers to students' responsibility to conduct group-discussion to identify to what extent they achieve their goals and maintain effective working relationships among members. In addition, there are four factors that determine the effectiveness of a collaborative group: (1) social interaction refers to interpersonal behaviours required for positive group interaction; such as communication, respect, acceptance, and willingness to work together, (2) task management implies students' skills and actions for achieving the task, such as sharing, and helping others to complete team tasks, (3) leadership means facilitating and coordinating group efforts, encouraging students' participation in activities, and monitoring, and (4) trust indicates students' interpersonal and communication skills that lead to getting to know and trust others, and managing conflict (Resta, Awalt, & Menchaca, 2002). Therefore, structuring the collaborative learning environment according to the elements provided by Johnson and Johnson (2004), as well as the factors which determine the effectiveness of collaborative group presented by Resta et al. (2002), can effectively facilitate learning (O'Donnell, 1999), increase the students' participation and responsibility for learning

(Griffiths & Partington, 1992), construct individual knowledge (Webb & Palincsar, 1996), develop students' skills of problem-solving, decision-making and critical thinking (Beard & Hartley, 1984), and facilitate high-level collaboration processes (Kollar et al., 2006). However, other perspectives can be found as well, such as Cohen (1994), Dillenbourg, Baker, Blaye and O'Malley (1995), and Slavin (1983) who argued that if collaboration among group members has not been structured systematically, it does neither guarantee engaging the students in high-level collaboration processes nor facilitate learning itself.

There are several theoretical perspectives on collaborative learning. There have been at least three major views on collaborative learning which are normally used: (a) socio-cognitive conflict theory, that is based on a Piagetian assumption which supports that the instantiation of cognitive conflict created by social interaction leads to higher levels of reasoning and learning (Ames & Murray, 1982; Doise, Mugny, & Perret-Clermont, 1976; Murray, 1972), (b) expert-novice theory that follows a Vygotskian tradition and attributes the benefits to the scaffolding provided by the more capable peer in the group (Chaiklin, 2003; Kruger & Tomasello, 1986; Lantolf, 2000; Martinez, 1987), and (c) the knowledge co-construction theory that was first advocated by Sullivan (1953) and his followers which argue that processes of negotiation may lead to higher levels of representation and thinking (Baker & Bielaczyc, 1995; Roschelle, 1992; Schwartz, 1995; Weinberger et al., 2005). All these perspectives confirm the important role of individuals in seeking and constructing knowledge within a meaningful context and that knowledge is fundamentally situated in the environment within which it was acquired (Derry & Lesgold, 1996; Wilson et al., 1995).

Research on collaborative learning suggests various academic and social benefits of collaborative learning that have been widely described. Generally, main results show that collaboration can lead to deeper engagement, higher achievement, and better negotiation skills compared to individual learning (Miyake, 1986). Particularly, students are often motivated in collaborative learning through receiving mutual feedback from their group members. In addition, collaboration promotes students' participation in social processes stand in a positive relation to individual cognitive change, such as argumentation and cognitive processes, which encourages interaction and discussion amongst students as well as enables them to verbalize their own thought processes and consider others' perspectives. Developing students' creative thinking is an important goal of collaborative learning which can be achieved by engaging them in various situations of discovery learning (Damon, 1984). Finally, collaborative learning can promote the development of problem solving skills by introducing students to the process of generating ideas and solutions, which in turn may lead to better understanding, promote deep learning and enable students to retain knowledge and apply it in other contexts (Gillies & Ashman, 2003; Johnson, James, Lye, & McDonald, 2000; Manion & Alexander, 1997; Stevens & Slavin, 1995; Damon, 1984; Webb & Palinscar, 1996).

As shown above, engaging students in collaborative learning environments, which are structured appropriately with the aim of fostering web design knowledge may be more effective than individualized learning environments, and help learners acquire both domain-independent knowledge, such as problem solving, metacognitive, reasoning, critical thinking, self-directed learning, communication and teamwork skills, as well as domain-specific knowledge. There are a number of educational strategies and approaches based on collaborative learning (e.g., design-based learning, group projects, and group problem solving tasks) that fit the nature of the web design process and might be used to enable students to acquire both domain-general and domain-specific knowledge of web design.

Summary

In today's information society, media literacy competencies have become necessary for individuals who have to be well-prepared for success in such an emerging age (Piette & Giroux, 2001). Students, especially in higher education, need to acquire the skills of analyzing and creating messages in different forms (e.g., print, audio, video, and multimedia). However, the training provided to the students in media literacy is still not enough (e.g., Aufderheide, 1993; Scull & Kupersmidt, 2011).

Web design skills are important components of media literacy that also needs further training for students especially in higher education (Selber, 2004). Therefore, preparing and providing web design courses for students at the college and university levels, who have to design and create well-designed websites, are imperatives. Well-designed websites should be the desired goal for the students who design and build websites. Designing and building good websites may attract and keep users' attention and encourage them to frequently visit the website (Bucy et al., 1999). The Yale University Center for Advanced Instructional Media provided a set of research-based standards that is recommended for use in educational institutions. These standards were divided into seven categories of standards for designing and building websites that concern business, educational, or personal use. Therefore, learning, following, and applying such standards that concern different components of website may be helpful for the students during the construction of their websites. In this way, suggested web design courses should help students to design and build websites as well as apply web design standards effectively in their web pages. In addition, such courses should be designed to facilitate the acquisition of two types of knowledge: (a) declarative knowledge, which refers to factual knowledge in memory that influences the execution of skilled action (Wall et al., 1985), and (b) procedural knowledge that describes the procedures or operations performed on declarative knowledge (Smith, 1994). In this way, the acquisition of web design skills requires students to acquire all needed factual knowledge about design and building good website first, and after that to practice them to acquire web design skills.

This chapter suggested collaborative learning for facilitating the acquisition of domain-general and domain-specific knowledge of web design, since collaborative learning is an appropriate approach for complex learning processes such as the design process (e.g., Lehrer, 1993; Lehrer, Erickson, & Connell, 1994; Liu, 1998; Papastergiou, 2005). Moreover, if collaborative learning is built and structured properly, it may be a promising approach for enabling the students to acquire higher levels of domain-general and domain-specific knowledge. In addition, collaboration learning suggests several educational approaches (e.g., design-based learning) that could be used for facilitating the design activities and related learning outcomes.

Online Design-based Learning (DBL)

A promising approach to support students' acquisition of web design knowledge and skills is Design-based Learning (DBL). In DBL, students engage in design problems where they build and test artifacts (e.g., models, projects, computer programs, or devices) as means to acquire both domain-specific knowledge and more general design and inquiry skills; see Kolodner, 2002). Over the last years, educational research has developed quite a number of different DBL approaches, such as Learning by Design (LBD; Kolodner, 2002), Design-based Science (DBS; Fortus et al., 2004), and Engineering Competitions (Sadler et al., 2000). Although these approaches all come under the label of "DBL", there are differences between them. In LBD, for example, students go through two cycles of activities. One cycle concerns the design of the artifact (e.g., designing and building a miniature car that goes from one end of the classroom to the other), while the other focuses on the investigation of the designed artifacts by means of controlled experiments. In both cycles, activities on different social levels (individual, small groups, and plenary) are realized to help students acquire science knowledge and skills and to benefit from each others' comments and suggestions. Therefore, in order to support the acquisition of different knowledge types (declarative and procedural knowledge; see chapter 2) of web design, DBL might be a promising approach especially if it can be moved to an online context.

In this chapter, the theoretical construct of design-based learning will be portrayed first. Next, a selected number of DBL approaches will be presented, and an overview about presented DBL approaches will be given. After that, online DBL will be introduced and advantages of realizing DBL as an online learning experience will be discussed. Finally, expected problems that may occur during an implementation of online DBL will be addressed.

Design-based Learning (DBL)

In order to facilitate students' acquisition of domain-general and domain-specific knowledge as well as to engage students in high level of mental processes, pedagogical practices that emphasise active learning and problem-solving should be put into practice. In active learning, the students can develop their thinking, perform meaningful activities, learn content deeply, practice scientific process skills, and construct positive attitudes towards science much more than traditional teaching (Bransford, Brown, & Cocking, 2000; Lee & Breitenberg, 2010). Through such learning, students can work in groups to think about needs, decide about their priorities, solve problems, design artifacts or experiments, participate in projects, present their ideas and reflect on the ideas of their peers (Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001). Several empirical findings indicate positive effects of active learning methodologies such as problem-based learning, project-based learning, and collaborative learning (Prince, 2004). For example, Dombrowski (1997) conducted a study combining collaborative learning and problem-based learning. This study investigated the effect of collaborative problem-based learning on students' self-esteem and domain-specific knowledge of generating web pages. The sample of the study consisted of 42 high schools. The students were asked to work collaboratively in order to develop an on-line unit from beginning to end (open-ended problems). Through the learning process, the students engaged in different activities, such as selecting topics, identifying objectives, organizing the scope and sequencing of the online units, and designing and writing the online lessons. The author used a checklist to identify the different roles that the students played, such as project manager, instructional designer, graphic designer, computer programmer, and Internet specialist. Furthermore, two inventories that were used for gathering data on the participants included knowledge/skills, a project team checklist for assessing prior knowledge and skills of developing the online unit, and the Coppersmith Self Esteem Inventory. One of the important results from this study is that students who worked together in a problem-solving context acquired high levels of domain-specific knowledge and skills related to generating web pages.

Design-based learning is a type of active learning that uses new ways for achieving long-term goals and learning outcomes (Kolodner, 2002; Lee & Breitenberg, 2010). Design-based learning is considered as a kind of combination between three methodologies of active learning: (a) problem-based learning (PBL), which is a pedagogical tool where students work in groups to find information, learn concepts, and come up with a solution to the problem (Savery & Duffy, 1996), (b) project-based learning, where students work collaboratively to solve specific learning problems by creating a project (e.g., videos, presentations, or posters) as a solution to the problem (Krajcik & Czerniak, 2007), and (c) inquiry learning in which students start with what they know and after that make observations, pose questions about what they do not know, conduct investigations to solve problems, use tools to gather, analyze, and interpret data, and draw conclusions to answer their questions, as well as predictions, construct new understandings and communicate the results to others (Stripling, 2003).

The basic idea of DBL is providing students with motivating design challenges such as “Design a miniature car that can go from one side of the classroom to the other” (e.g., with the aid of straw, paper, and glue; see Kolodner, 2002). Engaging in such design processes is supposed to enable students to learn content knowledge in the context of trying to achieve the design challenge, as well as the acquisition of social and communicative, inquiry-related skills (e.g., communication, collaboration and problem-solving skills; see Kolodner, 2002). Thus, the act of designing an artefact - typically in collaboration with fellow learners and under teacher guidance - is meant to be a vehicle for individual knowledge and skill acquisition. In this way, DBL involves many skills and processes and requires students to go through many cycles of analysis, investigation, and improvement to acquire the scientific knowledge. In each cycle, the students are supposed to learn specific content and concepts, apply what they have learned, test their applications, interpret the results, and improve designs, which may lead them to find better solution for the design task (Puntambekar & Kolodner, 2005).

Engaging students in DBL to design and build such products enables them to work collaboratively with others in real design activities (e.g., planning and conducting experiments, testing the validity of ideas, developing new solutions, and thinking critically), that are similar to problem solving as a reason for learning the content, and to achieve design challenges (Barak & Raz 1998; de Vries, 1997; Doppelt, 2003; Kolodner, 2002). Furthermore, such kinds of design activities enable students to construct cognitive concepts and participate in learning processes according to their own preferences, learning styles, and skills (Barak & Maymon, 1998; Doppelt, 2005), as well as to gain learner-constructed knowledge, instead of passive learning developed from traditional teaching and memorizing information (Doppelt, Mehalik, Schunn, Silk, & Krysinski, 2008; Gardner, 1991). Working in a community of designers, who are partners in teamwork through DBL, enables students to generate different ideas to a greater extent compared to when working individually, develop their skills related to communication, presentation, and problem solving (Butcher, Stefani, & Tariq, 1995; Doppelt, 2006), which in turn gives them the chance to gain more success in both domain-general and domain-specific knowledge (Barlex, 1994; Doppelt & Barak, 2002; Doppelt, 2005; Kolodner, Crismond, Gray, Holbrook, & Puntambekar, 1998; Verner & Hershko, 2003).

Generally, effective DBL requires engaging students productively in high levels of design processes. Overall, design processes can be classified into two types of processes: (1) *Collaborative processes* that point toward social activities that students have to engage in, as well as the different roles that determine how the student has to play to interact positively with others. Such kind of activities are expected to facilitate and improve the interaction between the students and may lead them to more elaboration of the content, which finally may positively affect the acquisition of domain-general and domain-specific knowledge, and (2) *content-related processes* that refer to learning domain-specific content and focusing on content-related concepts. Content-related processes can be conducted individually or collaboratively by engaging the students in more elaborations and discussions about the content, which in turn may facilitate the acquisition of domain-general and domain-specific knowledge.

Several empirical findings showed that engaging students in DBL activities leads to several positive results. For example, in a study by Kolodner, Gray, and Fasse (2003), the authors examined to what extent Learning by Design™ (LBD) enabled middle school students to transfer their problem-solving knowledge and skills to new situations (from Vehicles LBD unit to Launcher unit). The students worked in groups but the number of students in each group was not reported. The authors conducted a performance assessment to both students who had participated in LBD units and a control group of students from traditional classrooms. The task involved the testing of materials used to manufacture tires under different road conditions and measured the force needed to overcome sliding friction. The assessment tasks were videotaped for analysis, but the video analysis process followed by the researches is not described. The students were scored with respect to different dimensions of learning processes and outcomes (e.g., self-checks during experiments, science practice of designing and running experiments, distribution of the tasks, negotiations during collaboration, and use of science terms) by using a scale from 1 to 5. The researchers conducted *t*-tests analysis during two school years for comparing the performance between different classes regarding such dimensions. The results showed that LBD students outperformed control-group classes regarding self-checks, science practice, distribution of efforts, and negotiations during collaboration, but not concerning use of science terms. For instance, on "science practice of designing and running experiments", the standard level students in the LBD condition outperformed standard-level students in the control group. The same results repeated over two years. In addition, the researchers mentioned that LBD students were better at transferring their knowledge and skills to new situations than the control group. Furthermore, the collected data indicated that LBD students outperformed students in the control condition with respect to collaborating with their partners in the dimension of the science practice "designing and running experiments". Regarding science terms, the authors suggested that students need more focus on the concepts that they have to use in their discussions.

Clearly, DBL has potentials that can be helpful for students in their acquisition of domain-general and domain-specific knowledge. On the same line with what was argued in chapter 2, however, McCormick, Murphy, and Hennessy (1994) reported that engaging students in DBL without enough support does not guarantee desired outcomes. From their perspective, DBL is a kind of problem-solving that involves different complex and challenging design processes (e.g., identifying the need, collecting information, suggesting solutions, choosing the appropriate solution, designing and building artifacts, and evaluating designs) that require adequate scaffolding. For example, in a study by Krajcik, Blumenfeld, Marx, Bass, Fredricks, and Soloway (1998), students were asked to design an apparatus for measuring the decomposition process of materials. The results showed that the students conducted thoughtful experiments and asked interesting questions but they failed to provide any evidence for their inquiry activities. For instance, the students conducted discussions about the relationship between acid and erosion but they were not able to verify them. In addition, in a study of Resnick, Berg, and Eisenberg (2000), students could design artifacts (modern scientific instrumentations), but failed to provide enough explanations about their designs (e.g., how and why their designs worked).

Scaffolding for Design-based Learning Environments

The concept of scaffolding was increasingly used over the past decades by educators and researchers to address a form of adult-child interaction. The term scaffolding has been used to describe tools, strategies, and guides provided to help students accomplish tasks that go beyond the level of what they can do on their own (Hannafin, Land, & Oliver, 1999; Olson & Pratt, 2000; Wood, Bruner & Ross, 1976; Wyeth & Venz 2004). Scaffolding instruction as a teaching strategy provides individualized support based on Vygotsky's notion of zone of proximal development (ZPD) that defines the area between what students can accomplish by themselves and what they can accomplish with assistance (Chang, Sung, & Chen, 2002; Rogoff, 1990; Vygotsky, 1978).

Scaffolds are considered as temporary aids during complex learning situations, such as design-based learning, to assist students in specific times to build on their prior knowledge and perceive new information which facilitate achieving tasks independently and enable them to reach a higher level of understanding within their ZPD (Chang et al., 2002; Collins, 1985; Stone, 1998). Bransford et al. (2000) described specific aspects of scaffolding that could be used to support students' activities and tasks. (1) Motivating students to continue working on the task, (2) simplifying complex tasks in order to be accessible and achievable for the students, (3) guiding students toward the goals that should be achieved, (4) differentiating clearly between students' activities and desired solutions, and (5) reducing students' frustration and risk during carrying out the activities. Overall, the main goal of using the scaffolding is helping the students to be independent and capable enough to solve problems (Hartman, 2002). However, Vygotsky (1978) suggested that the students have to be supported with adequate scaffolds. Particularly, students should be challenged through learning activities according to their current knowledge but at the same time challenges must not be too difficult. On the contrast, students should not receive much information in order to always be challenged. Generally, the scaffolds should be enough to allow students to accomplish tasks on their own (Hogan & Pressley, 1997).

As mentioned in the definition of scaffolding, scaffolds could be provided not only by people (e.g., educators, peers) but also by tools that can be used by students to assist them with instructional activities, such as computers or written artifacts, which provide students with scaffolds. For example, in a study by Puntambekar and Kolodner (1998) scaffolding was provided in the form of design diaries to support students' design-related activities, and in a study by Quintana and Zhang (2004) middle-school students were supported by scaffolded software through their online inquiry. Furthermore, scaffolds can be provided in different forms, such as prompts, cues, demonstration, guidelines, suggestions, questions, hints, and partial solutions (Hartman, 2002; McDevitt & Ormrod, 2002) in order to encourage students to understand and participate effectively in the learning process (e.g., Jackson, Krajcik, & Soloway, 1998; Scardamalia & Bereiter, 1985). For instance, Brown and Palincsar (1987) used scaffolding in a form of changing roles (reciprocal teaching)..

In the next sections, selected DBL approaches will be presented and analyzed according to the two types of design processes in order to determine how and to what extent the students were supported through these processes, as well as to take advantages of the experimental studies that were conducted in DBL.

Comprehensive Overview over DBL Approaches from the Literature

A review of the educational research literature on DBL yielded several of DBL approaches. To gain a comprehensive overview over different DBL approaches in the literature, a web search using ERIC, PSYC INFO, Springerlink, EBSCO Host, and ISI web of knowledge was conducted*, which lead to a total of 9690 articles. Upon inspection, the six most cited DBL approaches are “Learning-by-Design” (e.g., Kolodner, 2002; 94 hits), “Design-based Modeling” (e.g., Penner, Lehrer, & Schauble, 1998; 14 hits), “Design-based Science” (Fortus et al., 2004; 13 articles), “Engineering Competitions” (Sadler et al., 2000; eight articles), “Challenge 2000 Multimedia Project”, (e.g., Penuel & Means, 1999; six articles), and the "Systems-design" approach (e.g., Mehalik, Doppelt, & Schuun, 2008; five articles). In the following sections, all selected DBL approaches will be presented and analyzed with respect to the following questions: (1) How does the DBL approach work? (2) What are the collaborative and content-related processes that are scaffolded in the approach? (3) How are they scaffolded? And (4) what is the empirical evidence (if found) that supports the approach?

Learning by Design (LBD)

The Learning by Design (LBD) approach has been developed and elaborated by Janet Kolodner and her colleagues at the Georgia Institute of Technology (Holbrook, Gray, Fasse, Camp, & Kolodner, 2001; Kolodner, 2002). "Vehicles in Motion" is one example of a LBD unit which challenges asks students to build a miniature vehicle and a balloon-powered propulsion system that is powerful enough to make the car go as far and straight as possible in order to learn about force and motion in a physical science unit. At the beginning, students work in small groups to explore the different aspects of the designs, discover the factors that affect the car's motion, and develop hypotheses for mastering the challenge. Next, the groups join a white board session to discuss their ideas and questions (about the design and related science content). Then, students work in small groups to investigate these questions by conducting experiments. During a subsequent "Poster session", the groups share their observations, measurements, and results of their experiments (usually in a poster form). After finishing all groups’ presentations, the teacher helps students to generate one or more rules of thumb which will be used as science principles to guide them in their subsequent design efforts. Next, all the groups present their design ideas (in a draft form) in a "Pin-Up session" for discussing their ideas, getting suggestions, and learning from each other. After that, each group is supposed to build their final design, which is finally reported in a whole class session called the "Gallery Walk" (Kolodner, 2002; Kolodner, Crismond, Fasse, Gray, Holbrook, & Puntambekar, 2003a).

* The search process was carried out at the beginning of April 2008.

LBD consists of two interconnected cycles of activities; an investigative cycle and a design/redesign cycle (see figure 3.3.1). These two cycles are designed to help students master their design challenge and are supposed to enable them to acquire domain knowledge (e.g., concepts of force and motion) and develop competence in rather general scientific and non-scientific activities, such as conducting scientific experiments, communicating and collaborating with peers, or problem-solving (Crismond, Camp, Ryan, & Kolodner, 2001; Kolodner, 2002). Through the investigative cycle, the students determine what they have to learn and how they get the necessary knowledge as well as reflect on and discuss their investigations' results. Through the design/redesign cycle the students present their design ideas, build the designs and discuss and analyze the results of their experiments (Kolodner, 2002). Each iteration of LBD cycles focuses on the same concepts but with increasing complexity.

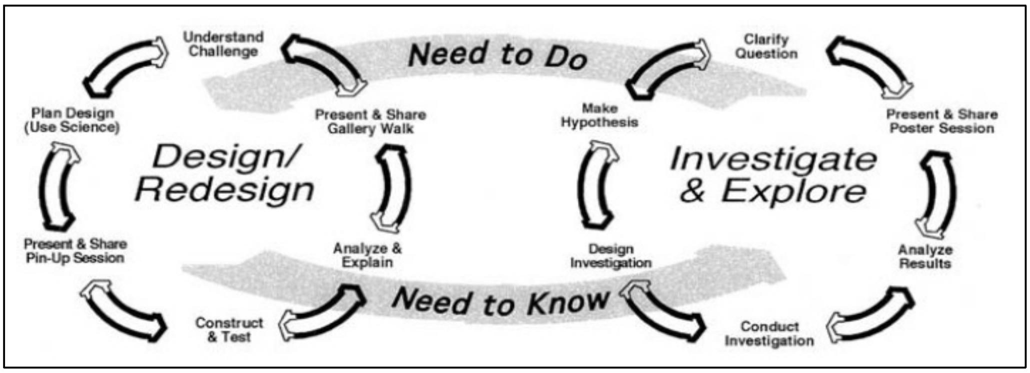

Figure 3.3.1: Learning by Design Cycles (see Kolodner et al., 2003, p. 511)

In the LBD approach, the collaborative processes are conducted in small groups and in plenary sessions. In small groups, the students are supposed to perform several collaborative processes, which vary between messing about with materials or devices, raising questions, negotiating a design procedure, and building and improving designs. Through the LBD approach the students are also supposed to engage in different plenary sessions (e.g., white boarding, poster, pin-up, and gallery sessions) for different purposes. For example, the white boarding session is devoted for organizing collected information after each stage, recording what the students know at the beginning of investigations and any changes that may arise, recording the goals of challenges, and providing a common status record about previous and current knowledge. The gallery walk session has student present their design to the class. The collaborative processes in the plenary sessions focus on presenting collected data, results, or designs and discussions with other small groups about their experiences during the design process. All collaborative processes taking place in small groups and plenary sessions are supported by three sources of scaffolding. First, the *teacher,* who provides students with feedback on their activities while working in the small groups, and helps them to solve problems related to their design and investigation processes (e.g., understanding and running design tests, identifying sources of friction in vehicles, and construction-related problems). In the plenary sessions, the teacher gives feedback on tstudents' investigations and designs, asks questions to the students, and makes suggestions to help them improve their designs and performances. However, the teacher does not provide direct answers to the students' questions, but instead s/he asks questions or makes suggestions that can enable the students to overcome their problems independently. (2) Second, *tools,* such as diaries containing prompts related to each step of the design process, are used to enable students carry out the design step during small groups and whole class sessions. This scaffolding source also includes software, such as SMILE (Supportive Multi-User Interactive Learning Environment), that enables small groups to organize their ideas to address challenging issues and prepare reflective summaries on what they have learned. (3) Third, scaffolding is expected to be occasionally provided by *peers,* who share their ideas and information to overcome design problems while working in small groups, and discuss and evaluate different designs and results in the plenary sessions (Narayanan et al., 1996; Puntambekar & Kolodner, 1998; Vattam & Kolodner, 2006).

Content-related processes are varied between reading some pages or materials related to the content (e.g., friction) individually, engaging in content-related discussions through working in small groups (e.g., lessening friction in their vehicles), and engaging in whole class presentations, where the teacher introduces and explains a variety of important scientific concepts (e.g., friction and gravity) to the whole class. In this way, the content-related processes are supported with the same three sources of scaffolding (teacher, tools, and peers) that are used to support the collaborative processes of the LBD approach.

There are several empirical studies on the effectiveness of the LBD approach. These include both case studies (e.g., Holbrook, Gray, Fasse, Camp, & Kolodner, 2001) and more rigorous experimental studies involving a control group design. For example, Gray, Camp, Holbrook and Kolodner (2001) conducted a quantitatively oriented empirical study. This study investigated the effect of using LBD on the collaborative and content-related processes of the students. The study had two groups. First one, the experimental group which used the LBD approach. Second, the comparison group which learnt with traditional learning methods. The study included 60 middle school students. A series of problem-solving tasks were developed to assess the students' scientific reasoning and collaboration skills. Each task was designed in three parts: (1) designing/writing an experiment to gather evidence to address an issue in the context of a real-world problem, (2) working in groups to conduct a specified experiment and gathering data from this experiment, and (3) answering questions that require the students to utilize the collected data and apply their knowledge of science to interpret the data. The study used video data on performance by recording the students' activities and the discussions as well as a coding scheme including different categories (negotiations during collaboration, distribution of the task, use of prior knowledge; adequacy of prior knowledge mentioned, science talk, science practice, and self-checks during the design of the experiment) with each category being scored on a Likert scale of 1 - 5, with 5 being the highest score. Overall, the main results of this study showed that LBD students were better in comparison with the students who had assigned to the control condition with respect to collaboration, metacognitive awareness of their practices, and ability to remember and use what they had previously learned (Gray et al., 2001).

Design-based Modeling

The second DBL approach is the Design-based Modeling approach that has been introduced by Richard Lehrer and Leona Schauble at the University of Wisconsin-Madison (Lehrer & Schauble, 2000). In Design-based Modeling, students were asked to build a model of human elbow as one example of design tasks by engaging in two phases of activities, which are a design and an exploration/biomechanics of motion phases. Through the design phase, the students worked together to build and test their models. Next, they had the opportunity to modify their models by incorporating mechanisms for motion (e.g., biceps and triceps) and by adding other functional joints, such as shoulders and hands. Regarding the second phase (exploration/biomechanics of motion), the students were engaged in an investigation process to explore the effect of manipulating the location of the load and the position of the biceps to enable them to mathematize the functioning of the elbow and understand the implications of the design manipulations (Penner, Lehrer, & Schauble, 1998).

The Design-based Modeling approach uses the design context for developing students' understanding of the natural world by designing, building, testing, and evaluation of models. Modeling practices are deemed to aid students both in mathematical and scientific explanations and understanding of the relation between mathematics and science, for example by constructing and interpreting data tables and graphs that show the relation between force, point of muscle attachment, and load position.

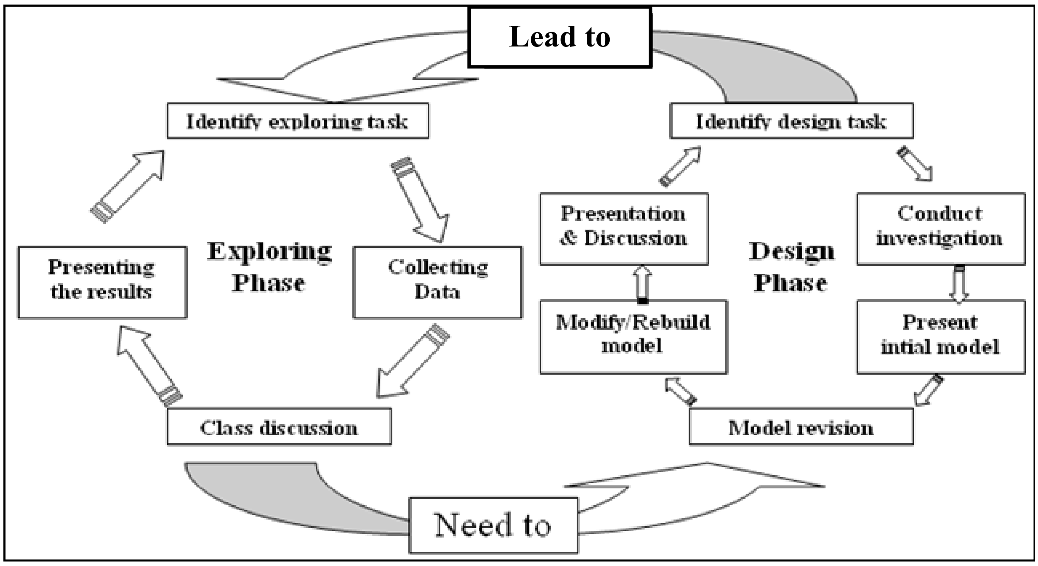

Figure 3.3.2: Design-based Modeling Cycles (representation created by the author)

As figure 3.3.2 shows, the design phase begins by presenting the design task to the students. Then, the students are divided into small groups (dyads or triads) to investigate and build their initial models, followed by model revision. The design phase ends by discussing and evaluating students' revised models. These models are used as a starting point that leads to the biomechanics of motion phase, where the students are supposed to use their models to engage in exploration activities. Through the exploration phase, the students work in small groups of four students each and use their models for collecting data and constructing data tables and graphs. At the end of this phase, the groups analyze and interpret their data and work on an adequate representation of it, which is followed by presenting the results to the whole class and drawing conclusions (Penner, Giles, Lehrer, & Schauble, 1996; Penner et al., 1998).

Like in the LBD approach, the collaborative processes vary between small group and whole class sessions. The students engage in small groups to discuss the design task, do investigations, develop and evaluate different design ideas, design and build models, conduct experiments, and perform mathematical calculations. Other collaborative processes are realized during the whole class sessions, such as presenting the models to whole groups, identifying the strengths and weakness of the designs, reporting the collected data, interpreting, analyzing, and evaluating the results (Penner et al., 1998). The teacher appears to be an important source of supporting the collaborative processes who, for example, guides the students to generate and revise adequate hypotheses for achieving the design task. In addition, through the exploration phase, the teacher enables the students to summarize collected data, for instance by drawing graphs and tables, writes notes on the board, discusses the students' ideas, and provides suggestions. Through whole group discussions, the teacher is supposed to provide feedback, comments and questions for supporting class discussion and individual work. Different tools can be found as a source of scaffolding in the Design-based Modeling approach, such as using boards for writing notes, tables for summarizing collected data, and graphs for demonstrating collected data. Furthermore, peers can be considered as a third source of scaffolding in Design-based Modeling, since the teacher encourages students to help each other and share their information, experiences, and resources both in small group (e.g., thinking and building artifacts) and whole class discussion (e.g., asking questions and critiquing the designs). However, it is not clear to what extent they support each other during working in small groups, since they may be provided by more or less scaffolds for each other according to each learning situation.

With respect to content-related processes, whole class discussions are considered as the main method for focusing, sharing, explaining, and justifying the content and scientific concepts. From the literature, it is however not clear whether Design-based Modeling engages the students in specific processes to learn the content and focus more on the scientific concepts. Therefore, the teacher and peers are considered as main sources of supporting content-related processes by engaging the students in content-based discussions.

Even though the Design-based Modeling approach had 14 hits during the literature search, only one empirical study on this approach was found. This study has been conducted by Penner et al. (1998). The study explored the effect of using a Design-based Modeling environment on advancing students' understanding of the natural world via designing, building, testing, and evaluating human elbow models? The participants of this study were 17 third grade students who worked in dyads or triads during the design phase and in groups of four students during the exploration phase. The data of this study was collected by field notes, audio recordings, and work products (e.g., physical models, tables, and graphs). The study used the discussion, model building, evaluation, tables, graphs, and revision as evidence for achieving the goals. Neither a control group nor pre and post tests were used. Analyzing the dialogues between the teacher and the students about the results of each group (measurements related to the relation between muscle points and weight positions) and other collected data reflected positive outcomes of the approach, such as students understanding of the relation between the structure and function of the design as well as their understanding of the scientific concepts and principles that underlie the whole scientific investigation (Penner et al., 1998). However, the lack of a control group and of knowledge measures forbids to make inferences whether this approach is better than traditional learning.

Design-based Science (DBS)

The Design-based Science (DBS) approach has been developed by a team at the University of Michigan to engage students in a context of designing artifacts as a way for acquiring new scientific understanding and skills of solving real-world problem (Fortus, Dershimer, Mamlok, Marx, & Krajcik, 2002; Mamlok, Dershimer, Fortus, Krajcik, & Marx, 2002). One example of the models that shows how the DBS approach works is designing and building a model house that withstands extreme environmental conditions (Fortus et al., 2004). At the beginning, students receive the task and the trigger points for starting their investigation (e.g., showing a movie about an arctic blizzard and a Sahara sandstorm) and are lead to think about the weather conditions in each environment. After that, the students move to the Background Research phase in which, for example, they receive new scientific concepts from the teacher, read selected materials, search and gather information, share and analyze collected data on a whiteboard, and watch the teacher's demonstrations. In the Develop Personal and Group Ideas phase, each student in a group of four presents his/her own design solution, which is followed by the group selecting the superior solution for the problem and writing the justification for the selected solution down. In the Construct 2D and 3D artifacts phase, each group splits into pairs (to give the students the chance to create and interact with their models) for constructing the models according to the group’s suggested solution. Then, they rejoin again for discussing and comparing the models, and each group selects the superior design to present and evaluate it in the Feedback phase. At the end of the learning cycle, a pin-up session is conducted for all groups to revise and further improve their understanding as well as to test, evaluate, and receive comments on the models from the teacher and the entire class (Fortus et al., 2004; Fortus, Dershimer, Krajcik, Marx, & Mamlok-Naaman, 2005; Mamlok et al., 2002).

In the DBS approach, the students go through one cycle of activities (as illustrated in figure 3.3.3) which are supposed to develop their scientific knowledge (e.g., how batteries decay and how to measure this) and their skills to solve real-world problems by engaging them in the design of artifacts (e.g., batteries that make use of safe materials and model house can face extreme environmental conditions). Each iteration of the DBS cycle focuses on different content and the students usually complete it in an orderly manner (in some cases the steps are executed in a different order; Fortus et al., 2004; Mamlok et al., 2002).

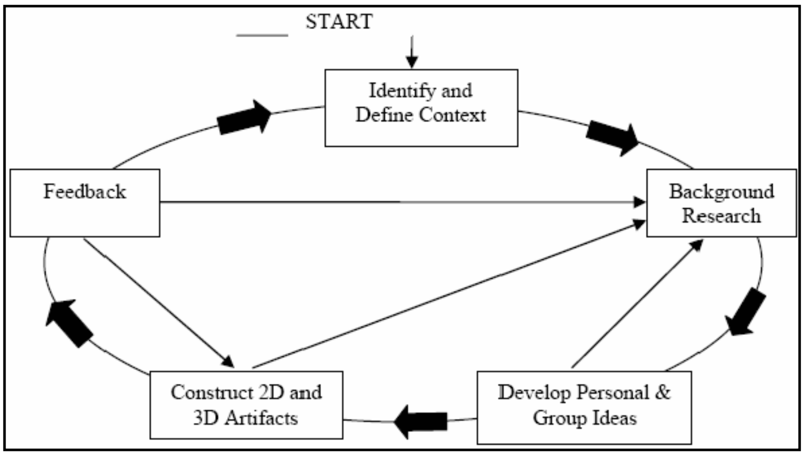

Figure 3.3.3: The Design-based Science Learning Cycle (see Fortus et al., 2005, p.859)

Each DBS cycle is situated within and driven by several processes (collaborative and content-related processes). The collaborative processes are carried out on three levels: pairs, small groups, and whole class. The collaborative processes vary between sharing and analyzing collected data, identifying and discussing performance criteria for the design within the small group, conducting investigations, designing and building artifacts in pairs, and discussing and comparing the designs in small groups. Furthermore, in feedback sessions, the students present, compare, analyze and evaluate the different models, and report findings (Fortus et al., 2004). All collaborative processes are supported by the teacher, who provides the students with different kinds of scaffolds (e.g., the trigger points for action, guide the students during collecting and analyzing data, and evaluation and feedback on group's decisions and models). Furthermore, some tools can be found in DBS which are used as scaffolds, such as empty graphs for analyzing and comparing the results of each group. In addition, it was allowed to the students to support each other both in small groups (pairs and groups of four) and in the entire class. Therefore, in the DBS approach peers' interaction is supposed to be another source of scaffolding that may enable the students to discuss, conduct, critique, analyze, and evaluate their experiments and results (Fortus et al., 2004). In addition, the students are allowed to support each other both in small groups (pairs and groups of four) and the entire class. Therefore, in the DBS approach peers' interaction is supposed to be another source of scaffolding that may enable the students to perform the collaborative processes (Fortus et al., 2004).

The DBL approach suggests several content-related processes that are assumed to enable students learn the content deeply and construct an appropriate knowledge background about the design task. These processes are provided in the form of a set of lessons that introduce new scientific concepts, involve reading of selected material on content, and promote searching and gathering of content-related information. Furthermore, they enhance sharing and analyzing collected information on a white board, engagement in demonstrations provided by the teacher, and working with computer-based simulations of phenomena (Fortus et al., 2004). Therefore, the DBS approach perceives teachers, tools (e.g., learning material and computer-based simulations), and peers as scaffolds that support content-based processes. Overall, the DBS approach seems to equally focus on engaging students in both types of processes (collaborative and content-based processes).

A number of studies have been conducted on the DBS approach. For example, Fortus and his colleagues (2004) conducted a study based on teaching 'how do I design a structure for extreme environmental conditions?' in order to develop new scientific knowledge and design skills as a solution to a real- world problem. 149 ninth-grade and 10th-grade students in four integrated science and two physical science classes participated in this study. Students' scientific knowledge was assessed through posters and models constructed during the learning cycle, as well as by using pre and post instruction written tests. In this study the results were only based on one experimental group, as there was no control group. The post-tests showed an increase in the scientific knowledge compared to the pre tests while the models and posters showed application of this newly knowledge in solving a design problem (Fortus et al., 2004).

Engineering Competitions

Sadler and his colleagues introduced the Engineering Competitions approach at Harvard–Smithsonian Center for Astrophysics as an opportunity for middle-school science students to acquire science process skills and learn physical science concepts by engaging in engineering design challenges (Sadler et al., 2000). An example of Engineering Competitions is the two-dimensional suspension bridge challenge. At the beginning, the teacher asks the students to copy an initial prototype, which is a single sheet of paper hung on two posts, as well as a 1 kg load that is suspended from a hole on the bottom. Next, the students start to individually copy the initial prototype and write their notes and findings. After that, they move on to work with their partners in small groups (2-4 students). Sequentially, the students receive an improvement challenge, which is reducing the weight of the paper. In this way, the students have to cut away some paper from their model. Thus, the students engage in a whole class discussion about where they have to make the cuts in their models. Finally, the students move to work in teams to make suggested cuts and test their models in a public session (Sadler et al., 2000).

The basic idea of the Engineering Competitions approach is engaging the students in design activities to design and build tangible devices, which is supposed to facilitate the acquisition of science process skills and physics concepts as well as to engage the students to solve science-based problem-solving situations and prepare them for future careers related to science and technology (Sadler et al., 2000). In Engineering Competitions, the students have to go through one cycle of activities that are considered as a combination between free play and structured laboratory experiments (as illustrated in figure 3.3.4).

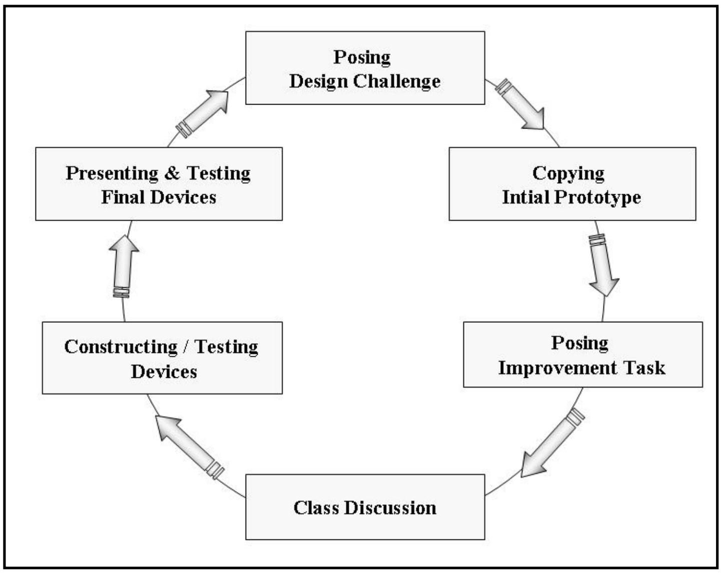

Figure 3.3.4: Engineering Competitions Cycle (representation created by the author)

The teacher starts the design activities by providing the students with a design challenge in the form of a compelling problem. Next, the students move on to work in small groups to copy an initial prototype design that is carefully developed to enable the students to produce a similar device quickly. The teacher again asks the students to revise and improve their devices. Sequentially, a whole class discussion is conducted for determining a set of variables that may improve the efficiency of the device. After that, the students start improving their devices by applying the proposed variables on their devices and engage in repetitive activities of constructing and testing the devices. Finally, devices are presented in a public testing session.

The Engineering Competitions approach provides a context for the students to practice different kinds of collaborative processes, such as improving the initial design in small groups, engaging in whole class discussions for improving the designs, investigating effects of specific variables on their devices, constructing and testing the devices, and presenting the devices in a public session. The collaborative processes are supported by all three sources of scaffolding that are used in the previous DBL approaches (1) first, the *teacher* appears as an important source of scaffolding in Engineering Competitions who, for example, demonstrates the design challenge and improvement tasks, as well as evaluates and critiques the designs at public session. (2) Second, *tools* which refer to several tools that are used as a second source of scaffolding in such approach, such as the diagrams and prototypes that were used to demonstrate the design challenge and storyboards that were utilized to reflect the different stages of achieving the challenge. And (3) in the same line with other DBL approaches, *peers* are available as third source of scaffolding to support each other. For example in this approach, the students worked in small groups (e.g., constructing and testing devices) and whole class sessions (e.g., discussing proposed solutions for the problem, evaluating, and critiquing the final models) to enhance their performance and understanding of science (Sadler et al., 2000).

With respect to content-related processes, it seems that the Engineering Competitions approach does not involve specific processes directly oriented toward learning the content, such as reading specific materials or engaging in specific sessions that completely focus on the content and scientific concepts. As shown above, engaging the students in free play and collaborative design activities are considered the main ways for learning physical science concepts. In this way, the discussions between the students and the teacher or/and peers about the devices are considered as main support that the students receive for learning the content.

Regarding the empirical outcomes, in the Engineering Competitions approach, Sadler and his colleagues (2000) conducted a study in a middle school. The research question of this study was: What is the effect of using the engineering challenges on acquiring science process skills and concepts of physics? This study used a one-condition pre-post design; there was no control condition. The treatment group included 457 students (Grades 5 to 9). There were different tools used for collecting data, such as open-ended pre- and post-tests to measure changes in students' ability, student interviews to focus on the students' explanations for the results that they gathered within a particular design challenge, and science process skills which had been measured using an 11-item open-ended pre- and post-tests instrument. The results indicated that the Engineering Competitions approach contributed to a growth in science process skills and in students' realization of the unique aspects of the scientific process and design challenges enabled the students to develop their skills in planning, construction, and testing (Sadler et al., 2000).

Challenge 2000 Multimedia Project

The Challenge 2000 Multimedia Project was created in 1995 and has been designed for students in grades K-12 by researchers at SRI International Center of Technology and Learning in order to enable the students to acquire skills needed for the high-tech workplace, collaboration skills, decision making, self assessment, complex problem solving, and content knowledge (Penuel, Cole, & Korbak, 1999; Penuel, Means, & Simkins, 2000). One example of the Challenge 2000 approach is a physics project about developing video footage of amusement park rides and their associated forces and acceleration changes with the aim of learning the physics of the rides (Penuel, Korbak, & Cole, 2002). At first, the design task and the details of the challenge were presented to the students by the teacher. Then, the students were paired to collect data, pictures and videos for the project. Students were allowed to share equipment, materials, and calculations. Next, they had to integrate the collected data in their projects and print out a graph of collected data. Through the whole class discussion, each group presented and explained its multimedia project to other groups (e.g., comparing the calculations related to the force in a circular loop and a tear-shaped loop) which is supposed to lead to more discussions and to get feedback on the projects as well as to stimulate the students to improve or modify their projects. At the end of the semester, the videos were presented in a film festival accompanied by much celebration, which allows more contact between the classroom and other classrooms, and the community (Penuel & Means, 1999; Penuel et al., 2002).

In this approach, the students go through one cycle of activities (see figure 3.2.5) to plan and produce final projects in a multimedia format (e.g., HyperStudio stacks, web pages or sites, PowerPoint presentations, animations and videos, and music CDs) that serve as a solution for real-world problems (Penuel et al., 1999, 2002).

The cycle of the activity starts with providing the design task. Next, the students continue with collecting needed data and resources, as well as constructing their background about the design problem for their projects. Then, the students start their investigations and building their projects. Through the whole class discussions, the students can present their projects and get feedback from others. Finally, the students have a chance to improve their projects before the festival presentation.

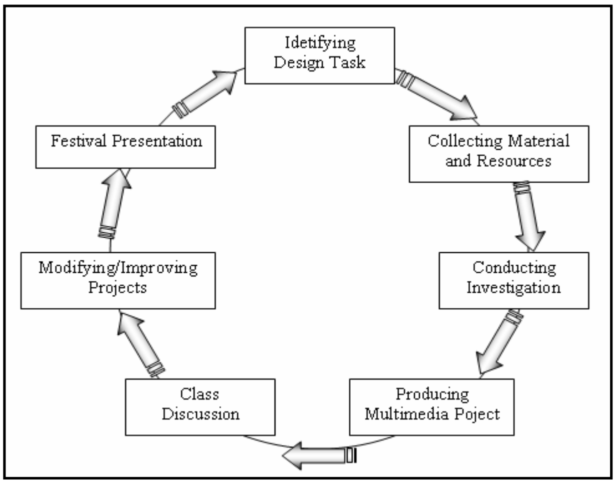

Figure 3.3.5: Challenge 2000 Multimedia Project Cycle (representation created by the author)

In the Challenge 2000 approach, the students are supposed to engage in a set of collaborative processes, including collecting data and materials for the project, asking and investigating project-based questions, building multimedia projects (e.g., presentation, websites), presenting and justifying their ideas, and deciding and revising the structure of the final presentation. The teacher plays different roles to support the students through their investigations in the Challenge 2000 approach. For example, the teacher asks the students questions to stimulate them to think more critically about their designs and provides appropriate feedback about the students' ideas while critiquing their projects during the whole class sessions. In addition, a set of tools is used to support the students' activities, such as using digital cameras for collecting data and images and films to present essential information about the challenge. Peers are also supposed to be used as a source of scaffolding in the Challenge 2000 approach. For example, students are allowed to share the materials and calculations with each other, plan for the project together in small groups, discuss the proposed ideas for the project and embrace the superior one, and to evaluate and critique each group's project (Penuel & Means, 1999).

The Challenge 2000 approach provides several opportunities for students to engage in specific content-based processes. For instance, the students have to use software and online learning resources as an integral part of school curriculum for learning content. Also, they have to watch videos concerning desired science content and discuss with each other the best way for using multimedia for exploring the content. Like the collaborative processes, all three sources of scaffolding, namely the teacher, tools (software and online learning resources), and peers, are used for supporting content-based processes. Overall, the Challenge 2000 approach seeks to engage students in supported collaborative and content-related processes to help them draw connections between science concepts and solutions for real world problems.

Unfortunately, there is no clear description of any sort of empirical study that had been conducted with respect to Challenge 2000, but instead some descriptions of prototypical activities have been reported. For example, several papers describe the effect of using Challenge 2000 compared with traditional teaching methods on understanding content knowledge about physics (of the rides) and the practical skills needed for designing websites and presentations. The participants were 12th-grade physics students who engaged in designing and producing multimedia projects. The students were involved in an experimental group (the classrooms who participated in the multimedia project) and a control group (classrooms who are taught by traditional teaching methods). The results depended on using performance assessment (for measuring students' skill in constructing the presentation) and teachers and researchers' reports and observations. The results indicated that the students engaged in the Challenge 2000 environment increased their understanding and competence more than the students in comparison groups. In addition, the results of the performance assessment showed that the experimental group outperformed the comparison group in practical skills and attention to audience (Office of Educational Research and Improvement, 2002; Penuel & Means, 1999; Penuel et al., 2002).

Systems Design Approach

Mehalik and his colleagues (2008) introduced the Systems Design approach at the University of Pittsburgh for middle school students to enable them to acquire the concepts and principles of electricity (e.g., voltages, resistance, and current) in science classes and to develop their competence in solving real-life problems, and systems thinking (Mehalik et al., 2008). Constructing and building an electrical alarm system is one example of the Systems Design approach that shows how such an approach works (see figure 3.3.6). In each phase of the design process, the students work individually and in groups. The students start their activities by (1) first, identifying and understanding the problem. After that (2) the students start analysing their needs, identify the specifications of the needed system, and develop their decision requirements (e.g., timers, volume controls, wires, batteries) from their needs. Next, (3) a set of performance criteria which should be found in the final design is constructed by the students. Following, (4) the students generate several proposed design ideas which they think to be the best solution for the problem. Afterwards (5) the students are guided to choose which design best meets their needs. Next, (6) they start to build their design and test it. In the Reflect and Evaluate phase, (7) the students have the opportunity to compare their ideas (designs) against the performance criteria which they identified in advance and to reflect upon the different designs. Finally, the students go back to test and improve the system (needs, requirements, alternatives, etc.) in the light of the reflection and evaluation discussion (Mehalik et al., 2008).

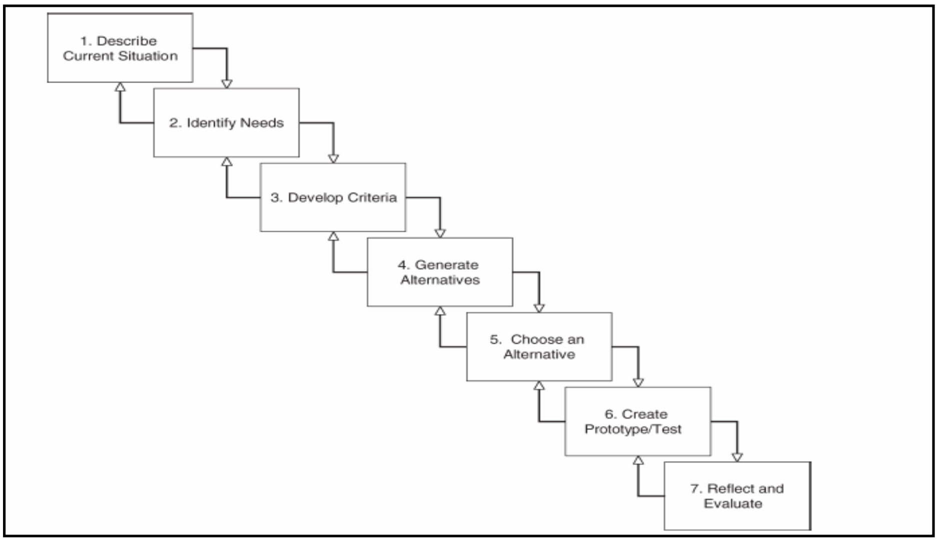

Figure 3.3.6: The seven stages of systems design and analysis (see Mehalik et al., 2008, p.74)

Overall, the Systems Design approach depends on (a) design activities to engage the students in the technological design process to solve real world problems and (b) system thinking, which refers to explaining the system and its parts to others. For achieving that, the authors developed a module that requires engaging the students in different collaborative and content-related processes together. As shown in the example, the students have to engage in different collaborative processes, such as developing and discussing the ideas, identifying performance criteria for devices, building the devices, and evaluating and improving them. Scaffolding for collaborative processes is provided by the teacher who presents the students with steps and sequence of design process and guides the students through different types of thinking (e.g., think about needs, requirements, alternatives, and decision criteria). In addition through whole class presentations, the teacher engages in evaluating, critiquing and discussing the weaknesses and strengths in each design. A second source of scaffolding, that can be found in this approach, are the tools widely used for supporting the students' activities, such as using figures to illustrate different dimensions of the design task (e.g., illustrating the system inputs and outputs to enable the students to understand exactly specification of the desired system), and using boards to note the experimental conditions, and discuss the results. The System Design approach uses peer interaction as a kind of scaffolding, who are supposed to share and collaborate to take decisions in each phase of the design process as well as to evaluate the final products (Mehalik et al., 2008).

Regarding content-based processes, the students are assumed to engage in several processes that focus on the content and electricity concepts. For example, the students are asked to read the students' guide and learning materials that are prepared by the authors and relate to the content. In addition, each stage of the design process involves different content-related processes. For example, at the beginning, the students engage in a process of making choices of which designs to build that involve learning content without identifying content items for pursuing. Through building ideas and designs processes, the students are supposed to use different components that require an understanding of how each component should work and how it can be improved. In this way, the teacher, tools (e.g., guides and figures), and peers are the sources of scaffolding that are used to support the content-related processes (Mehalik et al., 2008).

Regarding the empirical outcomes, one empirical study has been conducted by Mehalik et al. (2008). The main question of this study is: To what extent does the System Design approach affect students' learning compared with a scripted inquiry approach? The study consisted of two groups. First, the design group included 10 teachers and 587 students (26 classes) implementing the system design approach. Second, the inquiry group included five teachers and 466 students (20 classes) following the scripted inquiry approach, which provided step-by step instructions for most aspects of the students' investigation. The researchers used pre- and post-tests to measure changes in students' knowledge of electricity concepts. The results showed that learning with a Systems Design approach led to better results than scripted inquiry in science knowledge content.

Overview about DBL Approaches

There is consensus between all presented DBL approaches that the design process is complex and requires the students to be supported in almost all design activities. The students have to engage in one or more cycles of design activities, which involve several design activities to achieve desired goals. Therefore, a number of DBL approaches were established which vary in terms of amount and forms of scaffolding provided to support the students through DBL activities. It can be noted that scaffolding comes from three sources, which are the teacher/expert, tools, and peers. Furthermore, all DBL approaches aim to integrate students' knowledge into their design processes (de Vries, 1996) by engaging them in the design process to achieve authentic designs through real-life situations.

In general, all approaches explicitly aim to enable the students to acquire two kinds of knowledge: On the one hand, all approaches have a strong emphasis on facilitating domain-general skills, such as problem-solving skills, experimenting skills and communication and collaboration skills. For example, in DBS, students are assumed to acquire communication, collaboration, and experimenting skills by engaging in several collaborative activities in small groups, between groups, and the entire class in which scientific activities are needed, which with sufficient guidance is assumed to lead to the acquisition of such skills. On the other hand, through engaging in a design activity, students are supposed to acquire domain-specific science knowledge. For example, in Engineering Competitions building devices (e.g., suspension bridge challenge) is supposed to lead the students to acquire knowledge of physical science, whereas it is expected that building models (e.g., the human elbow) through the Design-based Modeling approach would facilitate the acquisition of domain-specific knowledge and skills concerning mathematics and science.

Learning outcomes surely are not exclusively determined by teachers, peers and tools. Even more important are the *processes* in which students engage during DBL. In existing DBL approaches, two types of processes can be identified, which are collaborative and content-related processes. Each presented DBL approach follows a specific way of conducting its *collaborative processes* according to its design goals. For example, the LBD approach structures its activities in the form of two cycles of activities (investigate & explore and design/redesign cycles) that are supposed to move students towards a successful achievement of goals, and each cycle's iteration focuses on similar science concepts but at increasing levels of complexity. The Systems Design approach provides the opportunity to the students to engage in collaborative processes, which are completed in an orderly manner to achieve the design goals, whereas the DBS approach follows one cycle of processes and each cycle's iteration focuses on different science concepts. There is a set of collaborative processes that are common to the described DBL approaches: (1) Discussing and understanding the design problem and its dimensions, (2) collecting the basic information about the problem that enable the students to get a clear image of the problem and its dimensions, (3) specifying acceptable performance criteria, in the light of which the designs can be evaluated, (4) collecting resources or materials that are needed for achieving the design, (5) constructing and modifying the designs, and (6) presenting the designs of each group and receiving the feedback from the teacher and other groups. Engaging the students in design-based discussions is a common activity in all approaches which are conducted collaboratively through small groups sessions and plenary sessions as a way for developing the collaboration skills between the participants and increasing domain-specific discourse. Such an activity was conducted through different phases of the design process, such as conducting experiments, planning and building the designs, and discussing and evaluating the final designs. Collaboration and interaction between the students is supported in all DBL approaches by peers and either teacher, tools, both or none of the two. SMILE software is a famous digital technology tool that was used in the LBD approach to enable the students to organize their thought, reflect on their design, planning, or investigative collaborative experiences, as well as to provide the students with prompts in the form of hints and examples to complete their presentations before presenting them in whole class sessions (Lamberty, Mitchell, Owensby, Sternberg, & Kolodner, 2001). Whole class sessions enable the students to write up their results, plans, and design experiences and share all of these with other partners. This kind of scaffolding enables the students to increase domain-specific discourse, develop scientific arguments, and engage in science practices.

With respect to *content-related processes*, most selected DBL approaches provide a framework where the students are supposed to engage in design-based collaboration processes in order to acquire domain-general knowledge (e.g., collaboration and problem solving) and domain-specific knowledge (e.g., scientific concepts). In this way, some content-related processes can be conducted collaboratively and thus are also collaboration processes. Few DBL approaches (e.g., LBD, DBS, Challenging 2000, and Systems Design) identify specific activities to engage the students in content-related processes independently (e.g., reading specific pages, engaging in content-related presentations, and watching content-related videos). Although such processes are conducted in the form of presentations by the teacher, sharing knowledge on white boards, or individually, none of the DBL approaches involves small group meetings that focus on content-related discussions that are expected to increase the students' discussions about the content and its concepts. All small group discussions are devoted to working on the designs that are usually accompanied with learning and discussing the content and related scientific concepts. The content-related processes are supported in all DBL approaches by the teacher and peers as well as in some approaches (e.g., DBL, Challenge 2000, and Systems Design approach) with tools, which vary between traditional (e.g., pages about the content and white board), and digital technology (e.g., online learning resources, software, and computer-based simulations). In addition, when digital technology (e.g., HyperStudio stacks, web pages or sites, PowerPoint presentations, animations and videos, and music CDs) is used as a design task like in the Challenge 2000 approach, the students engage in different content-related processes that concern both learning the content itself (e.g., engaging in prepared content-related presentations, watching content-related videos, and using online learning materials) and finding compatibility between the content and the media that should provide it to the audiences (e.g., judging the science content that should be provided to audiences and identifying the best way to explore the content by using multimedia). In this way, the nature of the design task, such as digital designs may require students to engage in additional content-related activities that are related to the target audiences and the nature of the media. In general, it can be noticed that the different DBL approaches aim at engaging students in content-based processes that can be assumed to stand in a positive relation to individual learning outcomes (Chi, De Leeuw, Chiu, & LaVancher, 1994; King, 1990; Webb & Farivar, 1994). The selected DBL approaches show that such kind of activities lead effectively to individual knowledge acquisition but most of the empirical studies that referred to such effects did not use control groups. However, it can also be noticed that most approaches do not provide specific guidance concerning how high-level content-related processes would have to look like. For example, explanations-based discourse through small groups' discussions may provide students with information on how something works and may also be much more elaborated. Furthermore, explanations can be used to provide a much stronger potential to support individual learning, both for the explainer and the listener (Chi & Bassok, 1989; King, 1990; Webb, Jonathan, Fall & Fall, 1995). Most approaches set a frame in which these processes may or may not occur instead of trying to engage students directly in high level of content-based processes. Therefore, DBL might benefit from more direct scaffolding.

With respect to scaffolding, the *teacher/expert* appears in all existing DBL approaches as a facilitator rather than as a source of knowledge. In all DBL approaches, the teacher is responsible to provide the design task, clarify its dimensions, and motivate the students to conduct their investigations. While presenting and evaluating the designs, the teacher's role is to evaluate the presented designs and to give feedback to the students. However, the teacher's role is somewhat different in other stages according to each single approach. For example, in LBD, the teacher is responsible to move the students through the different stages of problem-solving as well as to monitor the processes, motivate the students to externalize their own thinking, and evaluate and comment on other students' thinking to help the students extract ideas and questions. However, LBD also realizes a fading approach in that the teacher is supposed to reduce his/her scaffolding activities over time to give the students the chance to gain experiences in a more self-regulated way, and in this case the teacher's role is limited to monitoring the group process and writing notes about how to best facilitate students (Hmelo, Holton, & Kolodner, 2000). In a similar way, in Design-based Modeling, the teacher moves the students through the different design stages and supports them in each stage. For example, s/he guides them to generate and revise hypotheses, summarizes collected data, and facilitates the design process by providing suggestions and cues. Some of the approaches even give specific suggestions on how to prepare teachers to successfully run DBL in their classrooms. This is true for LBD, Challenge 2000 Multimedia Project, and the System Design approach (Kolodner, 2002, Mehalik et al., 2008; Penuel & Means, 1999). Generally, the preparation appears in two forms: First, pre-training that enables the teacher to efficiently carry out his/her role.. For example, in System Design, the teachers had a series of five professional development workshops before starting their teaching in the approach (Mehalik et al., 2008). Second, some approaches support the teacher also during the realization of DBL. For example, LBD uses a partnership model that has teachers use SWIKI to communicate with each other, share what they learned on how to effectively run LBD, to ask each other for assistance (Fasse, Gray, Holbrook, Camp, & Ryan, 2001).

The *tools* are realized as the second source of scaffolding that are used differently in the selected DBL approaches. In general, DBL uses tools in a twofold fashion. On the one hand, tools play a role as the raw material used to create an artefact, like for example the rubber band, the glue and the paper cups that students use in LBD to design a miniature car. On the other hand, tools play a role as scaffolds to support the learning process. When analyzing the different approaches, such tool scaffolds appear in two forms. On the one hand, some approaches use "traditional" tools, such as whiteboards, papers, pencils, graphics, or handouts. On the other hand, digital tools are used, such as computer simulations, digital cameras, computers, digital resources, or Web-based collaborative tools. For example, the LBD approach involves a certain software called SMILE (Supportive Multi-User Interactive Learning Environment) that enables small groups to organize their ideas for addressing the challenge and prepare reflective summaries about what they have learned (Narayanan et al, 1996; Puntambekar & Kolodner, 1998; Vattam & Kolodner, 2006). In this way, the digital tools can be used to support processes that can not or only hardly be scaffolded with non-digital tools. Yet, the selection of digital tools to fit particular age levels should be taken into consideration. For example, many studies use visualization tools (e.g., graphics and simulation examples) to support lower grade students. For example, in Design-based Modeling, the teacher uses graphs and tables for summarizing and demonstrating data to third grade students. In addition, there is a strong relation between the range and number of the provided tools and the complexity of the tasks. For example, in the LBD approach the students have to go through two cycles of design and investigation activities which include more than ten stages, and each stage involves a wide range of processes (collaboration and content-related processes). In order to support this complex process, LBD uses a large number of different traditional and digital tools (e.g., software and diaries). Another observation is that tool use is not limited to the students only, but may include the teacher also. For example, Engineering Competitions has the teacher use a prototype to explain and demonstrate the design task to the students. As another example, Design-based Modeling has the teacher use traditional boards for writing down notes and discussing the students' ideas. Of course, if well-designed, both traditional and digital tools have a high potential to effectively scaffold the learning process. Especially for digital tools, it may be easy to incorporate appropriate scaffolds, such as collaboration scripts or more content-related instructional devices such as concept maps to help students in their learning process (see also the "peers" section below). However, using several tools that are not familiar to the students requires supporting them with appropriate scaffolds to use such tools correctly rather than be a reason of hindering learning (Dillenbourg, 2002).

Concerning the *peers* (third source of scaffolding), it can be noted that all presented DBL approaches make use of collaborative peer learning in one way or another. However, the way students collaborate with each other typically is very open. It is more like a general guideline that peers are allowed and asked to assist each other in their small groups through the various stages of the design process and to share ideas, ask questions, discuss the proposed solution for the problem, and divide the work between each other. Also, with respect to the size of the small groups, most approaches do not give specific suggestions. However, most DBL approaches tend to reduce the size of the small groups to give a chance for more interaction and discussion. Yet, some approaches even vary group sizes during their realization, such as in Design-based Modeling, where students in some phases work in dyads (e.g., to design and build the models), while during experimentation, groups consist of four students. However, it is striking that none of the selected DBL approaches addresses the need of structuring collaboration as a condition for effective learning (e.g., Cohen, 1994; Gillies, 2004). From this perspective, one might speculate that adding scaffolds directed at an improvement of interactive processes occurring within the members of a small group (such as collaboration scripts; see Kollar et al., 2006) will increase the effectiveness of these approaches. However, during DBL, peers do not only play a role as potential partners during small group phases. Instead, all presented approaches include whole class discussions in which students have the opportunity to exchange ideas, ask questions, learn from each other, and evaluate the artifacts created in the small groups, and to get feedback from the teacher and others students. Yet, the frequency of these discussions is different from one approach to the next. For example, in LBD, all small groups meet in four plenary sessions (White boarding, Poster session, Pin Up session, Gallery walk session). In contrast, System Design has only one meeting between all small groups. It is certainly a question for future research on how frequently such plenary activities should occur during DBL. Independent from the sheer number of plenary discussions, what probably is even more important is how they are structured. Also here, well-designed scaffolds might boost the effectiveness of DBL in general.

The *empirical outcomes* show that design-based learning has potentials to enable students to achieve domain-general and domain-specific knowledge (Doppelt et al., 2008, Fortus et al. 2004, Fortus, Dershimerb, Krajcik, Marx, & Mamlok, 2005; Gray et al., 2001; Kolodner et al., 2003b; Puntambekar & Kolodner, 2005). Even more, the empirical studies proved superiority of design-based learning classes over the comparison class. However, the empirical research generally did not use quantitative methods. Few approaches conducted rigorous quasi-experimental research methods (e.g., LBD and System Design).

Overall, supporting collaborative and content-related processes in most selected DBL approaches is conducted in unsystematic ways. Engaging students in a collaborative framework and asking them to collaborate and learn content without supporting them with specific guidance concerning high levels of collaboration and learning content does not guarantee engaging the students in high levels of collaborative and content-related processes. In addition, in some DBL approaches (e.g., Design-based Modeling) the collaboration is supported with several scaffolds, whereas supporting activities that concern learning content is limited. Thus, this would lead to a question this study is trying to answer, which is: To what extent does the combination between systematic social and content scaffolds affect the design-based learning processes? With respect to empirical studies, conducting more experimental studies which use quantitative methods that reveal rigorous empirical results are needed.

Online DBL

Online technology can provide a different context for DBL and it can also provide further advantages based on the fact that online technology can be used to provide systematic scaffolding for supporting different design processes (e.g., Stahl, 2006; Vizcaino & du Boulay, 2002). Lately, especially rather student-centered instructional approaches such as inquiry learning or project-based learning devote a lot of attention to online learning environments to realize the kind of learning they are aiming at (e.g., de Jong, 2006; Slotta &

Linn, 2009). All these approaches emphasize the importance of students exploring ideas, conducting investigations, engaging in projects on topics, working collaboratively, discussing their ideas, and gaining conceptual understanding (Jonassen et al., 1999; Papert, 1993), and very obviously, online environment can be thought of as providing a supportive context for these processes to occur. In the next section, advantages of moving DBL to online learning will be presented.

Advantages of realizing DBL as an online learning experience

Due to the rapid development of computers and the Internet, the use of technology to support collaborative learning has been increasingly examined. In online learning contexts, digital technology can be used to support, facilitate, and mediate collaborative learning processes (Wasson & Morch, 1999).

Throughout the presented DBL approaches, digital technology is used in different forms. For example, digital technology appeared as a design goal through the Challenge 2000 approach, in which students run a multimedia project (videos combining footage of amusement park rides and their associated forces). In other approaches, digital technologies act as scaffolds, that is, they are used to support both teachers/experts and students through the DBL approach. For example, in LBD, the SWIKI (user-editable web page) is used to facilitate the communication and interaction among teachers in the LBD environment. It is considered to aid teachers to exchange and share their experiences and simultaneously get help for their work. However, there is yet no research on completely web-based DBL.

Online learning environments are considered as one of the most promising ideas by many researchers to improve teaching and learning with the aid of modern information, computers, and communication technology. In online contexts, computer networks are used to facilitate the interaction among participants and improve the learning environment. Furthermore, the participants can communicate by aid of a number of asynchronous and synchronous communication tools. Online learning can provide an appropriate environment to support collaboration between students (Kreijns, Kirschner, & Jochems, 2003), facilitate collective learning (Pea, Edelson, & Gomez, 1994), or group cognition (Stahl, 2006).

The online context moves the learning from teacher-based learning to a social interaction context where the students engage in knowledge construction processes through working in groups. In such a context, the students are supposed to learn by doing and by engaging in shared learning activities over distributed learning environments (Brandon & Hollingshead, 1999; Dede, 1999).

Furthermore, students in online contexts who learn collaboratively may receive advanced support for a socially distributed process of inquiry, which may facilitate the advancement of learning community knowledge (e.g., setting up specific questions, searching answers, giving explanations, or searching for scientific information; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999). Moreover, online learning appears to facilitate more students' exchange of ideas and reflection on their views compared to traditional classrooms, which in turn, may facilitate students' acquisition of domain-specific and domain-general knowledge (see Vizcaino & du Boulay, 2002; Weinberger, 2003). Engaging students in asynchronous learning through online contexts can overcome the difficulties related to forming and maintaining groups, and arranging meeting time, which in turn may facilitate attending virtual classes (Stahl, 2006). In online environments, most students can participate in the learning activities according to their own learning style and needs, since online environment can be particularly well suited to some learning styles and personality needs. For example, online learning fits introverted students more than face-to-face situations do, as they often find it easier to communicate via computer-mediated communication. Independent students can also find more online courses that can fit their needs (Guzdial, 2003). Working in groups in an online learning environment is supposed to enable students to improve their social skills, exchange their information and experiences about tasks, and interact as equals and share mental models, purposes and practices (Crawley, 2004).

There are a number of factors that can influence the effectiveness of collaborative learning in online contexts. Communication and interaction are important factors that can facilitate shared understanding and knowledge construction (Bonk & Cunnigngham, 1998; Herring, 2004; Kreijns et al., 2003; Stahl, 2006). In this way, facilitated communication and interaction between the participants are required for achieving high levels of collaborative and content-related processes. Therefore, research on increasing interaction in online contexts should be based on investigating how the interaction can be promoted pedagogically and how the online environment itself can facilitate the communication and interaction among participants (Hmelo-Silver, 2003; Scardamalia & Bereiter, 1996; Stahl, 2006; Suthers, Vatrapua, Medinaa, Josepha, & Dwyera, 2008).

In addition, there are specific indicators which determine the successfulness of an online learning environment. Conducting meaningful and productive discussions between the participants is the best indicator for successful online learning. Such discussions need to focus on content and ideas related to the group task, exchanges of and reflections on groups' thoughts (e.g., asking question, giving answers, providing explanations, or justifying rejection). Knowledge construction can be also achieved with the use of content-related concepts and the application of collaboration skills in subsequent collaborative transfer task (Hmelo-Silver, 2003; Stahl, 2006). A high level of interactions (i.e., smooth coordination of the ongoing interaction, such as turn-taking and threading; see Herring, 2004; Liaw & Huang, 2000), an approximately equal participation of all group members (Johnson & Johnson, 1999), adequate learning experiences (Johnson & Johnson, 1999), and high quality contributions (Hathorn & Ingram; 2002) are considered additional indicators of successful online learning.

Realizing Online DBL as CSCL

One reason to suggest CSCL environments for applying DBL is the relative link with recent development of theories of learning and instruction (Lehtinen, Hämäläinen, & Mälkönen, 1998) that fit well for DBL, such as constructivist educational theory that focuses on engaging the students in real-world context and problem-solving situations as well as the social cohesion theory that suggests working in groups for better learning (Brandon & Hollingshead, 1999).

The approaches that were developed for CSCL contexts proved that adoption and using technology as a mediating artefact has the ability to improve teaching and learning (Rasmussen, 2005; Scardamalia & Bereiter, 2006). Recently, there is a general trend in CSCL to move the virtual learning of students into communities of learners and project forms with authentic problems (Brown & Campione, 1994), which mean that moving DBL into a CSCL context is likely to fit such trends and find many capabilities that may lead to effective online DBL.

In educational research literature, there is evidence suggesting that DBL can be successfully transferred to online CSCL environments (e.g., Puntambekar & Kolodner, 1998; Vattam & Kolodner, 2006; Zhao & Chan, 2009). Online CSCL has a number of features that are favorable to DBL. Furthermore, many other student-centered approaches, such as problem based learning (see Zumbach, Hillers, & Reimann, 2003) and inquiry learning (see Zhao & Chan, 2009) have been realized in online CSCL environments, but DBL has not yet. In the following sections, aspects of CSCL that are likely to fit DBL as well as salient characteristics of DBL (task structuring, scaffolding, collaborative processes, and content-related processes) that can benefit from the potentials of CSCL context will be discussed.

Task structuring in online DBL

Online DBL is supposed to require stricter structures and guidelines than DBL in face-to-face contexts due to the high complexity of online problem-solving processes (Dennen, 2000; Orrill, 2002; Steinkuehler, Derry, Hmelo-Silver, & Demarcelle, 2002). Task structuring in online DBL is assumed to enable students to be familiar with the design activities and their sequence, which in turn may facilitate their engagement in collaborative activities and decision making related to their design task as well as avoid cognitive overload. Task structuring can be applied to the whole design process or be limited to specific activities, such as students' discussions (Orrill, 2002; Steinkuehler et al., 2002).

Problem-based learning, project-based learning, and Learning by Design (LBD) are more general instructional approaches that have positive learning outcomes when conducted in CSCL contexts (e.g., Blumenfeld, Marx, Soloway, & Krajcik, 1996; Fasse, et al., 2001; Rummel & Spada, 2005). For example, in the SMILE software, which was used as a working environment in the LBD approach, the task structure applied to the whole design process adopted both the LBD structure and an additional structure provided by the SMILE software.

This determined students' reflection during the design process, at the end of a challenge sequence, and throughout the collaboration phase, which finally led to the increase of content-related discourse processes and development of scientific arguments (Fasse, et al., 2001). Engaging the students through such a CSCL context supported their understanding and application (Lamberty et al., 2001).

Scaffolding in online DBL

Scaffolding can be defined as providing assistance to the students to be able to carry out tasks (e.g., build a design or solve a problem), they could not carry out by themselves (Bruner, 1985; Cazden, 1983). In DBL, scaffolding might be needed to support students' activities and engage students in high levels of discussion.

CSCL environments can be designed to facilitate engaging the students in synchronous or asynchronous coordinated activities where they can share their perspectives and expertise from different areas to build a design, solve a problem, or perform a task together to construct a shared conception of tasks (Brown & Campione, 1994; Roschelle & Teasley, 1995). The idea of CSCL itself involves engaging students in social situations for supporting students' collaboration and interaction. Generally, through online DBL, CSCL environments are likely to support students' collaboration in two different aspects. First, supporting students by monitoring the design difficulties, which are expected to appear through their activities and providing adequate support. Second, supporting the teacher to perform his/her tasks, such as participating in synchronous or asynchronous discussions with students, providing online feedback on the designs, and monitoring the students' activities (Khandaker & Soh, 2009).

According to the framework that was developed by Quintana et al. (2004) to facilitate theoretical and empirical investigations of scaffolding approaches for software tools, several tools can be utilized through the CSCL context. Such tools can be used to shape how students perceive and understand complex tasks and interact with the content through three areas that support science inquiry: Sense making, process management, and articulation and reflection. Furthermore, CSCL contexts can involve software tools which provide needed structures for complex and challenging tasks (e.g., Bell & Davis, 2000; Guzdial, 1994; Soloway, Guzdial & Hay, 1994; Toth, Suthers, & Lesgold, 2002). For instance, Guzdial (1994) through the description of "software-realized scaffolding" identified three roles of software for supporting students through CSCL settings: (a) communicating processes to students, (b) providing students with hints and reminders about their work, and (c) articulating processes to encourage students' reflection. In addition, Soloway et al. (1994) provided the idea of "learner-centered design", where they argued that software should focus on supporting tasks that students have to achieve as well as tools and interfaces that students have to use.

CSCL environments have the potential to provide effective social interaction. For example, peers or teacher-student interactions may act as scaffolding that provides expertise models and observes students' progress. This in turn may support students' thinking, understanding, self-evaluation, and activities and foster the development of students' self-confidence to achieve the design task (Bandura, 1997; Schunk, 1991).

Several empirical studies show the potentials of using CSCL for supporting collaboration, students' discussions, and social interaction (e.g., Hoppe et al., 2000; Mebane, Porcelli, Attanasio, & Pulino, 2007; Roschelle & Teasley, 1995), which may facilitate the students' investigations through online DBL. For example, in a study of Francescato, Mebane, Porcelli, Attanasio, and Pulino (2007), collaborative learning in face-to-face and CSCL contexts (online university courses) were compared with respect to developing professional skills and social capital. The participants of this study were 166 clinical and community psychology majors. They were randomly assigned to two seminars, one online and one face-to-face. In both seminars, the teacher-expert built small group learning activities into a seminar series consisting of weekly modules. The same teacher worked as content-expert and process-facilitator in both types of seminars. The students worked collaboratively to learn the same subject (community psychology) and learnt the same professional skills (mostly interviewing and discussion groups skills to diagnose strong and weak points of an environmental setting such as a neighborhood or an association, or a community group) half in online and half in face-to-face groups. The students who worked in face-to-face context met in a university classroom and worked in small groups to conduct their collaborative activities. The online students worked in an online context, in small groups and as a part of two face-to-face meetings: to receive instructions on the function of the technologies used for online participation (mailing lists and the Yahoo groups platform) and to complete survey forms for this research, and at the end, to complete a post-seminar survey. The modules were designed to be completed either in a weekly three hour face-to-face meeting or online during the same week. Students were evaluated with a variety of assessment tools, including specific questionnaires to evaluate learning in each seminar and asking the students to produce a final paper to evaluate competence development. A scale of academic self-efficacy for the university environment was also used to evaluate students' beliefs about their capacities (e.g., regulating their motivation, organizing their studies, and finding support for their learning). Moreover, another 15-item scale of perceived social efficacy was used in order to assess the students' beliefs about their ability to fit in and take a proactive social role. The results of this study showed that the different groups of participants could achieve similar growth in level of professional knowledge, social self-efficacy, self-efficacy for problem solving and empowerment. However, the students who worked in the CSCL context were top performers on competence-based tasks. Moreover, evaluating the same students after nine months showed that social ties, formed initially more in the face-to-face groups, lasted more among online students (Mebane et al., 2007).

It is expected that CSCL tools can also provide pedagogical and technological support for collaborative learning and design activities. This support may vary, including a large set of design activities, such as understanding tasks, generating hypotheses, elaboration, searching and evaluating online resources (Ludvigsen & Mørch, 2009). In addition, there are promising software tools that appear in the DBL approaches, such as SMILE (mentioned in sections 3.2.1 and 3.3) and the SWIKI website (mentioned in sections 3.4.1 and 3.3), which are used in LBD. These tools enable the participants to engage in collaborative activities in the real-world CSCL classroom.

Collaborative processes in online DBL

CSCL has the potential to provide high level communication, which facilitates collaboration, interactions, and discussions among students (Graves & Klawe, 1997). CSCL is likely to provide a highly diverse, interdependent, and technologically rich workplace that is required for conducting processes related to design tasks. There are many studies that show that engaging students in CSCL by using either synchronous or asynchronous communication tools leads to superior results regarding collaborative processes, such as collaboration and interaction activities, discussions, and collecting information and resources compared to a face-to-face context (Fjermestad, 2004; Stahl, 2006). In this way, these features are well suited for DBL.

Piaget (1954) considered that social situations are necessary for learning to occur and Vygotsky (1978) argued that social interaction among students can lead to knowledge acquisition and the development of social skills (Lehtinen et al., 1998; Wilcox & Williams, 1997). Therefore, engaging students in CSCL to work in groups through the design process may improve the social interaction among them, where they can find network connections, interfaces and joint databases (Relan & Gillani, 1997). Moreover, working in groups encourages students to consciously construct new knowledge on the social level, which in turn coordinates the interaction among the students (Dillenbourg, 2002; Lehtinen et al., 1998). In addition, engaging students in high-level collaborative processes through CSCL enables them to reach high-level thinking through active and interactive learning (Harasim, Hiltz, Teles, & Turoff, 1997), which in turn may facilitate knowledge construction (Brett, 2004; Stahl, 2004). However, the quality of the online interaction depends on supporting the interaction that is supposed to be provided by the teacher, such as plans and structure (Fjermestad, 2004). There are numerous studies on CSCL environments demonstrating encouraging effects on the amount and quality of collaborative processes that are widely needed for online DBL (e.g., Benbunan-Fich, Hiltz, & Turoff, 2003; Lamon, Secules, Petrosino, & Hackett, 1996; Scardamalia & Bereiter, 1994; Wilcox & Williams, 1997). For example, in a study of Benbunan-Fich et al. (2003), the authors used a quasi experimental design to compare asynchronous CSCL groups with face-to-face collaborative learning groups in computer ethics. The face-to-face condition included five groups of four to six students, while the CSCL condition included seven groups working in an asynchronous text-based computer-mediated communication system. The results showed that CSCL groups engaged in better and longer collaborative processes, such as conducting discussions and delivering reports compared to the face-to-face condition. Other studies have focused on the social aspect of CSCL, and found that engaging students with different abilities and expertise in group work through a CSCL context in order to solve problems together improves the amount and quality of social interaction (Wilcox & Williams, 1997).

An identifiable strength of CSCL refers to the possibility of engaging students in improved, broad and deep discussions and conversations (Graves & Klawe, 1998). For example, through online written discussions, the students can find a discussion database that facilitates reviewing what they have written or what their partners have written, and the teacher has an opportunity to review and analyze the students' discourses any time with the aim of diagnosing and facilitating the learning difficulties, assessing, or grading the students (Resta & Laferriere, 2007). Forums are another form of asynchronous online written discussions that enable students to receive clarification, more information, and feedback on their activities (Day, Lou, & Van Slyke, 2004).

Regarding the size of the group, CSCL environments allow the students to work in either small groups or large groups by using different synchronous and asynchronous communication tools. In addition, through CSCL it is possible to conduct plenary sessions, in which the students and the teacher can discuss and evaluate the designs by using social tools (e.g., wikis, forums, or videoconferencing). In this way, CSCL has potentials to accommodate different group sizes.

Content-related processes in online DBL

CSCL is considered as an appropriate context that can be used for supporting content-related processes that are also essential for successful DBL. In CSCL, students can engage in different content-related processes individually or collaboratively with others. Several studies indicate that engaging students in CSCL can improve their cognitive performance (e.g., Rimmershaw, 1999) and foster their deep understanding (Scardamalia & Bereiter, 1994; Stone-Wiske, 2002), which in turn may improve and facilitate the acquisition of domain-specific knowledge. Other studies have also found that knowledge retention can be enhanced through collaborative learning in CSCL, like in individual learning (Guzdial, 2003).

The nature of CSCL adds a flexibility of time and space to DBL. CSCL can provide a virtual rich workplace in which the students have more time to analyze and reflect on the content and to compose thoughtful responses through several communication tools (Althaus, 1996) when compared to face-to-face discussions (Marttunen & Laurinen, 2009). In addition, the students can be distributed in place and time to learn and discuss the content (e.g., Collis & Moonen, 2001; Palmieri, 1997). Furthermore, engaging the students in online content-related discussions by using synchronous or asynchronous communication tools allows them to have a printed copy of their discussions and foster their reflection (Bonk & King, 1998).

The rich resource environment provided by online DBL can be considered as very helpful, where students can search and get needed information and knowledge related to the content or the design task. Through an appropriate CSCL environment, students can have access to rich and dynamic resources (e.g., search engines, digital libraries, electronic journals, and forums) as well as contact to human resources (e.g., experts, practitioners, and peers) for receiving content-related support from others (Bonk & King, 1998). For example, important resources for both teacher and students in online DBL are Internet browsers for accessing information and digital resources. In CSCL environment, Internet browsers can already be embedded and available for students and the teacher. In addition, different scaffolds can be used to support students in CSCL environments with content scaffolding, including digital visual representations to potentially increase the amount of students' discussions (Fischer, Bruhn, Gräsel & Mandl, 2002) and foster meaningful discourses related to content learning (Jacobson & Levin, 1995; Suthers, 2003).

CSCL offers an increasing number of generic tools, such as e-mail, chat, wikis, blogs, electronic bulletin boards, audio and video conferencing, Web-based Instructional Management Systems tools (Course Management System, CMS; Learning Management System, LMS), and virtual learning environments (e.g., Blackboard/WebCT, Moodle, and Sakai) that are designed to support both collaborative and content-related processes. For example, TAPPED_IN is a CSCL environment that was designed to support collaboration between distributed participants by using synchronous communication tools (virtual rooms; Schlager & Schank, 1997). Belvedere is another example, which was used to engage students in a scientific inquiry process. Belvedere is a shared-workspace system for collaborative learning that involves a chat window and a shared visual workspace where learners construct scientific explanations (Suthers & Hundhausen, 2003).

With respect to the cognitive aspects that can facilitate learning content, meaning making is a cognitive aspect that can be supported by a CSCL environment. Meaning making concerns the meaning of utterances during the students' discussions about the content that involve different perspectives, ideas, or opinions expressing the students' understanding (Dillenbourg, Baker, Blaye, & O'Malley; 1996). Shared meaning between two or more students is likely to lead to more understanding of the content. Critical thinking is another cognitive aspect that is suggested to be supported in CSCL. Critical thinking is defined as high level cognitive skills that require evaluating arguments, interpreting, analysing, and inference which are needed for a high level of online discussion-based learning (Astleitner, 2002; Brandon & Hollingshead, 1999). According to Brandon and Hollingshead (1999), critical thinking includes the last three mental tasks (analysis, synthesis, and evaluation) of Bloom's taxonomy (1956) of cognitive domain, which involve more complex mental tasks, such as separating concepts or ideas into component parts, building a structure or pattern from diverse ideas, and making judgments about the value of ideas and contents. Therefore, CSCL researchers (e.g., Bullen, 1997; Garrison, Anderson, & Archer, 2001; Newman, Webb, & Cochrane, 1995) suggested CSCL as an adequate context for critical thinking or higher levels of mental processes. In this way, DBL is considered as a critical thinking context, which may be appropriate for CSCL. In addition, a CSCL context can be used to facilitate engaging the students in the process of knowledge-seeking inquiry which is one of the key features of CSCL environments (Koschmann, Kelson, Feltovich, & Barrows, 1996; Koschmann, Hall, & Miyake, 2002). This process is a cognitive process that requires more than already available students' knowledge. Knowledge-seeking inquiry processes usually lead to the production of self-explanations (Brown & Campione, 1994; Scardamalia & Bereiter, 1994). This may foster students' conception and allow them to connect new knowledge with existing knowledge to potentially facilitate the acquisition of domain-specific knowledge. Educational studies show that engaging students in interaction activities with their partners and teacher in online contexts increases students' motivation to learn more about a subject matter compared to others who have fewer opportunities for interaction (Johnson, Johnson, & Smith 1998; Springer, Stanne, & Donovan, 1998).

Online DBL: Expected problems with implementation

Current knowledge about CSCL environments and their potentials with reference to online collaboration, task structuring, and online learning support, provide interesting and useful insights in considering the possibility of transferring DBL to CSCL. However, it is not reasonable to expect that CSCL is the magic solution for online DBL, since the whole picture about online DBL is still incomplete. Almost no study has investigated the effects of online DBL in the past. DBL in face-to-face contexts is a very complex process and involves a large number of challenging activities and the students need to be completely supported through their investigations. Therefore, it is expected that engaging students in online DBL will be a complex and challenging task and supporting students' investigations through the design process will also be critical.

There are two main problems in CSCL that are expected to affect developing web design skills through online DBL. *First*, the low-level collaboration that usually appears through the spontaneous collaboration and discussions in CSCL environment, which can be described as shallow collaboration. As related research has shown, students' discussions in CSCL often lack inquiry-based discussions (Jarvela & Hakkinen, 2002), and students usually accept their partners' perspective easily without engaging in critical discussions regarding different perspectives or interpretations (Admiraal, Lockhorst, Wubbels, Korthagen, & Veen, 1998; Angeli, Valanides, & Bonk, 2003). Further empirical studies demonstrate that students in asynchronous CSCL usually work at an individual level of learning rather than an interactive level and fail to build on their partners' contributions (Thomas, 2002). In addition, students often engage actively in activities that only require superficial interaction, such as sharing information and seldom engage in higher level collaboration processes, such as high-level inquiry-based discussions (Kanuka & Anderson, 1998; Pawan, Paulus, Yalcin, & Chang, 2003). *Second*, superficial content-related discussions in which the students usually depend on their feeling and experiences through their discussions instead of engaging in deep discussions about what they have to learn. Thus, as research has shown, spontaneously engaging students in a CSCL context does not guarantee that higher level content-related discussion and reflection will occur (e.g., Admiraal et al., 1998).

For instance, in a study by Admiraal et al. (1998), the main goal was to compare student teachers' experiences of computer conferencing in a learning environment at the three levels of teacher education in the Netherlands with other experiences in different contexts, especially in the USA. 85 student teachers and 14 supervisors participated in this study. The participants worked in groups varying between groups of four student-teachers and one supervisor and 21 student-teachers and two supervisors. Two surveys were used to assess student teachers' expectations (e.g., the time they would spend on the computer conferences, the themes of their messages, and the perceived outcomes of computer conferences), whereas student teachers in the primary teacher education program completed one survey after the student-teaching practical classes. Furthermore, panel interviews with student teachers from three of the teacher education programs regarding similar aspects as in the surveys were conducted. Other interviews with supervisors of the graduate teacher education program were conducted concerning their moderator role and the perceived outcomes of the computer conferences in the supervision of students. Finally, all e-mail messages that were sent to the discussion groups were collected, and were analyzed with respect to the themes of the messages, participants' reflection and their responses. One important result of the study was the participants' and their supervisors' use of the web-based conferencing just for superficial discussions addressed at exchanging their experiences with little focus on teaching and exchanging their content knowledge.

Overall, CSCL has great potentials to make it a promising context for online DBL. Characteristics of computer-mediated communication may enable online DBL to provide opportunities for advanced learning regarding domain-general and domain-specific knowledge as well as domain-specific cognitive processes. However, researchers have found that many CSCL discussions appeared to lack both content-related discourse and effective collaboration skills. Therefore, to fully realize the supposed benefits of online DBL, external support focusing on content and collaboration is needed.

Summary

This chapter deals with Design-based Learning (DBL), which is related to active learning. The basic idea of DBL is engaging students to collaborative design activities in order to complete specific design tasks and facilitate the acquisition of both domain-general and domain-specific knowledge. DBL falls under the pedagogical umbrellas of three methodologies of active learning (a) problem-based learning, (b) project-based learning, and (c) inquiry learning. However, supporting students through DBL is necessary to engage productively in the design processes, which include (1) collaborative processes and (2) content-related processes.

Although there are several DBL approaches, there are differences between them regarding the way they engage students in design processes, the design processes themselves (collaborative and content-related processes), and support mechanisms to the design processes. For example, in LBD, the students work through two cycles of activities, which include multiple iterations of building, modifying, evaluating, and revising the designs with focusing on the same science concepts with an increasing level of complexity, whereas in DBS the students learn through one iterative cycle of activities, but each iteration focuses on different science concepts. Overall, analyzing DBL approaches reveals that collaboration has nowhere been scaffolded systemically. Furthermore, it is clear that content-related discourses processes often do not get enough support, too. In addition, further empirical studies that use quantitative methods and give rigorous empirical results are still required.

Based on above, online learning may provide an adequate context for DBL, where the design processes can be supported systemically. Online DBL may gain many advantages when it is moved into an online context, such as communicating by different asynchronous and synchronous communication tools regardless of meeting time and place as well as enable students to participate in the design activities according to their learning style and needs. CSCL is considered as an adequate in which students can work in small and large groups to design and build projects with authentic problems (Brown & Campione, 1994), which involves a great potential to fit the nature of DBL. However, there are two main problems related to CSCL that should be put into consideration, which are: (a) low-level collaboration that is usually associated with spontaneous collaboration and discussions in CSCL environment and (b) superficial content-related discussions. Therefore, supporting online DBL with appropriate social and content scaffolding is required for effective online DBL, which in turn may lead to high levels of domain-general and domain-specific knowledge.

4. Supporting Online Design-based Learning through Collaboration Scripts and Incomplete Concept Maps

As described in chapter 3, DBL requires students to engage in complex web design processes. During the web design process, the students need to engage in different collaborative processes, such as practicing design, running experiments, analyzing results, drawing conclusions, and taking decisions with the aim to develop web design skills and understanding needed to undertake solution of the complex, ill-structured problem. In addition, the students have to engage in high level of content-related processes in order to learn content deeply. Online DBL is expected to be accompanied by more complexity and challenges relate mainly to collaboration skills and content-related discourse processes.

Supporting online DBL is strongly required for two reasons: On the one hand, the nature of digital media and Internet technologies allows the students to work in groups in order to solve problems or achieve design tasks. This in turn requires supporting inquiry processes in online contexts (Kollar, 2006). On the other hand, the nature of design-based learning requires supporting the students with adequate scaffolding through different design activities (Hmelo, Holton, Allen, & Kolodner, 1997).

In CSCL, students have to engage in high levels of collaborative and content-related discourse processes related to design and building artifacts in order to guarantee effective online DBL. However, research on collaborative learning shows that students often do not collaborate well spontaneously (Cohen, 1994) concerning, for instance, equal participation (Cohen & Lotan, 1995), engaging in high-level argumentation (Bell, 2004), and the level of knowledge acquisition (Fischer et al., 2002), which are expected to be amplified in online learning. Furthermore, engaging students in such complex tasks without appropriate scaffolds for learning content is likely to fail to bridge the gap between scientific and technical approaches to inquiry, may not allow students to engage in deep discussions about content, and provide adequate justifications and explanations regarding their designs, which may in turn affect negatively the acquisition of domain-specific and domain-general knowledge. Research on DBL (e.g., Kolodner et al., 2003b) shows that content-related discourse is usually conducted on a low level and students have to receive further support concerning learning of content and scientific concepts. Research on CSCL (e.g., Admiraal et al., 1998) also confirmed the need to provide appropriate scaffolding for supporting online content-related discussions.

Therefore, additional support during online DBL seems to be promising. There are at least two categories of scaffolding that have a certain potential to improve online DBL: (a) social scaffolding, that refers to the guidance and structuring of social interactions (Kollar et al., 2006), and (b) content scaffolding, that refers to conceptual support concerning the content of the task (Cox & Brna, 1995). Computer-supported collaboration scripts could be used as social scaffolding and incomplete concept maps could be utilized as shared external representations that may be useful as content scaffolding.

Collaboration scripts are scaffolds that aim to improve collaboration through structuring the interactive processes between learning partners by specifying, sequencing and distributing learning activities and roles among learners in a small group (Kollar et al., 2006). For example, Kollar and his colleagues (2007) demonstrated that collaboration scripts are able to improve collaboration processes and individual learning outcomes. Moreover, collaboration scripts may facilitate communicative-coordinative processes between students and guide them through complex learning processes (Dillenbourg, 2002). With respect to knowledge acquisition, there is evidence that collaboration scripts can positively affect especially the acquisition of more domain-general knowledge, but, if properly designed, may also facilitate the acquisition of domain-specific knowledge (Weinberger et al., 2010).

Incomplete concept maps are a type of shared external representations that may be appropriate in supporting content-related discourse processes in CSCL. Concept maps are visual representations that graphically depict relations between concepts (Baker, 2003; Cox & Brna, 1995). Studies on concept maps and graphical organizers indicate positive effects on comprehension of content (e.g., Romance & Vitale, 2002), intensive discourse about content (Fischer et al., 2002), and content quality of discussions (Jacobson & Levin, 1995; Suthers, 2003). One strength of using concept maps lies in the graphical representation to visualize and manage domain-specific knowledge necessary for the design task (Tergan & Keller, 2005), which enables students to understand and remember complex information and abstract concept relationships better (Armstrong, 2003) as well as to organize and communicate their ideas and thoughts (Cox & Brna, 1995; Jonassen et al., 1993). Even more, concept maps that involve missing concepts and relationships can increase students' activities for seeking missing information, which may in turn positively affect learning outcomes (Baker, 2003).

In this chapter, supporting students in online DBL environments will be justified first. Second, computer supported collaboration scripts will be introduced in detail as social scaffolding for structuring of social interactions in CSCL environments. After that, how collaboration scripts can be implemented in CSCL environments will be introduced. Subsequently, incomplete concept maps as a promising content scaffolding for increasing the students' activities in CSCL environments will be presented. Next, a connection between web design skills on the one hand and collaboration scripts and incomplete concept maps on the other hand will be made. Finally, the implementation of incomplete concept maps into CSCL environments will be discussed.

4.1. Computer-Supported Collaboration Scripts as a Way to Provide Social Scaffolding

As already shown, DBL involves different collaborative activities (e.g., planning and running experiments, conducting content-related discussions, and testing the validity of ideas), but as research has shown, collaboration rarely is on a high level if it is not appropriately scaffolded. There are indications that engaging students in collaborative learning through computer-mediated learning environments does not guarantee success of group members in the learning process because they often face difficulties regarding what tasks they work on and how they interact with each other, which may facilitate or prevent each other's learning (Barron, 2000; Cartwright, 1968; Kiesler, 1992; Straus & McGrath, 1994). For example, students sometimes do not participate actively or engage in off-task talk and engage in superficial discussions rather than in in-depth thinking and inquiry based discussions, which are regarded as indicators for high level collaboration (Doise, 1990).

In virtual environments, teacher and students as sources of scaffolding are separated by time or space, or both, which often leads to lower level of social interaction compared to collaborative learning in traditional classrooms (Beuschel, 2003; Stahl, 2002). Therefore, finding appropriate external supports that are able to improve collaboration and interaction between students, facilitate engagement and participation in learning activities, lead to high level discussions, and guide them toward cognitive goals and outcomes of collaborative work through CSCL environment is a critical issue.

In recent years, structuring tools have received widespread attention for supporting the computer-mediated learning environments regarding different aspects, such as synchronous and asynchronous communications and supporting periods, for instance, one hour to a full semester (Dillenbourg, 2002; Weinberger, Reiserer, Ertl, Fischer, & Mandl 2003). Providing the students with structuring tools can directly affect collaborative learning activities and may lead to engage students in higher level interaction processes (Roschelle & Pea, 1999).

One promising way of structuring interaction and providing instructions to engage students in web design activities in collaboration is to design predefined collaboration scripts and integrate them into CSCL environments (Dillenbourg & Jermann, 2007; Kollar et al., 2006). Collaboration scripts can be defined as powerful instructional interventions that facilitate high-level collaboration processes by specifying, sequencing and distributing learning activities and roles among learners in a small group (Kollar et al., 2006). Specifying web design activities enables students to focus on beneficial activities for collaborative knowledge construction (e.g., asking high level questions, giving high level answers, and giving high level reactions to answers) and to avoid other activities that may be detrimental. Moreover, engaging students in sequenced web design activities warrant that they engage in the specified activities at specific times (e.g., starting by asking question first and second step is giving answer), which may lead to improve transactivity of students' discussions. Furthermore, assigning activities and roles to the students warrants that all students engage in the specified activities and already perform what they have been asked to do (e.g., one student may be assigned the activity to ask questions regarding specific content of web design and the second student may be expected to answer these questions, after that the dyad may change their roles and start a new discussion on different content; Weinberger, 2003). Collaboration scripts focus mainly on social and cognitive activities in which students are expected to engage and at the same time that rarely occur in the absence of scripts more than other collaborative learning approaches. In this way, scripts may lead to higher level interaction, and thus, to better understanding and learning.

Over the last years, a number of collaboration scripts for computer-mediated settings have been developed based on empirical findings and socio-cognitive theories to directly support collaborative learning (e.g., Baker & Lund, 1997; Dillenbourg & Jerman, 2007; Kollar et al., 2006; Stegmann et al., 2007; Weinberger et al., 2003). One example of such scripts is presented by Baker and Lund (1997), where the students worked in dyads in a text-based learning environment supported with a collaboration script to collaboratively create an energy chain model by using a synchronous communication tool (chat) and a shared physics diagram. Through this script the students had to engage in elaborative activities such as giving explanations and perform coordination activities by forcing them to use buttons containing specific prompts as starters for their discussions (e.g., "I propose to…", "I think that…", and "Where do we start?"), which were located on the communication interface. After clicking on one of the buttons, the student had to complete the sentence with his/her own words and send it to his/her partner through the chat window. The results indicated that collaboration scripts enable the students to overcome the problems that were related to chat communication (e.g., incoherent text and missing nonverbal cues). The students conducted the learning activities flexibly.

A number of experimental studies have reported positive effects of collaboration scripts on learning. For example, some studies demonstrated the scripts' ability to improve collaboration processes and individual learning outcomes through structuring the interactive processes between learning partners (Kollar et al., 2007). Furthermore, collaboration scripts can improve students' engagement in online discussions (Schoonenboom, 2008; Weinberger et al., 2007) and typically the quality of discussions (Stegmann et al., 2007; Weinberger et al., 2005; 2010). In addition, collaboration scripts may facilitate communicative and coordinative processes between students and provide guidance to them through complex learning processes (Hoppe et al., 2000).

One example that shows the effects of computer-supported collaboration scripts on domain-general knowledge is a study by Kollar and his colleagues (2007). In this study, the authors used the collaboration script to enable students to engage in high level of collaborative processes, such as well-formulating arguments, counterarguments and integrations in the Web-based Inquiry Science Environment (WISE; Slotta, & Linn, 2009). (98) Students participated in this study from two German secondary schools (Grade 8 to 10), who worked in dyads through a 2X2-factorial design with independent variables structured internal scripts (low vs. high levels) and structured external scripts (low vs. high levels). The collaboration scripts were implemented into a biology curriculum unit of the WISE-environment about deformed frogs. In the high structured external script condition, the students had to generate a sequence of argument (an argument, a counterargument, and an integrative argument) with a piece of data, a claim, and a reason. While in the low-structured external script condition, the students had to use a blank text box to write down their argumentations. Analyzing the students' processes were conducting by coding the transcripts of students' discourse (oral and written statements). Learning outcomes were measured by two post-tests in open-answer format. The results show that the collaboration script enabled the students to develop higher levels of the domain-general competence of argumentation. In contrast, the collaboration script did not lead to high levels of domain-specific knowledge.

Overall, there is evidence that collaboration scripts can positively affect the acquisition of domain-general knowledge. The general results pattern, at least in more lab-oriented studies, find effects only on domain-general knowledge, and no positive effect on domain-specific knowledge can be found. However, due to types of computer-supported collaboration scripts (e.g., a peer-review script) the acquisition of domain-specific knowledge could be also facilitated (e.g., Diziol, Rummel, Spada, & Mclaren, 2007; Weinberger, Ertl, Fischer, & Mandl, 2005).

For example, Weinberger and his colleagues (2005) investigated the effect of epistemic and social scripts on the individual knowledge acquisition as the outcome of collaborative learning in the computer-supported learning environments. In this study, a problem-oriented peer discussion environment based on discussion boards was used. (96) Students of Educational Science at the University of Munich participated in the study. The authors established a 2×2-factorial design with "epistemic script" (with vs. without) and "social script" (with vs. without) as independent variables. The students were distributed to three different laboratory rooms. The students worked in groups of three, where they were asked to discuss three cases using the attribution theory and to jointly compose at least one final analysis for each case. The individual knowledge acquisition was measured by analyzing written problem case solution of the learners. The results indicated that this kind of a peer-review script (social script) had a positive effect on the acquisition of domain-specific knowledge, whereas a script that focused on the content (epistemic script) had a negative effect on domain-specific knowledge acquisition (Weinberger et al., 2005).

4.1.1. Different kinds of collaboration scripts

There are some differences between collaboration scripts regarding many aspects. For example, collaboration scripts were applied in different settings, such as web-based learning, face-to-face, and mobile context (Fischer, Kollar, Mandl, & Haake, 2007). Furthermore, the primary target of collaboration scripts varied from structuring social activities between small groups via synchronous communication tools to improve interaction between students and individual activities over a long time in asynchronous context (Dillenbourg & Jermann, 2007). Therefore, well-identifying and structuring of learning activities facilitate the integration of scripts into learning contexts and increase its effectiveness.

Kollar and his colleagues (2006) provide a systematization of collaboration scripts that can be found in different contexts and for various goals. They identified five components that form the collaboration script: (1) Learning objectives, (2) activities, (3) sequencing, (4) role distribution, and (5) type of representation. Next, the authors analyzed several collaboration scripts based on such components, which showed how the systematization of each script can be varied according to such conceptual components. For example, collaboration scripts for computer-mediated learning varied with respect to *learning activities* between cognitive-elaborative (e.g., explaining and commenting) and communicative-coordinative activities (e.g., requesting agreement and arranging tasks). In addition, the *sequencing* of learning activities in each collaboration script was different, such as scripts developed by Guzdial and Turns (2000) and Pfister and Mühlpfordt (2002) gave the students much flexibility regarding engaging in specific activities or choosing the time of conducting activities, whereas other scripts, such as script that had been provided by Hron, Hesse, Reinhard and Picard (1997) gave the students explicit guidance concerning the sequence of activities they were supposed to perform.

Another different aspect regarding collaboration scripts is the target of script. For example, epistemic scripts focus on content aspects of the learning task more than engaging in transactive discourse in the virtual environment. In contrast, social scripts motivate students to interact with each other and engage in more discussions in the virtual environment (Kollar, Fischer, & Hesse, 2003; O'Donnell, 1999; Weinberger, 2003). Therefore, using collaboration scripts has to focus on both cognitive and social aspects of collaborative learning. Using epistemic scripts focus on structuring activities that facilitate individual-knowledge construction by supporting students with specific instructions, which may enable them to achieve the learning outcomes (Weinberger et al., 2003). On the other hand, social scripts focus on engaging students in high level interaction that improve collaborative knowledge construction, which in turn may facilitate the accomplishment of learning outcomes (Stegmann et al., 2007). There is evidence that using only epistemic scripts in computer-mediated learning does not guarantee better learning results (Weinberger et al., 2005).

The objective of collaboration scripts can also vary. First, scripts may focus on facilitation of the acquisition of the domain-specific knowledge about the learning material (e.g., knowledge about energy concept and knowledge about the biological problem; Baker & Lund, 1997; Hron et al., 1997). In addition, collaboration scripts especially in computer mediated environment may focus on helping students to acquire the domain-general knowledge, such as communication, coordination, and solving problems (kollar et al., 2006). Second, collaboration scripts especially in face-to-face settings focus on cognitive and metacognitive objectives. Such scripts aim to enable the students to acquire both domain-specific knowledge as well as additional elaborative strategies, such as questioning and explaining. In addition, collaboration scripts may prompt the students to acquire metacognitive skills, such as monitoring (Kollar et al., 2006; Rosenshine & Meister, 1994).

Therefore, the collaborative activities should be structured in the light of desired objectives to enable scripts to be optimally integrated into learning environment and enable students to acquire the different kinds of knowledge.

Also, using technology to support scripting is considered as a different aspect of collaboration scripts. The amount and type of technology used to support scripts can be also another different aspect of collaboration scripts. Lipponen (2001) differentiated the collaborative use of technology, where the script is not involved in specific technology (e.g., a worksheet involves sequences of instructions) from collaborative technology, where the script is embedded in specific learning environment follow specific sequences, engage in specific activities, receive needed resources and information, and reuse the script many times regardless the duration of collaborative learning phases (Kobbe, Weinberger, Dillenbourg, Harrer, Hämäläinen, Häkkinen, & Fischer, 2007).

Another difference between collaboration scripts could be the representation types of scripts. Collaboration scripts varied from textual (e.g., prompt cards) and auditive representations (e.g., giving instructions to the students by teacher) that have been used frequently through face-to-face contexts. In a face-to-face environment, the students had to practice the script for long time before actually applying it, which is supposed to lead the students to internalize the script instructions before their interaction. However in computer-mediated learning, collaboration scripts often vary between graphical representations (e.g., graphical diagrams) or textually (e.g., text presenting involving main concepts of the problem) and are usually used. One needs to take into account that identifying the representation type of collaboration script depends on the specific instructions that the students have to receive (Kollar et al., 2006).

As shown above, collaboration scripts varied regarding different aspects, but over all a limitation in prior research on scripts concerns the duration of using collaboration script that can be observed. Although there are few empirical studies conducted in authentic learning situations (e.g., Wecker et al., 2010), most of the previous studies on collaboration scripts have been conducted in lab in a rather short learning period. Therefore, investigating the effect of collaboration scripts when they are used for long learning period is still needed. This study is an attempt that explores such effect, since it examines effect of using computer-supported collaboration script as social scaffolding for supporting the groups' collaboration over several weeks.

4.1.2. Prompt-based collaboration scripts

King's (1999) script is a prominent approach to facilitate specific interactions between the students through collaborative learning. In this approach, King used guided peer questioning to prompt the students to engage in specific activities by using prompt cards.

King developed guided peer questioning (King, 1992) to increase the students' ability to ask task-related, thought-provoking questions spontaneously. She suggests that the students have to engage in high level interactions to be able to reach high levels of collaborative learning (King, 1989). From her perspective, engaging the students in task-related questions activities can be an indicator of the level of interaction between the students. Therefore, King conducted several studies (see King, 1989, 1990, 1991, 1992, 1994; King & Rosenshine, 1993) to teach students different strategies to ask task-related questions and developed the guided peer questioning approach (King, 1999).

Three different discourse approaches with specific prompts to support students in classrooms are provided by King: (a) complex knowledge construction, (b) problem solving, and (c) peer-tutoring. The prompts are incomplete sentences (question stems), the students are supposed to respond to and complete. Regarding the first approach (complex knowledge construction), the students are initially trained to give elaborated answers. Next, the students select few prompts from the whole prompt-list and generate several content-related questions by filling in the blanks in the prompts' sentences (e.g., "What does … mean?", "Explain why ...", and "What would happen if ...?"). After that, the students conduct their discussions by asking the questions and giving elaborated answers. With respect to the problem-solving approach, King uses prompts cards to support the students to structure their discourse. The prompts card involves question starters (e.g., "What is the problem?", "What do we know about the problem so far?", "What is our goal now?"). Small groups of students are supposed to use these prompts to discuss specific problems by reciprocally generating and asking questions as well as giving answers. Through a peer-tutoring approach, the students play reciprocal tutoring roles (questioner vs. explainer). Only the student who plays a questioner role use prompts of specific question types (e.g., review questions, thinking questions, and probing questions). The student who plays explainer role is supposed to give elaborative explanations as a reaction for the students (King, 1999).

Results of empirical research indicate that guided peer questioning has positive effects on individual knowledge acquisition when compared to discourse without instructional support (e.g., King, 1990). Furthermore, guided peer questioning enables students to engage in high-level interactions (e.g., asking thought-provoking questions and integrating new knowledge with prior knowledge).

The guided peer questioning approach is a script that can be employed as a trigger peer interaction between students, since the students are supposed to engaged in high level interaction. Using the guided peer questioning script as computer-supported collaboration script is supposed to enable the students to play specific roles according to specific sequence. In addition, that script can provide the students with text or guidance to specify the roles during the collaboration processes of web design in the form of starters or prompts, which are considered as a way to represent scripts. In this way, the students can not find script or description of roles that enable them to use these prompts (Weinberger, 2003).

Prompt-based collaboration scripts provide students with the opportunity to perform web design activities without splitting their attention between what they discuss and what they have to think about the specific roles they are supposed to play, because each role of the scripted collaboration is supported by specific prompts as in guided peer questioning. In this way, the students are supposed to respond to these prompts and thus, engage in the intended activities (King, 1999; O'Donnell & Dansereau, 1992). Therefore, computer-supported collaboration scripts are typically implemented as prompts or hints (e.g., Weinberger et al., 2005), buttons (e.g., Hron et al., 1997), or input text fields (e.g., Kollar et al., 2007).

A number of recent studies investigated the effects of prompt-based collaboration scripts on both processes and outcomes (e.g., Weinberger et al., 2005). The results of these studies induced prompt-based collaboration. For example, Ge and Land (2002) investigated the effects of question prompts on individual and collaborative learning. The results show that question prompts are especially effective in peer collaboration. In addition, question prompts can also support the individual students regarding specific learning processing (e.g., problem representation, solutions, justifications, and monitoring and evaluation). Furthermore, a study by Weinberger (2003) investigated the effects of epistemic and a social prompt-based collaboration script into a CSCL environment on processes and outcomes of collaborative knowledge construction. The results show that prompt-based collaboration scripts appeared feasible and effective instructional approach for CSCL. In addition, they can facilitate specific discourse activities and learning outcomes. Overall, Weinberger suggested that using prompt-based cooperation scripts in CSCL may warrant the quality of collaborative knowledge construction independent of the competencies of learners and teachers.

Therefore, the suggested prompt-based collaboration script, which aims to support online DBL, involves both script and prompts. The students in that script are not supposed to remember the different roles and related web design activities. Thus, prompts should indicate them automatically. Furthermore, the suggested script has to enable the students to engage in higher level inquiry processes on web design during their discussions in small groups. Therefore, through small groups' discussions the students are supposed to play different roles (e.g., asking a question, giving elaborative answer, and giving reactions to answers) in a specified sequence with the help of specific prompts. Such prompts are assumed to change automatically according to the student's role, which should be taken reciprocally. In this case, prompts may facilitate the students' discussions and enable them to perform the specific roles and activities easily.

4.1.3. Implementing prompt-based collaboration scripts in CSCL environment

Prompt-based collaboration scripts may be an appropriate and beneficial approach for CSCL environment. This approach can be realized by artifacts, which can be embodied into CSCL environments and utilized to improve structuring of collaborative learning activities in such environments. By adapting the interface of text-based computer-mediated communication (CMC), prompt-based collaboration scripts can be incorporated in such interface and used to structure the students' discussions and guide them through specific series of activities by adapting the interface (Baker & Lund, 1997; Nussbaum, Hartley, Sinatra, Reynolds, & Bendixen, 2002; Scardamalia, & Bereiter, 1996; Weinberger et al., 2005). In this way, the prompt-based collaboration script approach can be embodied with an online DBL environment and realized with socio-cognitive structuring functions of specifically designed interfaces.

Prompt-based collaboration scripts can be implemented in CSCL environments by adapting the interface to provide a discourse structure and prompts that are inserted into text-windows of web-based discussion boards beforehand (e.g., Hron et al., 1997; Nussbaum et al., 2002; Weinberger, 2003). For example, Weinberger (2003) engaged the students in a text-based computer-mediated learning environment, which was supported with two types of prompts: (a) social prompts (e.g., "The aspects are not clear to me yet" or "Regarding our differences of opinions") in the form of sentence starters which students could use when starting to write a message in text-based computer-mediated learning environments to support the roles of constructive critic and case analyst in collaborative knowledge construction and (b) epistemic scripts (e.g., "Does a success or a failure precede this attribution?" or "Is the attribution located internally or externally?") in the form of questions about the problem cases which aimed to enable students to first identify relevant case information, and relate the concepts of the attribution theory to the case information. These prompts were implemented into the text window, which students used to formulate messages in online discussion. The findings of this study show that prompts could facilitate the students' discussions activities induced by interface designed in text-based computer-mediated learning.

Besides using prompt-based collaboration scripts to facilitate web design processes of the collaborative construction of knowledge as well as using it as instructional support in collaborative learning, further advantages of prompt-based collaboration script can be found. First, using prompt-based collaboration scripts in CSCL environments may guarantee the quality of the instructional support (Weinberger, 2003). Second advantage, applying such scripts in CSCL environments does not require specific needs or individual learning prerequisites for identifying student activities. In addition, the students in CSCL environments may be able to decide to what extend the induced collaboration script are being followed or not. Finally, prompt-based collaboration scripts require less costs of instructional support, such as conducting prior training for collaborative learning and getting feedback from present experts, which may facilitate collaborative knowledge construction (Weinberger, 2003).

4.2. Incomplete Concept Maps as a Way to Provide Content-related Scaffolding

Engaging the students in high level of content-related discourse processes on web design requires enabling them to engage in deep understanding of content, web design concepts, and other concepts. Therefore, the learning process has to be an active process and the students have to engage positively in both action and reflection process on web design (Howe & Berben, 2003). In this way, the students should have the ability to construct their declarative and procedural web design knowledge (Ausubel, Novak, & Hanesian, 1978; Novak & Gowin, 1984; Novak, 1998). Through content-oriented structuring tools, the students can focus more on the content when they engage collaboratively in discussions and constructing web design knowledge, which can in turn facilitate collaborative knowledge construction (Fischer et al., 2002). Content-oriented structuring tools involve different kinds of external representations, such as diagrams, computer simulations, pictures, tables, and concept maps that focus on central ideas and abstract characteristics of the content (Weinberger et al., 2003).

Concept maps are content-oriented structuring tools based on Ausubel's theory of meaningful learning, in which the students have to link new knowledge to existing concepts that have been understood in order to learn meaningfully (Ausubel, 1963). A concept map can be defined as a graphical tool for organizing and representing knowledge by showing the relationships among concepts (e.g., Novak & Cañas, 2006). Novak and his colleagues developed concept maps in 1972 to enable students to understand science concepts and their relationships in a graphic and visual manner by providing ongoing reflection on the process as well as the relationships among concepts which enable the students to organize and represent knowledge (Novak, 1998).

A strength of concept maps is using instructional methods that encourage inquiry learning by constructing new web design knowledge in relation to prior knowledge as well as helping students to explore and organize their prior knowledge, visualize what they learn, and construct new knowledge by linking new knowledge to existing concepts already known by enabling the students to create a visual representation of concepts and arrange them hierarchically (Horton, McConney, Gallo, Woods, Senn, & Hamelin, 1993; Kinchin, 2000; Liu, 2004; Novak & Gowin, 1984; Novak, 1998; Wandersee, 1990). Furthermore, concept maps combine the advantages of the human visual perception system and benefits of visual knowledge representation (Kommers & Lanzing, 1997). In this way, when students create concept maps or complete missing information in incomplete concept maps concerning web design, a concept map can be defined as a visual representation of networks that show what the students understand about web design knowledge and the relationships between the concepts (Nakhleh & Saglam, 2005; Novak & Cañas, 2006). This representation can be described as a two-dimensional node-link representation regarding a knowledge domain in which concepts or ideas are illustrated in nodes, and links between the nodes represent the relationships between the ideas. The links may be labeled or unlabeled and may include arrows to indicate the direction of the relationship (Novak, 1998).

Another potential of concept map concerns the acquisition of declarative and procedural web design knowledge. Concept maps have been widely used as content scaffolding that may support the students to construct a deep understanding of the content (van Drie & van Boxtel, 2003) and improve knowledge retention and understanding of higher level concepts (Hall, Ramsay, & Raven, 2004). In addition, they also enable the students to generate meaningful learning by stimulating prior knowledge and establishing the relationships between concepts (Boxtel, Linden, Roelofs, & Erkens, 2002; Kinchin, 2001; Liu, 2004) and engage them in visual learning that prompts creative thinking and deep understanding of the content (Williams, 2004), which in turn may lead to facilitation of the acquisition of web design knowledge.

There are a number of empirical studies that show the relation between concept maps and the students' acquisition of domain specific knowledge (e.g., class grades, standard tests, and teacher-made tests). For example, Boujaoude and Attieh (2003) examined the effect of concept maps on domain specific knowledge of chemistry. (60) Students from tenth grade from a co-educational private high school in Lebanon participated in this study. Concept maps in this study were used as homework tool. The students worked into two groups (a) experimental group, who was trained to use concept maps as study tools for achieving homework and (b) control group, who studied the same chemistry content with regular exercises assigned as homework. The study used pre-post chemistry achievement tests to measure domain-specific knowledge. The results showed that concept maps enabled the students to achieve high level scores in chemistry and there was a significance difference between the students on the questions especially at the knowledge and comprehension levels (Boujaoude & Attieh, 2003).

Another example that shows effect of concept maps on domain-specific knowledge is the study of Barenholz and Tamir (1992). In this study, the authors explored the effect of using concept mapping on design, instruction, and assessment related to microbiology lessons for high school (grade 10 and 11) students. The students worked in two groups (a) experimental condition, where the students studied the microbiology program with concept maps themselves as mappers, and (b) control conditions, where the students the same program with concept maps. The authors asked participants to choose 20 to 25 concepts as key concepts in microbiology and build concept maps summarize most important topics in the course. The results suggested that the students who used concept maps showed higher level domain-specific content knowledge than students in the control condition (Barenholz & Tamir, 1992).

The possibility of presenting web design knowledge in a hierarchical form is additional strength of concept map. For example in some maps, the most general concepts are located on the top of the map, followed hierarchically by more specific and detailed concepts below (Novak, 1995). Some other maps may have a different format, where the general concepts are centered in the maps and the subordinate concepts are presented hierarchically in a spider web format. In such forms, each concept may appear only once in the map, however, may be linked to a number of other concepts. In this way, concept maps can be used as a thinking tool that enables the students to draw connections between meanings, and relationships between concepts (van Drie & van Boxtel, 2003). In addition, cross-links are another essential characteristic of concept maps that demonstrate how the concepts link to each other, which in turn enables students to visually see how some represented domains of knowledge link to each other (Novak, 1995). Another important characteristic of concept maps is that they can be easily utilized in a variety of applications, such as increasing students' discussions on web design, identifying misconceptions or alternatives conceptions, and helping students to understand the constructed nature of web design knowledge. Through all these applications, concept maps enable the students to make sense of their own experiences and construct their own meanings from their experiences (Novak, 1998).

Using concept maps in collaborative context is a strength that characterizes concept maps that can be used by individuals, but when they are used in collaboration, even more theoretical and empirical advantages may be observed such as supporting the students in problem solving related to the design tasks. Concept maps as graphical external representations often suggested for supporting externalizing cognition (e.g., Cox, 1999) and cognitive processing in knowledge acquisition and problem solving in a variety of learning and instructional settings (Fischer & Mandl, 2001; O'Donnell, Dansereau, & Hall, 2002). Using visualization tools like concept maps can well organize design task-relevant knowledge and structures of ideas, information, and web design knowledge, which may in turn enhance the problem solving of complex design tasks (Tergan & Keller, 2005). Concept maps may keep the students focused on web design concepts in the content and organize them in a hierarchy of concepts, which may enable the students to understand and remember complex information and then abstract concepts and the relations in a more understandable manner (Armstrong, 2003; Romance & Vitale, 2001). In addition, during the design process, concept maps can reduce cognitive load and expand the students' capabilities regarding the limitation of capacity and duration of their working memory, which may allow the students to meet requirements of complex cognitive task (Cox & Brna, 1995; Larkin & Simon, 1987; Sweller, 1994).

For example, Leary (1993) conducted a study to investigate the effect of concept maps on chemistry achievement in concept learning, problem solving, and numerical problem solving among high school students. The study involved a sample of 77 high school students enrolled in chemistry. The participants worked in control condition, in which students learning in traditional way without concept maps and in experimental condition, where the students engaged in learning by using concept maps. The students were asked to drawn concept maps that summarize unite on stoichiometry. The students also received feedback on their concept maps by the teacher. The participants were assessed with respect to Piagetian reasoning ability, verbal, quantitative, and visual-spatial reasoning. The results showed that students who used concept mapping outperformed those in control group regarding learning chemistry concepts. In addition, significant relationship between concept learning and numerical problem-solving was found only for the students who used concept mapping (Leary, 1993).

Another strength of using concept maps in web design context is supporting the students' interaction and improving collaboration skills. Engaging the students in concept maps-based web design activities may allow students to talk more about web design concepts and lead to more elaborative discussions (van Boxtel et el., 2002). Those kind of activities can involve many students working together collaboratively in various web design activities (e.g., collecting keywords or completing missing concepts). This may aid students to critique and discuss their maps with others in the same group and abstract the content, which in turn may lead to develop the students' collaboration skills (Cicognani, 2000). In addition, working collaboratively on concept maps may lead to facilitate the interaction and discussions between the students about web design and lead to better understanding (Preszler, 2004). Along this line, Fischer and Mandl (2001) suggested that providing the students with shared graphical representation tools like concept maps can foster knowledge convergence between learning partners. Furthermore, studies of van Boxtel, van der Linden, and Kanselaar (2000) and Okebukola (1992), show that using concept maps collaboratively can support and increase students' interaction and meaningful discourse when compared to others without concept maps. In this way, concept maps can be used as scaffolds that may support the students to assimilate and better comprehend web design knowledge, solve complex design tasks, and improve students' collaboration skills.

For instance, van Boxtel and her colleagues (2000) conducted an experimental study to examine the effect of using concept mapping task on the quality of students' interaction and learning outcomes. Concept mapping was used to engage students in the learning process with the aim of improving their understanding of electricity concepts. The participants were 40 students working collaboratively in dyads on a task related to electricity. In the experiment, a comparison between student interaction while constructing a concept map and student interaction while constructing a poster was conducted. In the group with the concept maps, the students (10 dyads) were asked to build concept maps by using ten given electricity concepts (e.g., voltage and resistance), whereas in the poster group, the students (9 dyads) were asked to explain how an electric torch works by using the same ten concepts with the concept maps group). The interaction of all students was videotaped. Transcripts of the video recordings were analyzed according to specific communicative skills (statements, arguments, evaluations, questions etc.). The results of the study indicated that students in the concept maps condition engaged in more discussions about electricity concepts, collaboratively elaborated on conflicts and reasoning, although they did not reach higher level individual learning outcomes. Overall, concept maps evoked the students to talk more and in an elaborated way about electricity concepts while promoting knowledge co-construction (van Boxtel et al., 2000).

4.2.1. Incomplete concept maps

Concept maps can be provided to the students by experts or constructed by students themselves. The results of empirical studies indicate that the students benefit greatly when they generate their own maps (Novak & Gowin, 1984; Moor & Readence, 1984). However, there are many difficulties usually associated with students-generating maps, such as the complexity of the process of constructing concept maps, which often requires much time, and leads to students' frustration as well as some students dislike drawing concept maps (e.g., Barenholz & Tamir, 1992; McCagg & Dansereau, 1991; McKeachie, 1984; Schau & Mattern, 1997). To bridge the gap between potential problems associated with students-generating maps and achieving the advantages of engaging the students in generating concept maps, some researchers proposed an alternative technique "incomplete concept maps" that combines students' potential to address expert-generating maps and at the same time having them generate a map, since engaging the students partially in constructed concept maps may increase positive involvement of students in the discussions and learning (Wachter, 1993) as well as facilitating content comprehension and reducing the mental load associated with constructing maps (Chang et al., 2002).

Incomplete concept maps are also known as the fill-in-concept map. In this technique, the students are provided with an incomplete framework of an expert concept map structure of a particular domain as a scaffold in which some of the concepts and/or the linking words have been left out. Students are then asked to fill in the blanks to complete the framework as accurately as possible, according to the expert's specifications either by generating the words, called "generated-and-fill-in" (e.g., Schau et al., 1997; Surber, 1984) or by choosing from a provided list, called "Select-and-fill-in" (SAFI) (e.g., Schau et al., 1997; Schau, Mattern, Zeilik, Teague, & Weber, 2001). This technique can be described as a strategy that allows students to learn complex concepts and its relationships deeply with hints and prompts involved in the context (Zittle, 2001).

Using incomplete concept maps in face-to-face and online settings has a great potential for learning (e.g., Tsai, Lin, & Yuan, 2001; Vanides, Yin, Tomita, & Ruiz-Primo, 2005). Employing this scaffold may stimulate students to think more about concepts and relations in the content (Schau et al., 1997) and increase meaningful discussions for seeking missing information about the content, which may in turn lead to promote scientific inquiry through the different phases of the design process and positively affect learning outcomes (Baker, 2003; Suthers, & Hundhausen, 2003; Toth, Suthers, & Lesgold, 2002; Wehry, Monroe-Ossi, & Fountain, 2010). Furthermore, incomplete concept maps may be used as representational guidance through the students' discussions to guide them to find missing information in maps (Suthers & Hundhausen, 2003). With respect to the area of solving problems (e.g., design process) and sciences, supporting groups' discussions with incomplete concept maps may foster formulation or clarification of ideas (Lampert & Cobb, 2003); justifications, reflections and search for missing information (Brown & Palincsar, 1989) as well as recognition of problems, formulation of questions and co-construction of explanations (Alexopoulou & Driver, 1996; Chan, 2001). Therefore, incomplete concept maps are hypothesized to engage students in high level cognitive and metacognitive processes, enhance and increase the students' discussions about the content, and finally improve learning outcomes.

With respect to experimental studies that addressed incomplete concept maps, most of such studies focused primarily on using incomplete concept maps as assessment tools to measure the individuals' knowledge in computer-based incomplete concept maps (e.g., Akkaya, Karakırık, & Durmuş, 2005; Chang, Chen, & Sung, 2001) and face-to-face settings (e.g., Himangshu, 2010; Schau et al., 1997) as well as comparing incomplete concept maps with students-generated-maps (e.g., Ruiz-Primo, Schultz, Li, & Shavelson, 2001; Schau & Mattern, 1997; Schau et al., 1997).

For example, in a study by Ruiz-Primo and her colleagues (2001), they compared between filling in incomplete concept maps and constructing concept maps regarding students' knowledge structure. (152) Students from high school chemistry and two teachers participated. At the beginning, the students and teachers were trained to construct concept maps and incomplete concept maps themselves. Through the study, four 20-node incomplete concept maps were constructed. Two of them 12 nodes were left blank and in the other two incomplete concept maps 12 linking lines were left blank. The four incomplete concept maps are (A) incomplete concept map with sample 1 of nodes left blank, (B) incomplete concept map with sample 2 of nodes left blank, (C) incomplete concept map with sample 1 of linking lines left blank, and (D) incomplete concept map with sample 2 of linking lines left blank. The students were tested in three phases, which were (1) all students constructing concept maps by using 20 concepts provided by teacher, (2) half of students filling in incomplete concept maps A and half of students filling in incomplete concept maps B, (3) half of students filling in incomplete concept maps C and half of students filling in incomplete concept maps D. The most important results are filling in incomplete concept maps and constructing concept maps are almost similar regarding students' knowledge structure as well as engaging students in constructing concept maps reflects better differences among students' knowledge structure (Ruiz-Primo et al., 2001).

In sum, little is known regarding the effects of using incomplete concept maps in online learning environments on supporting the students through their investigations to learn specific content in a collaboratively way within groups in authentic learning contexts. Thus, investigating the effect of using incomplete concept maps collaboratively as content scaffolding through the CSCL context on domain-general and domain-specific knowledge is still needed. This study is an attempt to fill this gap and to study incomplete concept maps as external support in online learning settings for group collaboration.

4.2.2. Implementing incomplete concept maps in CSCL environment

Generally, learning content through DBL is conducted individually and through engaging the students in content-related discourse processes. As mentioned in chapter 3, content-related discourse processes often are not conducted in high level through CSCL environment without adequate scaffolding. Incomplete concept maps may be used as scaffolds to enhance content-related discourse processes in online settings to structure collaboration and increase the discussion with respect to the content (Nussbaum, Hartley, Sinatra, Reynolds, & Bendixen, 2004; Veerman, 2000).

Implementing incomplete concept maps to support online DBL is assumed to help students to engage in higher levels of discussions about web design and related concepts. In addition, incomplete concept maps are supposed to engage the students in meaningful argumentation and high level of declarative and procedural web design knowledge than traditional discussion where students address the content superficially. Therefore, suggested incomplete concept maps are supposed to embed in each single phase of learning process. Furthermore, each incomplete concept map should be designed carefully to stimulate students to increase their discussions about web design, address all concepts in the content, and encourage students to discuss all sections of each map.

Although van Boxtel and his colleagues (2000) reported that constructing concept maps did not enable the students to acquire higher level individual learning outcomes, but completing missing information in incomplete concept maps individually, as preparation prior to the content-related discussions may lead to create better quality argumentation and learning results (e.g., Baker, 2003; Suthers & Hundhausen, 2003; Toth, Suthers & Lesgold, 2002) and after that collaboratively as shared external representations through the content-related discourse processes in small groups. Through the individual phases of using incomplete concept maps, students are supposed to individually review concept maps, learning materials, and/or learning activities of each learning phase in an attempt to find missing concepts and relations in the maps as well as preparing related questions and queries for discussion during group discussions. According to theories and findings of Beck and McKeown (2001) on the Questioning the Author approach, the students may construct meaning on what they read to improve comprehension, which may in turn enable the students to work more positively with the course material in order to complete missing information as well as in the subsequent online discussions regarding their observations. Through collaborative phases of using incomplete concept maps, the students are supposed to discuss with their partners what they think about missing concepts and relations as well as related questions and queries. In addition, each incomplete concept map should involve both missing concepts and relationships in order to force the students to focus not only on one of the two. Concepts and relationships in each incomplete concept maps should be also classified into different levels (general, intermediate, and specific concepts) to encourage students to address all levels of concepts during their discussions. Furthermore, such concepts and relationships should be organized in related groups and each group has to involve missing information (concepts or/and relationships) from different levels to force students to discuss all sections of the content.

4.3. Fostering Web Design Skills by Collaboration Scripts and Incomplete Concept Maps

In educational research literature, there is no evidence that either collaboration scripts or incomplete concept maps were used before to foster web design skills. Therefore, this study is a first attempt to use and apply these two approaches in a new domain. Collaboration scripts and incomplete concept maps are expected to be promising scaffolds to foster web design skills. On the one hand, the collaboration scripts are supposed to increase interaction between the learners (Kollar et al., 2007) and engage them in high levels of inquiry-based discussions (Weinberger et al., 2005). This is in turn may lead to improve the quality of content-related discourse related to web design. Moreover, collaboration scripts are likely to enable the students to engage in higher levels of collaboration processes (e.g., Cohen, 1994) facilitate communicative-coordinative processes between students (Dillenbourg, 2002; Rummel & Spada, 2005), which finally may facilitate the acquisition of students' collaboration skills. Further, there is empirical evidence that collaboration scripts that were used for a short learning period are able to facilitate the acquisition of domain-specific knowledge (e.g., Diziol, Rummel, Spada & Mclaren, 2007; Weinberger et al., 2010). In this way, using collaboration scripts through online DBL over a long time may facilitate the acquisition of domain-specific knowledge and skills on web design. On the other hand, incomplete concept maps are expected to increase students' discussions about the content related to web design and encourage them to focus more on web design concepts, which in turn my affect positively the quality of content-related discourse on web design. Incomplete concept maps are also supposed to stimulate the students to seek and discuss missing information (Schau, et al., 1997) and enable the students to clearly present, discuss, and justify their web design ideas (e.g., Lampert & Cobb, 2003), which may improve their collaboration skills. In addition, incomplete concept maps are supposed to provide the students with conceptual support concerning content related to web design and enable the students to remember complex information (e.g., Tergan & Keller, 2005), which may in turn facilitate the acquisition of domain-specific knowledge and skills on web design.

4.4. Summary

A significant problem that is expected to be faced while moving DBL into a CSCL context is engaging the students in high level of collaboration and content-related discourse processes. Therefore, supporting the students with adequate social and content scaffolding during such processes is inevitable.

A computer-supported collaboration script is a promising social scaffold that is expected to improve collaboration and interaction between students during online DBL. Collaboration scripts have the ability to structure the learning activities between students (Kollar et al., 2006), facilitate communicative coordinative processes between learning partners (Dillenbourg, 2002), guide them through complex processes (Hoppe et al., 2000), and positively affect domain-general knowledge (e.g., Kollar et al., 2007; Stegmann et al., 2007) and in some cases domain-specific knowledge (e.g., Weinberger et al., 2005).

Many differences between collaboration scripts can be observed regarding, for example, settings (e.g., online learning and face-to face), objectives (e.g., domain-general and domain-specific knowledge, and cognitive and metacognitive objectives), and the amount and type of technology that can be used to support scripts. In this way, each collaboration script has its own characteristics that require identifying and structuring learning activities accurately in order to enable script to be effectively integrated with the learning context.

Prompt-based collaboration script is a type of collaboration scripts that is suggested for supporting online DBL. Such script involves specific prompts that may facilitate engaging the students in guided peer questioning (King, 1992). Using this type of scripts is assumed to enable students to focus only on what they have to discuss without any need to remember the roles and related web design activities as well as it is supposed to engage the students in high levels of inquiry processes, which may in turn facilitate the acquisition of domain-general knowledge on web design. With respect to implementing the prompt-based collaboration script in order to support online DBL, this chapter argued that adapting the interface of chat rooms could be the way for incorporating the collaboration scrip to support the students' discussions (e.g., Baker & Lund, 1997; Weinberger et al., 2005) through the design process.

Incomplete concept maps are content-oriented structuring tools that can be used as content scaffolding for online DBL. Such kind of concept maps can visualize and manage domain-specific knowledge on web design necessary for the design task (Tergan & Keller, 2005), increase and facilitate the discussions between students (Jacobson & Levin, 1995), and stimulate the students to think more about web design concepts and relations in the content (Schau et al., 1997).

Incomplete concept maps are in a way in the middle of concept maps that can be provided to students and concept maps that can be constructed by them, which may bring together the advantages of both options. Regarding implementing incomplete concept maps in online DBL environment, this chapter provides a vision of how incomplete concept maps should be designed and used to support content-related discourse processes on web design. For example, using incomplete concept maps individually before content-related discussions is required, since it is supposed to enable the students to prepare high quality argumentation, questions and queries for the discussion that is supposed to conduct after the preparation phase (Bull & Broady, 1997; van Boxtel et al., 2000). Moreover, through the content-related discussion, incomplete concept maps have to be used as shared external representations that encourage the students to focus on all sections, web design concepts, and relationships in the content.

Overall, this chapter suggests that computer-supported collaboration scripts can function as social scaffolding and incomplete concept maps as content scaffolding for supporting online DBL with the aim to engage students effectively in higher level collaborative and content-related discourse processes on web design, which may in turn enable them to acquire domain-general and domain-specific knowledge related to design and building websites. Beside examining the effects of these two types of scaffolds on the learning outcomes, this chapter also identified specific aspects that have not been widely investigated before, namely (a) effects of using computer-supported collaboration scripts to support collaboration processes for a longer learning period (several weeks), and (2) effects of using incomplete concept maps collaboratively through CSCL environment, which will be examined in this study.

5. Methodological Consequences for the Empirical Study and Research Questions

It has been argued that collaboration skills and leading a high-level content-related discourse are essential processes for developing web design skills through online DBL. These processes hardly lead to effective outcomes spontaneously, thus, they need to be supported. Therefore, in the study that follows, computer-supported collaboration scripts and incomplete concept maps are integrated in an online DBL environment and used as scaffolds for supporting these processes as well as individual learning outcomes. In this chapter, the conceptual framework of the study will be summarized with respect to collaboration and content-based discussions processes, outcomes, and facilitation of the acquisition of web design skills in an online DBL environment. Finally, the research questions of this study will be outlined.

5.1. Methodological Consequences for the Empirical Study

In this study, an online DBL environment was created to be used in a university course concerning design and building websites. A computer-supported collaboration script and incomplete concept maps as independent variables were used. Regarding the dependent variables, collaboration and content-related discourse processes, and quality of published websites were measured as collaborative learning outcomes as well as declarative and procedural knowledge related to the design and building websites, which were measured as individual learning outcomes. Following, a framework including control variables, dependent variables, and independent variables will be conceptualized.

Based on the theoretical background, the collaboration skills and content-related discourse processes are expected to widely affect the acquisition of web design skills through online DBL environment. Supporting such processes through the design activities may enable students to engage in them through other unstructured situations. Therefore, such processes are likely to be apparent and well accessible through the collaborative students' discussions.

However, processes of collaboration skills and content-related discourse are expected to be influenced by a number of *context factors* in online DBL (learning task, environmental organization, learning structure, individual learning prerequisites, the computer-supported collaboration script, and incomplete concept maps). Regarding environmental organization and learning task, the students will participate in the same learning environment, same context organization, and same design task. Therefore, the experimental conditions are expected to be similar and comparable to standard conditions of students within the natural variance. With respect to individual learning prerequisites, this factor will be assessed and tested regarding declarative and procedural knowledge related to the design and building of websites. The students are assigned to dyads and conditions based on their pre-web design knowledge and skills, in a manner to guarantee equivalence between all conditions. Thus, all context factors except the computer-supported collaboration script and incomplete concept maps are held constant between the experimental conditions.

Collaboration and *content-related discourse* processes have been identified as essential aspects of the development of web design skills through online DBL. With respect to *collaboration process*, the social activities identify the different activities and roles based on interaction-related prompts that students participate in during their collaborative discussions as well as defining how each student interacts with his/her partner through the small group discussions. In the framework of this study, the *collaboration skills* include asking high level questions, giving high level answers, and giving high level reactions to answers (accepting answers with comments or refusing answers with justifications). *Content-related discourse* process points towards discussing and using the concepts and relationships that exist in the contents students deal with. These content-related activities are supposed to engage the students collaboratively in discussions and constructing knowledge, which in turn may facilitate the acquisition of domain-general and domain-specific knowledge related to the design and building of websites. In the framework of this study, the *content-related discourse quality* points towards used web design concepts which are realized through the students' unstructured discussion.

Regarding how the two kinds of instructional support affect the expected outcomes, computer-supported collaboration script and incomplete concept maps will be applied through the students' discussions that will be conducted in chat rooms embedded in online DBL environment. Collaboration script specifies sequences and distributes learning activities and roles among learners through their discussions. The computer-supported collaboration script will be based on King's (1999) script approach that can be implemented in online CSCL environments. Incomplete concept maps may provide visual representations that graphically reflect relations between concepts. The concept maps will be provided in the form of incomplete maps that involve missing concepts and relationships, which in turn are likely to evoke students' discussions about this missing information in the content. Combination between the collaboration script and incomplete concept maps may facilitate the interaction and collaboration between the students as well as enabling the students to focus more on learning the content. Therefore, supporting the students' design-based discussions with social and content scaffolds is expected to increase students' discussions and engage them in higher level discourse processes on website design concepts. In this way, collaboration script and incomplete concept maps may facilitate processes and outcomes of design and building websites.

The *outcomes* of the current study include both collaborative learning outcomes that are observable in the students' discourses and products (published websites) as well as individual learning outcomes, namely, knowledge and skills related to the design and building websites. Several types and qualities of outcomes can be distinguished. In the context of collaborative knowledge construction, different kinds of applicable knowledge can be distinguished as learning outcomes. The number of used web design concepts during an unstructured chat discussion that is conducted after the treatment (i.e. which will be conducted without collaboration script and incomplete concept maps) will be used as indicator for the first collaborative learning outcome, which is *content-related discourse quality*. The ability to apply different kinds of high-level questions, answers, and reactions to answers that can be observed in the unstructured chat discussion after the treatment has ended will be used as a second type of collaborative knowledge construction that indicates the *collaboration skills* students have acquired over the course of the study. Finally, the ability to publish websites collaboratively according to the constructive standards for designing websites students are supposed to learn through a set of online tutorial lessons on web design knowledge that is presented in the online DBL environment will be used to indicate the *quality of the published websites*, which are the fourth type of collaborative learning outcomes.

Individual learning outcomes are the *individuals' declarative and procedural knowledge* on web design that are measured by factual knowledge test and application-oriented knowledge test. The ability to answer multiple choice questions directed towards the functionalities of FrontPage software that the students had to use for designing and building their websites and the constructivist standards of design and building websites will be used to indicate the students' learning of *factual knowledge* related to design and building websites. In addition, the ability to practice and demonstrate specific web design skills (e.g., changing text font, adding frames to the web page, and inserting flash files) by using FrontPage software will be used to indicate the individual acquisition of *web deign skills*.

5.2. Research Questions

Based on the theoretical background of design and building websites as well as findings on social and content scaffolding, collaboration script and incomplete concept maps will be investigated in order to identify how the acquisition of web design skills of university students in online DBL environment can be facilitated. Therefore, several research questions can be formulated. First, effects of collaboration script and incomplete concept maps as well as their combination on *collaborative learning outcomes* shown in a subsequent collaborative transfer task will be examined. Second, effects of collaboration script and incomplete concept maps as well as their combination on *individual learning outcomes* will be studied.

Facilitating collaborative learning outcomes by collaboration scripts and incomplete concept maps

In this section, research questions that examine effects of collaboration script and incomplete concept maps on collaborative learning outcomes (content-related discourse quality, collaboration skills, and quality of published websites) will be presented.

First research question: Improving content-related discourse quality by collaboration scripts and incomplete concept maps

The first research question investigates the effects of collaboration script and incomplete concept maps as well as their combination on the content-related discourse quality shown in an unstructured chat session students engage in after the treatment.

RQ) To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *content-related discourse quality* shown in a subsequent collaborative transfer task in online DBL environments?

There are indications that collaboration scripts are able to engage the students in high level of argumentative discourse (Weinberger et al., 2005) and increase the interaction between the learning partners (Kollar et al., 2007), which in turn may engage them in higher level discourse processes about the content and improve the content-related discourse quality in an online DBL environment. In addition, incomplete concept maps should increase discourse about content by focusing students on discussing concepts and their relationships, and enable the students to understand and remember complex information and abstract concept relationships (Armstrong, 2003; Cox & Brna, 1995; Fischer, Bruhn, Gräsel & Mandl, 2002). Therefore, incomplete concept maps are expected to increase students' discussions about content and thus may lead to improve the content-related discourse quality. In general, the combination between the independent variables is expected to foster and facilitate higher level discourse processes on web design concepts and its relationships as well as increasing their content-related discussions.

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *content-related discourse quality* in their final unstructured chats than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *content-related discourse quality* in their final unstructured chats than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher *content-related discourse quality* in their final unstructured chats compared to all other three conditions.

Second research question: Facilitating collaboration skills by collaboration scripts and incomplete concept maps

The second research question examines the effects of collaboration script and incomplete concept maps on the collaboration skills student exhibit in a chat discussion after the end of the treatment.

RQ) To what extent do a collaboration script and incomplete concept maps as well as their combination affect *the collaboration skills* shown in a subsequent collaborative transfer task in online DBL environments?

The collaboration script is supposed to enable the students to engage in higher-level of collaboration processes (e.g., Cohen, 1994), which are expected to encourage them to ask more questions, searching and giving answers, evaluating answers and engaging in discussions about the content. Furthermore, the collaboration script has the ability to facilitate communicative-coordinative processes between students (Dillenbourg, 2002; Rummel & Spada, 2005), which may enable the students to interact and conduct high levels of such processes easily, which at the end may lead to facilitate the acquisition of collaboration skills. In addition, using incomplete concept maps may stimulate the students to think more about the contents, which is likely to foster them to engage in high levels of asking more content-related questions, giving answers, and evaluating the partner's answer then giving appropriate reactions. Moreover, incomplete concept maps may enable the students to clearly express, clarify, and justify their ideas, which may facilitate and increase their discussions (Brown & Palincsar, 1989; Lampert & Cobb, 2003). Since incomplete concept maps involve missing concepts makes one expect to stimulate the students to ask more content-related questions and search the missing information and discuss that information. Therefore, the combination between collaboration script and incomplete concept maps may develop the students' collaboration skills more than implementing one of both individually.

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *collaboration skills* in their final unstructured chats than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *collaboration skills* in their final unstructured chats than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher *collaboration skills* in their final unstructured chats compared to all other three conditions.

Third research question: Improving quality of published websites by collaboration scripts and incomplete concept maps

Finally, the third research question related to collaborative learning outcomes examines the effects of collaboration script and incomplete concept maps, as well as their combination, on the quality of products in terms of websites that are collaboratively designed, built, modified, and published by the students.

RQ) To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *quality of published websites* in an online DBL environment?

There is no clear empirical evidence indicating positive effects of using either collaboration script or incomplete concept maps individually on the quality of collaborative products produced as a result of online discussions between participants. However, it is expected that using collaboration scripts and incomplete concept maps together may facilitate and increase the students' discussions regarding planning, building, evaluating, and modifying their websites (Brown & Palincsar, 1989; Cohen, 1994; Lampert & Cobb, 2003). In addition, it is likely that the combination of both treatments may develop the students' knowledge and skills related to design and building websites as well as using the constructive standards of building websites, which may in turn enable them to construct and publish high quality websites.

Hypothesis 1: Students who had been provided with a collaboration script during treatment will not be able to improve the *quality of published websites* in an online DBL environment compared to students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will not be able to improve the *quality of published websites* in an online DBL environment compared to students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will be able to improve the *quality of published websites* in an online DBL environment compared to all other three conditions.

Facilitating individual learning outcomes by collaboration scripts and incomplete concept maps

In this section, research questions relate to the effects of collaboration scripts and incomplete concept maps on individual learning outcomes (declarative/factual knowledge and procedural knowledge/skills on web design).

Fourth research question: Facilitating the acquisition of domain-specific knowledge by collaboration scripts and incomplete concept maps

The fourth research question of this study examines the effects of collaboration scripts and incomplete concept maps on the factual knowledge related to design and building websites.

RQ) To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *acquisition of domain-specific knowledge* related to the design and building of websites in an online DBL environment?

Empirical findings point out that collaboration scripts can engage students in high level online discussions (Schoonenboom, 2008; Stegmann et al., 2007; Weinberger et al., 2007; Weinberger et al., 2010) as well as facilitating communicative and coordinative processes between students (Dillenbourg, 2002). Moreover, there is other empirical evidence showing that collaboration script has the ability to facilitate the acquisition of domain-specific knowledge (e.g., Diziol, Rummel, Spada & Mclaren, 2007; Weinberger et al., 2010). With respect to incomplete concept maps, there are indications that incomplete concept maps provide conceptual support concerning the domain specific content as well as increase and facilitate the discussions between students about the content, which may in turn improve the students understanding and remember complex information (Jacobson & Levin, 1995; Tergan & Keller, 2005). Therefore, the combination between the collaboration script and incomplete concept maps is expected to lead to a deeper elaboration of the content and thus, acquisition of factual knowledge related to design and building websites.

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *domain-specific knowledge* in an online design-based learning than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *domain-specific knowledge* in an online design-based learning than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher *domain-specific knowledge* in an online design-based learning compared to all other three conditions.

Fifth research question: Facilitating the acquisition of domain-specific skills by collaboration scripts and incomplete concept maps

The fifth research question examines the effects of the collaboration script and incomplete concept maps as well as their combination on web design skills that are related to design and building websites.

RQ) To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *acquisition of domain-specific skills* related to the design and building of websites in an online DBL environment?

Built on what has been argued regarding the acquisition of domain-specific knowledge, factual knowledge can be proceduralized and turned into skills (Anderson, 1982). Therefore, the expected factual knowledge is likely to at least partially be transformed into skills, which may in turn develop their skills related to design and building websites.

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *domain-specific skills* in an online design-based learning than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *domain-specific skills* in an online design-based learning than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher *domain-specific skills* in an online design-based learning compared to all other three conditions.

All research questions and hypotheses that have been mentioned in this chapter have been investigated and tested in a quasi-experimental field study. The method of this study is described in the following chapter.

6. Methods of the Empirical Study

The research questions and hypotheses were analyzed in a quasi-experimental field study where the impact of the treatments on learning outcomes was investigated in four experimental conditions. In this chapter, the sample and the design, the experimental learning environment, and the variables will be reported. Apart from this, the employed statistical procedures and methods of case studies will be presented.

6.1. Sample and Design

100 students from the Educational Technology Department of Tanta University (Egypt) from grade 3 and 4 from the Faculty of Specific Education participated in the study in the winter term of 2009. 15 participants were male, and 85 participants were female (M_{Age} = 20.00, *SD* = .71). The students participated in this study as a preparation for a mandatory web design course in which they were supposed to participate in the following summer term (for grade 4) and in the next year (for grade 3). All participants used Arabic as their first language (see table 6.1a).

Table 6.1a: *Demographic data of the participants in the four experimental conditions*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
Gender				
• Female	16	21	19	29
• Male	4	3	5	3
Age	*M* = 19.85 (*SD* = .81)	*M* = 19.92 (*SD* = .72)	*M* = 19.92 (*SD* = .65)	*M* = 20.22 (*SD* = .66)
First language				
• Arabic	20	24	24	32

To investigate the research questions described in chapter 5, a 2x2-factorial design with the independent factors “collaboration script” (without vs. with) and “incomplete concept maps” (without vs. with) was established. The students were randomly assigned to dyads and each dyad was randomly assigned to one of the four experimental conditions (see table 6.1b).

Table 6.1b: *2x2-factorial design of the empirical study*

		Collaboration Script	
		Without	**With**
Incomplete Concept Map	**Without**	N= 20 (10 dyads)	N= 24 (12 dyads)
	With	N= 24 (12 dyads)	N= 32 (16 dyads)

6.2. Online Design-based Learning Environment

The students participated in an Arabic online design-based learning (DBL) environment, which was inspired by the LBD approach (Kolodner, 2002), with the aim to design, build and publish tourist websites about Egypt by the aid of the software "FrontPage" as a design task. The online DBL environment was established via "Moodle 1.9.10", which is an open source course management system (CMS). The online DBL environment was accessible via the World Wide Web and built on standard html-web-pages. This section illustrates the different aspects of the online DBL environment and the experimental phases.

After logging in, the students were directed to a start page to welcome and give them an initial description about the structure of learning environment that they would use throughout the course. After that the students were able to access the interface of the online DBL environment. In the following paragraphs, the interface will be presented first; next, the structure of the online DBL environment will be addressed in details.

6.2.1. The interface

The learning environment interface had a rather simple design to enable the students to use and interact with each section easily (see figure 6.2.1). In the middle section of the interface, a short introduction about the course (design websites) and learning method (collaborative learning) that students had to follow through the course was presented, followed by a link to enable the student to login to the DBL environment. The link to the course appeared only after the student entered his/her correct username and password in the login block. In the right-hand and left-hand side of the interface eight blocks (four in each side) were located to provide information (e.g., date and time), security (e.g., login to the course), and/or learning services (e.g., needed software and translation) to the students. (1) *The interface tutorial block* included a video file explaining the function of each component as well as showed how the students could reach the learning environment and dealt with each single block and section in the learning environment interface. (2) *Login block* allows the student to login the online learning environment. After the student enters his/her username and password correctly, the login block disappears and the student gets the course's link. (3) *Software block* involved specific software was needed to the students before and during the course, such as "Firefox 2.0", which is the only browser that allows the collaboration script to work correctly (see section 6.4.2) and "FrontPage 2003" software that the students had to use for designing and building their websites. (4) The *online users block* shows the teacher and a list of students who have been logged into the course. This block was devoted to provide quick technical support to the students by exchanging private messages between the teacher and the students. (5) It was important to remind the students with the events of the course and groups as well as enabling each single student to create personal events during the course. Therefore, the learning environment interface was supported with a *calendar block*. (6) Using *the clock block* was useful for knowing the current time as well as to make sure that students were on time and no-one miss out on activities due to slow or fast watches. (7) Because the first language of the students was Arabic, it was necessary to support the students in all conditions with the *translator Google block* to enable them to translate difficult and vague foreign words to their language. (8) *The notes block* was customized to provide important information to the students, such as the best screen resolution fit the learning environment and important dates for the students. All eight blocks were fixed and available throughout the course period.

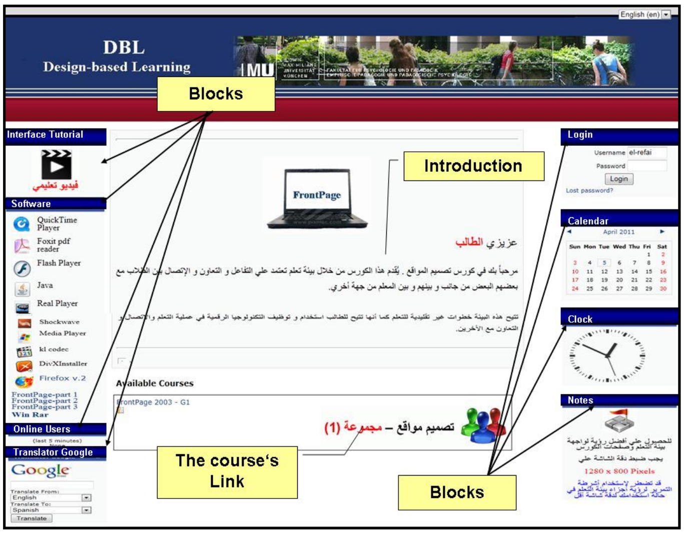

Figure 6.2.1: Screenshot of the learning environment interface

6.2.2. Structure of the online DBL environment

After clicking on the course link at the interface, students were directed to the online DBL environment, which was divided into three sections (see figure 6.2.2): (1) Tutorial videos, (2) course instructions and learning phases, and (3) communication tools. All three sections of the online DBL environment will be introduced in the following sections.

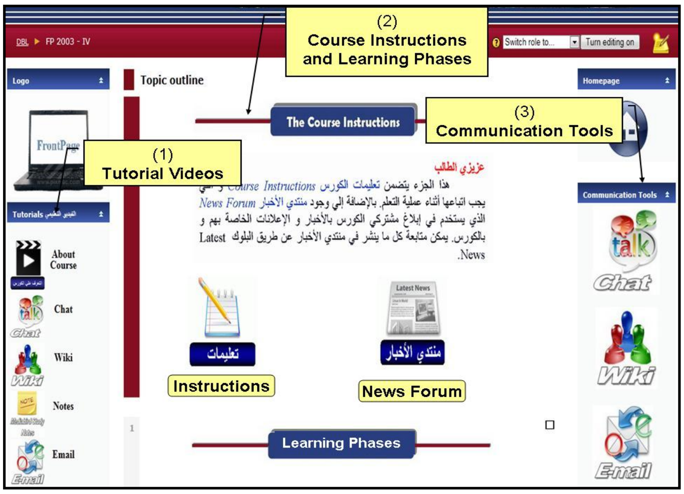

Figure 6.2.2: Screenshot of the online DBL environment

6.2.2.1. Tutorial videos

The left part of the screen included a set of tutorial videos about how to use the DBL environment and the communication tools (chat, Wiki, and e-mail) effectively. For example, the "About course" video described and explained the function of each component in the DBL environment and the "Chat" video showed the instructions and steps that the students had to follow during the chat session. The tutorial videos and lessons were built by using "Adobe Captivate 3" software.

6.2.2.2. Course instructions and learning phases

The middle section of the DBL environment involved two sub-sections: (1) *the course instructions section* involved general course instructions that the students had to follow during the course, such as "user account is secret and should not be shared with anyone". In addition, there was a news forum that could be used by the teacher to inform the participants with news and general announcements related to the course. (2) *Learning phases* section that was divided into seven sub-sections (one section for each learning phase), which in accordance with the course schedule appeared in a sequential order. Each learning phase consisted of (a) an *introduction* describing the learning phase and its goal that the students had to achieve before moving to the next phase and (b) links to the *learning materials* that the students had to use during the learning phase, such as Arabic and English resources, tutorial lessons, and standards for designing websites. Additional two links were found consistently in all learning phases (c) *instructions* for what the students had to follow during each learning phase. For example in learning content phase, "you have to write down all questions and notes that come up to your mind during learning lessons to share and discuss them with others through the Wiki session", and (d) the *tutorial video* to show the students how they can use each learning phase effectively (see figure 6.2.2.2).

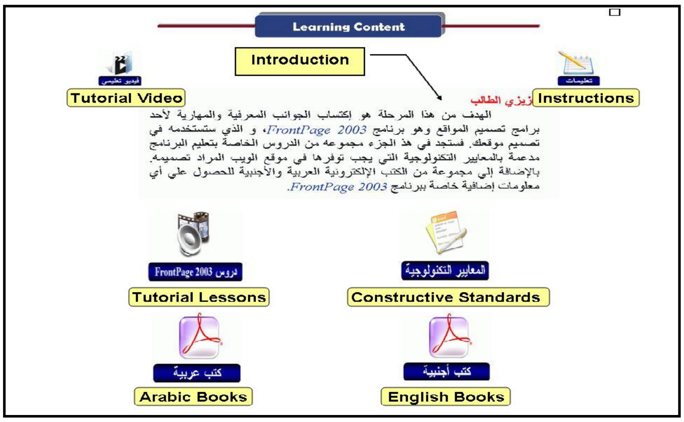

Figure 6.2.2.2: Screenshot of the content learning phase

6.2.2.3. Communication tools

Since the course was realized completely online and the students were not physically present in any case,, three communication tools (i.e., Chat rooms, Wiki pages, and email) were located in the right section of the DBL environment. Each dyad had a private chat room for conducting small-group discussions which were enhanced by either a collaboration script, an incomplete concept map, both, or none of the two. As pre-procedures of each chat session, the teacher had to make sure that each dyad was online on time before starting the chat session and that the duration of each chat session is equally set for all dyads. Therefore, the chat rooms were only available for discussion after teacher confirmation that each dyad appeared in the online users block and received confirmation messages from them that they are ready to start their discussion. Subsequently, the teacher had to adjust the chat room settings to be available for 90 min. In addition, each dyad had a private wiki page to receive comments, questions, and answers from other groups during the sessions. The duration of each Wiki session was one day. Through this time, each dyad was allowed to evaluate only the group, which was assigned to them before the session by the teacher. Moreover, the students had to use their email accounts to send messages and files to each other and/or teacher.

6.3. Experimental Phases

The experiment extended over seven phases (see table 6.3). (1) The *introduction and pre-tests* phase started by conducting face-to-face (FTF) session between the teacher (the researcher) and all participants for introducing the experiment and its details to the students. Next, the participants completed pre-tests on (a) factual knowledge about FrontPage software and standards for designing websites, and on (b) application oriented knowledge to assess their web design skills (see section 6.3.1). (2) During the *task presentation and exploration of already existing websites* phase, the design task was provided to the students, a set of existing website examples were explored by the individual students, and discussions about the websites examples were conducted first through the small groups' sessions by chat and then through an inter-group discussion by Wiki (see section 6.3.2). (3) Through the *online tutorials on web design knowledge and skills* phase, nine online tutorial lessons about FrontPage software and standards for designing websites (see appendix D) were presented to the students to first learn individually and after that to discuss them in small groups' discussions by chat and a final inter-group discussion by Wiki (see section 6.3.3). (4) In the *planning and discussing the setup of the websites* phase, each dyad had to develop a plan for their website individually and then had to discuss it in chat rooms. Furthermore, through the inter-group discussion in Wiki pages, their plan was evaluated from one other group (see section 6.3.4). (5) Through the *building and publishing the websites* phase, each dyad built two websites and then through their discussion during the small groups' session, they decided the superior one for publishing. In Wiki pages, where the inter-group discussion was conducted; each dyad had the chance to get feedback on their published website from others (see section 6.3.5). (6) In the *redesigning, rebuilding, or/and republishing the websites* phase, the students had only one opportunity to modify, rebuild, and republish their website. In this phase, the small groups' discussions were conducted in chat rooms without any treatment.

Evaluating published websites and giving feedback were provided in Wiki pages through the inter-group session (see section 6.3.6). (7) Finally in the *post-tests and debriefing* phase, the students conducted individual post-tests which were in parallel to the individual pre-tests (see section 6.3.7). In the following paragraphs, the experimental phases will be outlined in more detail.

Table 6.3: *Overview of the experimental phases*

	Phase	Day(s)	Duration	Social Plane
1.	**Introduction and pre-tests**	**3**		
	• Introductory explanations and discussion with participants.	1	30 min	Plenary session (Teacher and all Participants – FTF)
	• Pre-test of domain-specific knowledge.	1	60 min	Individually
	• Pre-test of domain-specific skills.	1	90 min	Individually
2.	**Task presentation and exploration of already existing websites**	**3**		
	• Providing the design task to the students. • Exploration of existing tourist websites examples.	1	1 day	Individually
	• Small groups' discussions about tourist websites examples (chat).	1	90 min	Dyads
	• Inter-group discussion about tourist websites examples (Wikis).	1	1 day	Inter-group session
3.	**Online tutorials on web design knowledge and skills**	**19**		
	• Nine online tutorials lessons. Each lesson involved…	18		
	- Working through the lesson	1	1 day	Individually
	- Small groups' discussions about each lesson (chat).	1	90 min	Dyads
	• Inter-group discussion about all lessons together (Wikis).	1	1 day	Inter-group session
4.	**Planning and discussing the setup of the websites**	**3**		
	• Planning the websites.	1	1 day	Individually
	• Small groups' discussions for identifying a plan for the website (chat).	1	90 min	Dyads
	• Inter-group discussion for evaluating the websites' plans (Wikis).	1	1 day	Inter-group session
5.	**Building and publishing the websites.**	**6**		
	• Building and publishing the website.	4	4 days	Individually

	Phase	Day(s)	Duration	Social Plane
	• Small groups' discussions about the published websites (chat)	1	90 min	Dyads
	• Inter-group discussion for evaluating the published websites (Wikis).	1	1 day	Inter-group session
6.	**Redesigning, rebuilding, or/and republishing the websites.**	**4**		
	• Improving and republishing the websites.	2	2 days	Individually
	• Small groups' discussions about the modified websites (chat)	1	90 min	Dyads
	• Inter-group discussion for evaluating the modified websites (Wikis).	1	1 day	Inter-group session
7.	**Post-tests and debriefing**	2		
	• Post-test of domain-specific knowledge.	1	60 min	Individually
	• Post-test of domain-specific skills.		90 min	Individually
	• Debriefing.	1	15 min	Plenary session (Teacher and all Participants – FTF)
	Total	**40**		

6.3.1. Introduction and pre-tests

The first phase was i*ntroduction and pre tests*, which was conducted in three days. In the first day, the teacher met all participants in face-to-face (FTF) session in order to introduce the experiment and to respond to any questions and/or inquiries concerning the experiment from the participants. Students were told that their learning processes would be analyzed in order to study their collaborative learning processes with new media and find possible points for improvement for web-based learning environments that can be used at the university level. Furthermore, the goals of the study were introduced to the university students. These goals were to experience different types of scaffolds to support the students through their virtual learning with new media, and to learn how to design, build, and publish websites by the aid of the software "FrontPage" according to specific research-based standards for design and building websites by collaborating with one learning partner through the small group discussions and with other learning partners through group sessions. After that, the teacher gave a presentation to introduce the online DBL environment and its components to the students. The students were informed concerning the duration of each phase and were provided with their own usernames and passwords for the learning environment. In the second day, the participants completed a pre-test (multiple choice test) individually on factual knowledge about FrontPage software and standards for designing websites. The duration of such test was 60 minutes. Only ten participants completed the whole pre factual knowledge test. The third day of this phase was devoted to conduct a pre-test individually on application oriented knowledge to assess web design skills of the participants. The time of the test was 90 minutes, which was completed only by seven students. The pre-tests were conducted in the labs of the faculty of specific education – Tanta University to measure individuals' domain-specific knowledge and domain-specific skills about FrontPage software (see section 6.5.2).

6.3.2. Task presentation and exploration of already existing websites

The task presentation and exploration of already existing websites phase was being conducted online for three days. In the course instructions and learning phases section (see section 6.2.1.2), the students found a sub-section that was devoted for this phase. In this section, the participants could obtain information on all needed details regarding the phase's procedures, how they had to carry out each procedure, and the specific time for each procedure by clicking the instruction's link that was located in the right side of that sub-section as well as by watching the tutorial video of such phase that was found in the left side. The learning materials of this phase included a specific link to the design task, where the students were supposed to find all details about the task that they had to achieve at the end of the course. The design task was limited to specific conditions, for example (1) the students should only use the components of that website (e.g., text, pictures, layers, sounds, etc.), that they had to learn about through the course and (2) the websites had to be designed according to specific research-based standards for designing websites, which the students received through the third phase of the experimental phases. Also, in the learning materials, the students found some selected websites examples, which were classified according to the research-based standards for designing websites. Such examples were varied between good and poor websites as well as between Arabic and English websites. Each website example included: (a) the title of the website, which was presented as a clickable link to the website, and (b) a short description of the website. Through the first day of this phase, the students had to work individually in labs and/or at home to know the phase's procedures and instructions as well as to explore the website examples. Furthermore, they had to write down their notes about each website either in the Note block, which was embedded in the learning environment or on a sheet of paper. Through the second day of such phase, each dyad had to discuss the website examples from different aspects (e.g., advantages and disadvantages, identified the best and worst websites and justified the selection) through the small group discussion by chat for 90 minutes. Moreover, each dyad had to complete their own wiki page before the inter-group discussion by writing the results of their discussion (e.g., notes, questions, facts, personal conclusions, etc). In the last day of this phase and before the inter-group discussion, the teacher sent an announcement in the news forum to inform the dyads with other small groups that they had to evaluate in the same condition. Each dyad was assigned to evaluate only one other group's Wiki page, but it was allowed to the students to visit other Wiki pages without providing any evaluation. Thus, during the inter-group discussion, each dyad received feedback from one other group in their Wiki page and also evaluated and provided feedback to one other group.

6.3.3. Online tutorials on web design knowledge and skills

The *online tutorials on web design knowledge and skills* phase was devoted to provide the students with essential knowledge and skills about "FrontPage" software that were required for designing and building websites according to research-based standards for designing websites. This phase was completely conducted online through 19 days. Nine online tutorial lessons about "FrontPage" software and specific research-based constructive standards for designing websites (see appendix D), which in accordance with the course schedule appeared in a sequential order within the learning materials of this phase, were provided to the students. The standards for designing websites were distributed to the lessons according to how they relate to each lesson. For example, lesson 4 "Multimedia" involved standards about using pictures and images (e.g., images should display at 100% with photo format as JPEG), videos (e.g., avoid to present two or more videos files at the same time on the same web page), and sounds (e.g., the user should have the possibility to stop or adjust the background sound of the website). First of all, the two permanent links (the instructions and tutorial video), that were embedded in each learning phase, provided the students with all details about that phase (e.g., learning goals, procedures, how the participants had to perform each procedure, and duration of each procedure). Two days were identified to complete each tutorial lesson either in labs or at home. In the first day, the students had to work individually through the lesson. The time of studying the tutorial lessons was unlimited; it was allowed to the students to watch each tutorial lesson at any time and for any number of times until the beginning of the next chat session. The second day was devoted for conducting discussions between dyads by chat for 90 minutes about the lesson. Next, each dyad had to write down their comments, notes, and questions about the lesson in their Wiki page. The inter-group discussion was conducted only one time at the end of this phase. Each dyad evaluated the group they were assigned on that group's Wiki page and received feedback from one specific group on their own Wiki page.

The tutorial lessons were about: (1) dealing with FrontPage 2003, (2) formatting web pages, (3) text and tables, (4) multimedia, (5) layers, (6) hyperlinks, (7) frames, (8) adding effects to web pages, and (9) managing and publishing websites. "Adobe Captivate 3" software was used to build the tutorial lessons. Each tutorial lesson consisted of three components: (a) topics section, (b) display area, and (c) control bar (see figure 6.3.3).

(a) Topics section

In the left hand side of the lesson screen, the lesson's topics were available (see figure 6.3.3). The topics in each lesson varied between the goals that the students had to achieve at the end of the lesson, FrontPage topics that involved the knowledge and skills the students had to acquire through the lesson, and the standards of designing websites related to the lesson.

(b) Display area

The display area was allocated on the right hand of the lesson screen. This area was devoted to present the tutorial video about the selected topic from the topics section (see figure 6.3.3). Each topic was presented and supported in the display area by sound explanation, video tutorial, and illustration bubbles (illustrate every mouse clicks in the display area).

(c) Control bar

Each lesson had a control bar as a part of the lesson screen, which allowed the students to manipulate and control the lesson, such as replay, play/pause, back, forward, and turn sound on/off to enable the student to interact with the lesson easily (see figure 6.3.3).

6.3.4. Planning and discussing the setup of the websites

The fourth learning phase is the *planning and discussing the setup of the websites*, which took place in three days. As usual, all needed details about this learning phase (e.g., goals, procedure and duration of this phase) were available by the two links (instructions and tutorial video) that were located in the sub-section of this phase. In the first day, the students worked individually to plan their sites. Each student had to put one suggested plan for his/her own website and to send it to his/her learning partner by email before the small group discussion. The plans were discussed and evaluated from each dyad during a small group chat discussion for 90 minutes in the second day of this phase. Each dyad had to suggest only one plan for their websites. Before, the inter-group discussion, the teacher informed each dyad with the group that they had to evaluate their plan by sending an announcement for each condition in the news forum. Next, each dyad was supposed to send their plan - in the form of word file - to the group that was assigned to evaluate them through the inter-group session. Finally, it was available to the student to conduct the inter-group session in Wiki pages through the last day of this phase.

6.3.5. Building and publishing the websites

Through the fifth phase (*the building and publishing the websites*), the participants worked online for six days to construct and publish their initial websites. First of all, the teacher asked the students to visit the two links of the instructions and tutorial video that were devoted to this phase in order to know all details about the current phase (e.g., goals, procedures, and duration of the phase and each procedure). Through the first four days of this phase, each student had to build and publish his/her website individually according to the proposed plan that each dyad suggested in the "Planning and discussing the setup of the websites" phase. After publishing the websites, each student had to send the URL of his/her website to his/her learning partner by email before the dyadic chat discussion. In the fifth day, each dyad conducted a chat discussion for 90 minutes to evaluate the two websites and chose the better one to be the official website for the group. Through the news forum, the teacher informed each dyad with the group that was responsible to evaluate their suggested website. In the last day of this phase, each dyad had a chance to receive feedback about their website from one other group in their Wiki page through the inter-group discussion.

6.3.6. Redesigning, rebuilding, or/and republishing the websites

The goal of the *redesigning, rebuilding, or/and republishing the websites* phase was to enable the participants to improve their products (plans and websites) according to the feedback that they had received from one other group and from visiting and reading the comments in other wiki pages. This phase was conducted online through four days. At the beginning, the teacher asked the participants to visit the links of the instructions and tutorial video that were prepared and embedded in the sub-section of this phase to inform the students with all needed details about what they had to do in this phase. Through the first two days, each student modified the plan and/or website as well as republished the website individually and then sent the URL of his/her published website to his/her learning partner. In the third day, each dyad conducted an unstructured chat discussion about the two modified websites and selected the superior one for republishing as the official website for the group. The discussions in these final unstructured chat sessions were used as the basis for the post-test measures of collaborative learning outcomes that are described in section 6.5.1. Next, the teacher informed each dyad in all conditions with the other group being supposed to evaluate their modified website. After that, each dyad sent the URL of their published website to the group that was responsible for evaluating their website by email. Finally, the inter-group discussion was conducted in Wiki pages for evaluating published websites after modification.

6.3.7. Post-tests and debriefing

After redesigning, rebuilding, and republishing the websites, the participants were asked to individually perform two post-tests in two days (one day for each test), which measured individuals' domain-specific knowledge and domain-specific skills concerning web design by aid of FrontPage software. The post-tests were equivalent to the pre-tests and were conducted in the labs of the faculty of specific education – Tanta University (see section 6.5.2). Finally, a debriefing FTF interview was conducted between the teacher and all the participants, the students were asked to write a short report about their experiences, impression about the experiment, problems and difficulties that they faced during the course, and suggestions for next courses. The data were collected just for improving future courses and studies related to the online DBL that are expected to conduct in the same settings, but such data have not been used during this study.

6.4. Experimental Conditions

The treatment was realized in the dyadic phases to support the small group discussions and varied between the conditions according to the experimental design. In this section, the four experimental conditions of the 2×2-design will be described. In this context, the computer-supported collaboration script and incomplete concept maps that were integrated into the dyads' chats will be illustrated.

6.4.1. Control condition

The students of the control condition did not receive scaffolds during their small group discussions. They were allowed to access regular chat rooms without a collaboration script and/or incomplete concept maps and thus, led unstructured discussions using regular chat facilities. In this condition, each dyad was asked to conduct an open discussion without any restrictions about the topic of each phase during the chat session. In the "Introduction and pre-tests" phase, the teacher introduced the possibility of the chat rooms to the students and asked them to watch the tutorial video of how to use the chat room before the first chat session. The chat rooms were set to close automatically after 90 minutes from the starting time of the chat sessions. It was allowed to the students to finish their discussion earlier, but the teacher asked the students to try to increase their discussions and to use all the available discussion time by sending an announcement in the news forum before each chat session.

6.4.2. Collaboration script only

Groups in the condition with collaboration script received only a collection of interaction-related prompts, which were inspired by the ASK to THINK – TEL WHY approach (King, 1997) to structure their collaborative discussions. The collaboration script was presented during all chat sessions except the final one (12 times altogether) and involved different activities and roles for each student (see figure 6.4.2a): (a) first, student 1 was instructed to ask a design-related question "*What is your perspective* about what we should do to improve our website?", (b) to which student 2 then was supposed to answer "*From my perspective* we should use tables to organize the contents of our website". Then (c) student 1 was asked to either accept the answer with or without comment(s) "*I agree* and we have to apply tables on all web pages" or to refuse the answer with or without justification(s). After that (d) student 2 could either accept his/her partner's answer with or without comment(s) "*I agree* because tables may solve the problem of organizing the website's contents better than layers that we currently use" or refuse his/her partner's answer with or without justification(s). Finally (e) the discussion between dyads about the questions repeated until both students agreed on the same answer "*I agree with your perspective*". After that the students' roles were switched to start a new cycle of the collaboration script (student 2 asks a new question and student 1 gives answer, etc.).

As mentioned, each chat room except for the final one was equipped with the script (see figure 6.4.2b). The right side of the chat room (discussion area) was where students could send and receive messages from their partner, while the collaboration script was allocated in the left side of the screen. The collaboration script section was divided into two parts: the upper part presented a visual representation of the script, while the bottom part involved specific prompts (based on the work by King, 1989) to assure a high level of discussion. There were prompts concerning questions (e.g., "Explain how…?" "What is the best…?" "Why…?"), answers (e.g., "I think the answer is…", "From my perspective…"), and reactions to answers (e.g., "I support this answer", "I agree but…", "I disagree because…"). Clicking on a prompt pasted the prompt into the chat window. Furthermore, the prompts were changed automatically according to the student's role after sending his/her message to his partner. In addition, the student was not allowed to write his/her message in the discussion area before selecting a prompt that was associated with his/her role.

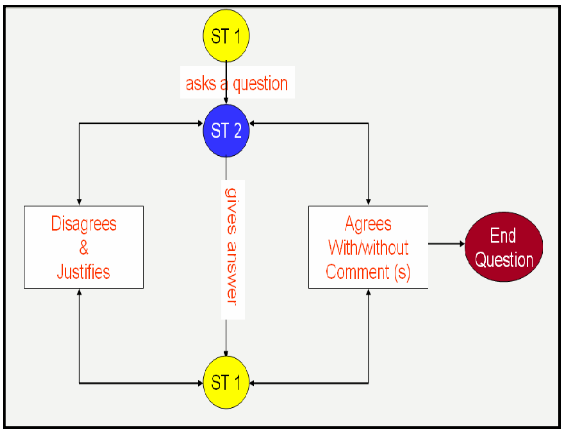

Figure 6.4.2a: Visual representation showing sequence of the computer-supported collaboration script

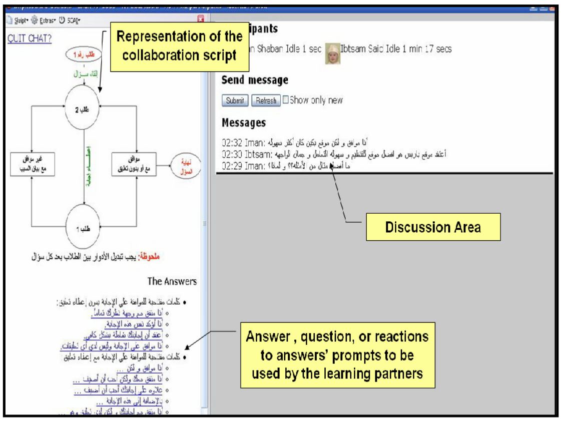

Figure 6.4.2b: Chat room supported with the computer-supported collaboration script

6.4.3. Incomplete concept maps only

In the condition with incomplete concept maps only, each chat but the final one was enhanced by an incomplete concept map, making up a total of twelve incomplete concept maps that students encountered in the learning environment. Each concept map involved the key concepts, principles, and propositions related to the contents of the particular learning phase, which were listed and ranked in a hierarchical order. Each level of the concept maps had the same color, shape (e.g., circles, oval, or rectangle), and size. Lines and arrows were used to indicate relationships between the concepts. Verbs were also put on each arrow to clarify the kind of relationship between the two concepts. Each concept map therefore represented a group of related concepts. In each group, some boxes and arrows were not named to evoke students' discussions about this missing information (see figure 6.4.3a) and to force them to discuss all sections of the map (Suthers, 2003). Students explicitly had the task to fill in blank spots in the concept map. The missing concepts were varied between specific concepts related more to the topic (e.g., bookmarks, hotspot area, DHTML effects) as well as intermediate (e.g., hyperlinks, Marque, jump menus), and general concepts (e.g., toolbars, multimedia, and interface) that focused on specific content. The missing verbs were limited to relationships between specific concepts (e.g., verb "create" to express the relationship from "image maps" concept to "hotspot area" concept) or between specific concepts with intermediate and/or general concepts (e.g., verb "write" to express the relationship from "Marque" as intermediate concept to "Marque text" as specific concept).

The incomplete concept maps were not embedded in the chat window, but they had been shown separately in another window and it was available to the students to complete them by writing directly in the blank spaces of missing concepts and relationships inside the concept maps (see figure 6.4.3b).

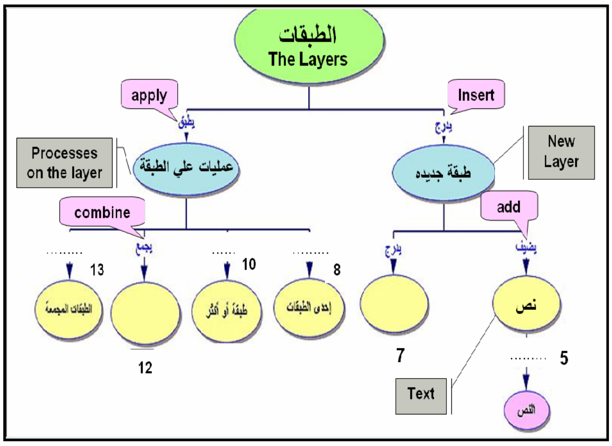

*Figure 6.4.3*a: Screenshot of incomplete concept map (representations in bubbles and square boxes serve as caption and were not presented in the concept map)

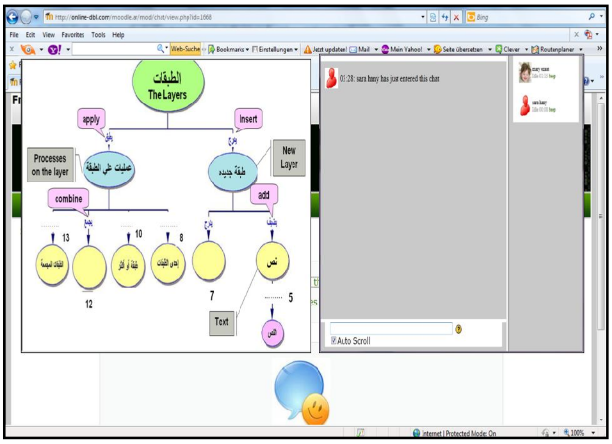

*Figure 6.4.3*b: Chat room supported with incomplete concept map

6.4.4. Collaboration script and incomplete concept maps

In the combined condition, the students were supported with both the computer-supported collaboration script and incomplete concept maps during their small group discussions (see figure 6.4.4). Each dyad had to complete the concept maps and discuss their content by following the activities and roles of the collaboration script.

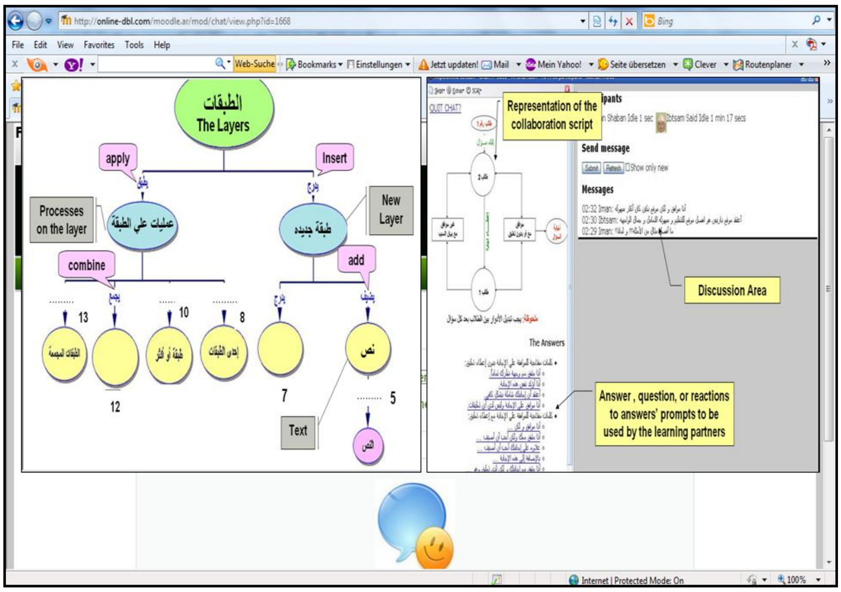

Figure 6.4.4: Chat room supported with computer-supported collaboration script and incomplete concept map

6.5. Dependent Variables and Instruments

The goal of the empirical study was to measure the effects of the collaboration script and incomplete concept maps on five different collaborative and individual learning outcomes: Post test 1 represented a near transfer test that measured the collaborative learning outcomes (a) content-related discourse quality, (b) collaboration skills in an unstructured chat that was still related to the web design tasks the students had to work on, and (c) the quality of the products (published websites); post test 2 assessed the individual learning outcomes that varied between individuals' (d) factual knowledge and (e) skills on web design.

6.5.1. Collaborative learning outcomes

The data for content related discourse quality and collaboration skills were collected during the final chat session which centered around the redesigning, rebuilding, and/or republishing the websites and which was realized without treatment. The data sources for such two collaborative learning outcome measures are the final chat discussions that occurred in each dyad. With respect to quality of products, the data was collected by assessing the websites that were published after the final unstructured chat session according to specific research-based standards for design and building websites (see appendix A).

Data analysis of final chat discussions

In the quantitative analysis, each discourse was segmented into meaningful sentences. In some cases, the students sent many contributions to compose only one meaningful sentence. For instance, the meaningful sentence "I agree to keep Egypt Nobel title but I suggest adding a subtitle to give further clarification to the website visitor" was divided into three contributions (incomplete meaningful sentences) during the discussions, which are "I agree", "to keep Egypt Nobel title but", and "I suggest adding a subtitle to give further clarification to the website visitor". Thus, agreement between two coders regarding the segments was conducted first. First, the same 10% of chat protocols were segmented by two coders. After that, inter-rater agreement between the coders was computed (total agreement = 86 %). With respect to the disagreements between the two coders, they were resolved by discussion. The remaining 90% of chat protocols were segmented by only one of the two coders.

6.5.1.1. Content-related discourse quality

To assess content-related discourse quality, a coding scheme was developed to capture what web design concepts were used during the discussions. Overall, there were 224 concepts that were included in the concept maps and mentioned in the tutorial lessons. The number of used concepts during the final chat discussion was used as an indicator for content-related discourse quality. Two independent raters were trained to identify the used concepts from the final chat discussion by processing ten small groups' discussions from different conditions, which were randomly selected. After that, inter-rater reliability was determined. The raters analyzed the students' discourse (ca. 800 meaningful sentences) independently from each other. Coder-correspondence for identifying the used concepts was .81 measured with Cohen's Kappa, which is an acceptable ratio. After that, the complete data were rated by one of the two raters.

6.5.1.2. Collaboration skills

Based on work by Bloom and his colleagues (1956), and King (1989), a multilevel coding scheme has been developed to analyze the segments that were identified in the first step, concerning the collaboration skills that were employed by the learners. Each level of the coding scheme involved specific categories (see figure 6.5.1.2) to cover all segments identified in the final discussion between small groups. The same raters were trained to identify the different categories of the collaboration script by processing the same chat discussions in ten small groups. Next, inter-rater reliability was calculated by the students' discourse (ca. 800 meaningful sentences - not the same that raters trained with) independently from each other (see next paragraphs). The various categories of the coding scheme will be described in the following paragraphs.

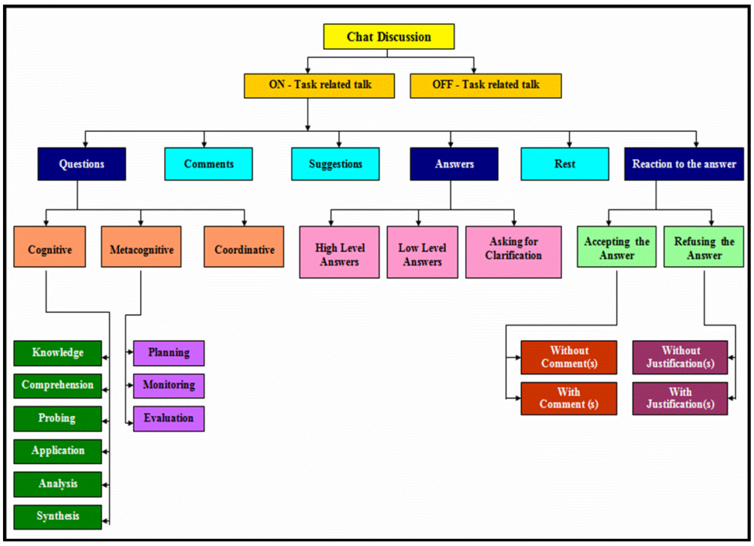

Figure 6.5.1.2: Coding scheme for a multi-level analysis of collaboration skills

On/off task: In a first step, on-task talk was differentiated from off-task talk. A segment was coded as on-task talk when the speaker's utterance was related to the web design task, such as planning the websites, evaluating the design, and/or discussing the content of the tutorial lessons. *Off-task talk* was coded when an utterance did not address the main task or other sub-tasks that the students had to achieve during the course, such as technical problems, greeting, and/or personal matters. The inter-rater reliability of on-task related talk and off-task related talk was measured with Cohen's Kappa and was very good (Cohen's κ = .97). For further analyses, only those segments which were coded as "on-task talk" in the first step of the analysis were included.

Collaboration activities: This dimension of the coding scheme overall included six variables. On the one hand, three categories (questions, answers, and reaction to answers) were derived from the collaboration script, i.e. these were activities that were explicitly triggered by the collaboration script. This was complemented by a bottom-up approach (e.g., by further categories deriving from the data) that led to three additional categories (comments, suggestions, and rest). The inter-rater reliabilities regarding these six categories were sufficient (for questions: Cohen's $\kappa = .97$, for answers: Cohen's $\kappa = .76$, $\kappa = .83$ for reactions to answers, etc). All six categories included further sub-categories that are presented in detail in the following paragraphs.

(1) Questions. Segments were coded as questions if they indicated a request for information, which was put forward or asked using interrogative sentences. These segments appeared either in the form of imperative sentences, which normally express commands (e.g., "Tell me what the layer is.") or as regular questions (e.g., "Does the published website look nice for you or not?"). Raters had to distinguish the three different types of questions (cognitive, metacognitive, and coordinative), which required the students to engage in different levels of mental processes that are expected to enable them to control their thinking or learning. The inter-rater reliability was measured with Cohen's Kappa with respect to the three sub-categories and was sufficient for all of them ($\kappa = .85$ for cognitive, $\kappa = .95$ for metacognitive, and $\kappa = .85$ for coordinative questions).

(a) *Cognitive questions* referred to questions which required the students to process information, apply knowledge, and change preferences. Answering this kind of questions required the student to implement different low-level processes (e.g., remember, classify, understand, apply, analyze, and synthesis the information). Two examples of cognitive questions in one dyad are presented in table 6.5.1.2a. In the first example, the question of *student 1* required *student 2* to remember specific information. In the second example, the question of *student 2* required the *student 1* to apply the information that s/he acquired.

Table 6.5.1.2a: *Examples of segments coded as cognitive questions*

Example 1	*Student 1*	"What are the modifications that you already identified for our website?"
Example 2	*Student 2*	"Could you change the theme of our website?"

The cognitive questions involved different types of questions, which are knowledge, comprehension, probing, application, analysis, and synthesis. The inter-rater reliability that was measured with Cohen's Kappa was acceptable regarding all sub-categories of cognitive questions (κ=.97 for knowledge, κ=.73 for comprehension, $\kappa = .93$ for probing, κ =.98 for application, κ=.74 for analysis, and κ=.93 for synthesis). In the following paragraphs, the different types of cognitive questions, which were extracted from the literature (Bloom et al., 1956; King, 1989) will be addressed.

- *Knowledge questions* referred to cases when answering the question required the student to remember specific information related to the content and/or previous ideas, suggestions, activities, or anything else and then to give it as answer to his/her partner's question. In other words, student had to give direct answer related to the content that had been learned or previous design activities that had been conducted. Therefore, when the question required the student to give answer depends on remembering, memorizing, recognizing, recalling identification, or recalling information that s/he previously learned; this question was coded as knowledge question. Different examples of knowledge questions are shown in table 6.5.1.2b. In the first example, *student 1* asked his/her partner just to remind him the definition of "Internal jumping". Thus, *student 2* had to remember specific information from the content and then give it directly as answer to his/her partner's question without any explanation. In the second example, *student 2* needed to know the disadvantages of his/her published website that were identified by his/her partner before the chat session. In this way, the addressee had already prepared specific information related to the specific design activity before the chat session, and s/he had to remember and provide his/her partner this information.

Table 6.5.1.2b: *Examples of segments coded as knowledge questions*

Example 1	*Student 1*	"Please, remind me what is Internal jumping?"
Example 2	*Student 2*	"Please, mention the disadvantages of my website that you have identified?"

- *Comprehension questions*. Questions were coded as comprehension questions when the answer required the student not only to remember specific information or what s/he had previously learned from the content but also to explain such information by using his/her own words (see example 1 in table 6.5.1.2c). Another case of the comprehension questions was when the student was asked to provide justification, interpretation, and/or explanation for his/her opinion, perspective, and/or design activities that s/he has previously conducted (see example 2 in table 6.5.1.2c). For instance, in the example 1 (see table 6.5.1.2c), the questioner seemed to know what the frames were, but s/he needed more clarification or explanation about its importance. Thus, the addressee had not only to remember specific information concerning the content but also to explain this information and give more clarification by using his/her own words. In the second example, *student 1* asked his/her partner to justify his/her suggestion related to one design activity. In this way, *student 2* had to give an explanation for his/her perspective. The previous two examples were coded as comprehension questions (not knowledge questions) because the addressee was asked not only to remember specific information but also to express it according to his/her understanding (as in example 1) or justify his/her opinion by using his/her own words (as in example 2).

Table 6.5.1.2c: *Examples of segments coded as comprehension questions*

Example 1	*Student 2*	"Could you explain why using frames is important?"
Example 2	*Student 2*	"Names of images' files must be in English not in Arabic"
	Student 1	"Why we have to do that?"

- *Probing questions* refer to the need to understand better. Therefore, when a student asked his/her partner to expand on an idea, be explicit and specific about a general statement made, or ask for more information as well as when the student failed to understand his/her partner question and asked for clarification or when s/he received vague information and needed clarification (see table 6.5.1.2d).

Table 6.5.1.2d: *Examples of segments coded as probing questions*

Example 1	*Student 2*	**"**What do you mean with links' list?**"**
Example 2	*Student 2*	"Do you mean we have to add photo gallery to collect all pictures together?"

- *Application questions* were coded as application questions when the addressee was asked to apply or practice what s/he had learned (facts, rules and/or principles) in a new situation (see example 1 in table 6.5.1.2e). Furthermore, when the addressee had to apply what s/he had learned to solve a problem related to the design task (see example 2 in table 6.5.1.2e). Overall, this kind of questions asked the student to move from the theoretical phase to the practical phase of addressing knowledge by applying their knowledge directly without thinking in any other innovative way. In the discourse example 1 (see table 6.5.1.2e), the addressee had to apply his/her knowledge into a new situation of design activity (change the background of Marquee) with no need to find an innovative way to do that. Another application question could be found in the second example, but the addressee in that example had to apply what s/he had learned (using flash files) to solve specific design problem related to videos that were found on the website.

Table 6.5.1.2e: *Examples of segments coded as application questions*

Example 1	*Student 1*	"Could you change the Marquee's background in the first web page?"
Example 2	*Student 2*	"Could you use flash files to overcome problems related to videos in our website?"

- *Analysis questions.* If the student was asked to subdivide a topic, idea, suggestion, product, or anything else to show its features, relationships, strengths, and/or weaknesses (see example 1 in table 6.5.1.2f) as well as to compare between two or more topics, ideas, suggestions, products, or anything else in order to identify similarities and differences between them, the question was classified as analysis question (see example 2 in table 6.5.1.2f). In addition, the question could be coded as analysis question when the student was asked to expect something, such as problems, difficulties, or improvements related to a topic, idea, suggestion, product, or anything else (see example 3 in table 6.5.1.2f). In the first discourse example (see table 6.5.1.2f), student 2 asked his/her partner to analyze the features of specific product (Hong Kong's website) to extract its advantages and disadvantages. In the second example, the questioner asked the addressee to compare between two products (published websites) in order to identify similarities and differences between them. In the third example, the addressee was asked to predict the problems that were expected after performing the specific design activity (adding frames to the website). Therefore, all three questions were classified as analysis questions.

Table 6.5.1.2f: *Examples of segments coded as analysis questions*

Example 1	*Student 1*	"I think the Hong Kong's website is the best one."
	Student 2	"What are its advantages and disadvantages?"
Example 2	*Student 2*	"Please, compare between our two websites"
Example 3	*Student 1*	"Could you expect the problems that may appear when we apply frames on our website?"

- *Synthesis questions.* When a student asked a question that led his/her partner to utilize what s/he had learned to construct, design, or create a new product or idea, this question was coded as a synthesis question. In other words, this kind of questions required the student to create a unique or original product by combining different ideas and thoughts. The example in table 6.5.1.2g presented a segment that was coded as synthesis question, since such a question required the addressee to utilize what s/he had learned about frames to provide a new way for improving the website. This question has not been classified as application question because there is not one specific solution or suggestion for answering this question due to the fact that the answer depends on the knowledge, experience, and ideas of each student.

Table 6.5.1.2g: *Examples of segments coded as synthesis questions*

Example 1	*Student 1*	"How can we use frames for improving the navigation in our website?"

(b) *Metacognitive questions*. Questions that invited the addressee to reflect on what s/he had been thinking and doing and so to become aware of something which previously might have been below the surface of consciousness and required the student to conduct higher-level processes used for decision making, planning, monitoring, evaluating were coded as metacognitive questions (see table 6.5.1.2h).

Table 6.5.1.2h: *Examples of segments coded as metacognitive questions*

Example 1	*Student 1*	"Do you think we are still on the right track?"

The raters differentiated between three types of metacognitive questions (planning, monitoring, and evaluation questions). The inter-rater reliabilities that were measured with Cohen's Kappa were sufficient ($\kappa = .77$ for planning, $\kappa = .90$ for monitoring, and $\kappa = .87$ for evaluation).

- *Planning questions.* Questions were coded as planning questions if they referred to the way of how the dyad approached the learning task and when the questioner indicated a need to know his/her partner's opinion or suggestion about how to deal with the task, next steps, or design problem (see first two examples in table 6.5.1.2i). In addition, the question could be coded as planning question when the questioner did not provide any opinions, suggestions, or ideas for solving specific design problem but was waiting his/her partner's opinions, suggestions, or ideas as a start point for conducting discussion. In other words, the questioner needed to know his/her partner's suggestion about treating the design problem and in turn would lead to conduct a discussion about how the dyad would deal with this problem (see examples 3 and 4 in table 6.5.1.2i).

Table 6.5.1.2i: *Examples of segments coded as planning questions*

Example 1	*Student 1*	"What are we trying to do here?"
Example 2	*Student 1*	"What should we do next?"
Example 3	*Student 2*	"What is your suggestion to solve this problem?"
Example 4	*Student 1*	"What do you suggest for overcoming the weakness of our published website?"

- *Monitoring questions.* The question that required the addressee to conduct monitor his/her or his/her partner's thinking or actions was classified as monitoring question(see table 6.5.1.2j).

Table 6.5.1.2j: *Examples of segments coded as monitoring questions*

Example 1	*Student 1*	"Do you think we have chosen the right procedure to solve the problem?"
Example 2	*Student 2*	"Do you think we are on the right track?"

- *Evaluation questions*. Questions were coded as evaluation questions when they asked the respondent to express his/her opinion about a product, idea, suggestion, or anything else (see example 1 in table 6.5.1.2k). Moreover, the evaluation questions were coded when a questioner provided a suggestion or an idea and needed to know his/her partner opinion by either supporting or refusing it (see example 2 in table 6.5.1.2k).

Table 6.5.1.2k: *Examples of segments coded as evaluation questions*

Example 1	*Student 1*	"Do you think our website meets the required standards?"
Example 2	*Student 2*	"What is your perspective about adding a Marquee in the homepage?"

(c) *Coordinative question* was classified when the dyad tried to arrange the ideas and tasks between each other to achieve the learning task correctly (see example 1 in table 6.5.1.2l). The questions that involved distributing roles or tasks between the students were coded also as coordinative questions (see example 2 in table 6.5.1.2l).

Table 6.5.1.2l: *Examples of segments coded as coordinative questions*

Example 1	*student 1*	"Should we change the video in the second page?"
Example 2	*student 2*	"What are the roles that should be carried out by each of us to improve our website?"

(2) Answers. Segments were coded as answer when the student gave a reply to a question or a solution, retaliation, or response that was relevant to the question. This was typically done when one student of a dyad asked a question to his/her partner and waited for his/her response. In the discourse example (see table 6.5.1.2m) the reply of *student 2* is coded as an answer.

Table 6.5.1.2m: *Example of segment coded as answer*

Student 1	"How many frames should be included in the main web page?"
Student 2	"Three frames because the number of frames in the web page should not be more than three".

The "answers" dimension involved three sub-categories: high level answers, low level answers, and asking for clarification. The inter-rater reliabilities with respect to these sub-categories, measured with Cohen's Kappa, were $\kappa = .90$ for high level answers, $\kappa = .95$ for low level answers, and $\kappa = .99$ for asking for clarification.

(a) *High level answers* were coded when the student gave a complete answer and enough information that covered his/her partner's question. In the example (see table 6.5.1.2n), the answer of student 2 was classified as high level answer.

Table 6.5.1.2n: *Example of segment coded as high level answer*

Student 1	"What do you suggest to improve our website?"
Student 2	"I think we have to add a photo gallery on the 4^{th} page and also an additional link for contact".

(b) *Low level answers*. Short answers that did not include any details were coded as low level answers. For example, when a student agreed or disagreed without further comments (e.g., "Yes" or "No") and when s/he gave a short reply related to the answer without any details (see table 6.5.1.2o), which was coded as low-level answer.

Table 6.5.1.2o: *Example of segment coded as low level answer*

Student 1	"What we have to add to improve the main page?"
Student 2	"Marque".

(c) *Asking for clarification*. Segments that did not appear in a question form but involved a request for further clarification or details about the partner's question were coded as asking for clarification. In other words, the student asked for clarification whenever s/he had not understood his/her partner's question by using a traditional sentence form (see table 6.5.1.2p)

Table 6.5.1.2p: *Example of segment coded as asking for clarification*

Example 1	*Student 1*	"I did not get your point"
Example 2	*Student 1*	"Your question is vague for me"

(3) Reaction to answers were coded when the student indicated either support for his/her partner's answer or suggestion (e.g., "I completely agree with your idea") or refused it (e.g., "I disagree with your answer because the interface of the website is crowded."). Short or long approvals and disapprovals were coded as reaction to answers as well. Reactions to answers included two sub-categories, accepting answers and refusing answers. The inter-rater reliabilities with respect to these sub-categories were sufficient ($\kappa = .92$ for accepting answers and $\kappa = .94$ for refusing answers).

(a) *Accepting answers.* When a student gave comments that represented an approval of his/her partner's answer, this comment was coded as "accepting answer". In the example (see table 6.5.1.2q), the second segment of student 1 refers to a tacit approval on his/her partner's answer.

Table 6.5.1.2q: *Example of segment coded as accepting answer*

Student 1	"What do you suggest to improve our website?"
Student 2	"I think we have to add photo gallery in the 4th page and also additional link for contact".
Student 1	"I agree and i think we have already a contact link on the main page".

The "accepting answers" category involved two sub-categories, which were "accepting answers with comment(s)" and "accepting answers without comment(s)". Inter-rater reliabilities that were measured with Cohen's Kappa was acceptable regarding sub-categories of accepting answers ($\kappa = .82$ for accepting the answers with comment(s) and $\kappa = .89$ for accepting the answers without comment(s)).

- *Accepting answer with comment(s)* was coded when a student gave a complete sentence rather than just giving a sign of approval on his/her partner's answer. In the example (see table 6.5.1.2r), the second segment of student 1 went beyond just accepting the answer of his/her partner by adding a comment to the answer.

Table 6.5.1.2r: *Example of segment coded as accepting answer with comment*

Student 1	"What do you suggest to improve our website?"
Student 2	"I think we have to add photo gallery in the 4th page and also additional link for contact".
Student 1	"I agree and i think we have already a contact link on the main page".

- *Accepting answer without comment(s).* Segments that were classified as accepting answers and that were limited to a short signs of approval without any additional comment were coded as "accepting answer without comment" (e.g., "Ok", "I support this answer", and "I think your answer is comprehensive enough").

(b) *Refusing answers.* When a student gave a comment that included a rejection of his/her partner's answer, this segment was classified as "refusing answers". For example in table 6.5.1.2s, the second segment of *student 1* was a comment on the answer and this comment involved refusing student 2's perspective. Therefore, this comment was coded as "refusing answers".

Table 6.5.1.2s: *Example of segment coded as refusing answer*

Student 1	"What about using bookmarks in the 3rd web page?"
Student 2	"I do not like to do that because the content in page 3 is not too much".
Student 1	"I have a different perspective that the navigation system should be similar in all pages of our website".

The category of refusing answers was divided into two sub-categories (refusing with justification(s) and refusing without justification(s)). The reliability of both sub-categories was acceptable. Cohen's Kappa was $\kappa = .83$ for refusing the answers with justification and $\kappa = .77$ for refusing the answers without justification.

- *Refusing answer with justification(s).* When a student gave a complete sentence that involved a sign of rejection to his/her partner's and included the reason(s) for rejection, this segment was coded as refusing answer with justification. For example, the second segment of student 2 (see table 6.5.1.2t) involved a rejection of his/her partner's answer as well as giving reason for this rejection.

Table 6.5.1.2t: *Example of segment coded as accepting answer with comment*

Student 2	"Do you have any suggestion to improve the main page?"
Student 1	"I suggest adding an additional frame on the main page."
Student 2	"I disagree because we have already three frames and the web page should not have more than three frames."

- *Refusing answer without justification(s).* When a student rejected his/her partner's answer and limited the rejection to give only short signs to refuse the answer without providing any clarification for refusing, this segment was classified as refusing answer without justification (e.g., "I disagree", "I object to this answer", and "I think your answer is not comprehensive enough").

(4) Comments. Segments that represented rather general remarks and that were not related to the previous three categories were coded as comments. Comments were defined as speech acts that gave a complete meaning to the partner and had different forms, such as a piece of information, observation, or statement. For example, the second segment of student *2* in table 6.5.1.2u was coded as comment because it is a general statement that deals with another aspect of the current discussion. Moreover, it does not refer to any one of the main three categories on the same level. Generally, comments were not a part of the collaboration script and did not have specific prompts, so they have not been taken into account during determining high-level collaboration skills.

Table 6.5.1.2u: *Example of segment coded as comment*

Student 1	"What title do you suggest to our website?"
Student 2	"I suggest future Egypt".

Student 1	"I agree it's a good title".
Student 2	"I do not like the content sequence of our website".

(5) Suggestions were coded when one student provided a proposal to an offering of advice to his/her partner as well as when the student presented a new idea that emerged in his/her mind concerning the discussion's topic (see table 6.5.1.2v).

Table 6.5.1.2v: *Example of segment coded as suggestions*

Example 1	*Student 2*	"I can suggest you to add captions for photos in all web pages".
Example 2	*Student 1*	"I suggest changing the theme of our website".

(6) ***Rest.*** Segments that had an incomplete meaning and at the same time did not belong to other categories in level 2 were coded as rest (e.g., "the interface is… no no its ok"). Generally, the previous five categories were enough to cover most segments of on-task related talk.

6.5.1.3. Quality of published websites

With respect to quality of published websites of groups, two raters were trained to assess the published websites according to what extent the dyads utilized and applied the constructive standards for designing websites (see appendix A), which were included and learned in the tutorial lessons that were provided through the 3rd learning phase (see section 6.3.3) on their websites. Such standards were a set of research-based standards for design and building websites cover all seven categories of the standards that were suggested by Yale's Web Style Guide (see section 2.3). Selected standards were divided into eight new categories according to the different components that the students had to design and add on their websites: (1) interface of website (e.g., interface's design should be simple, acceptable, and easy to use by the user), (2) text (e.g., text font types should not exceed three types), (3) images and graphics (e.g., the goal of image or graphic should be clear for users), (4) video, flash and animation (e.g., avoid to present two or more videos, flash files, and/or animation files at the same time on the same web page), (5) sound (e.g., the user should have the possibility to stop or adjust the background sound of the website), (6) hyperlinks and navigation styles (e.g., all hyperlinks on the website should work correctly), (7) frames (e.g., the maximum number of frames in the web page should not be more three frames), and (8) general standards (e.g., the website should be free of errors, such as design and language errors).

The value of each standard varied between 0 (the standard could not be applied), and 2 points (the standard was applied correctly). Raters were blind to the experimental condition during the coding procedure. The inter-rater reliability of quality of published websites that was measured with Cohen's Kappa and reached a sufficient value ($\kappa = .81$).

6.5.2. Individual learning outcomes

The learners' acquisition of both domain-specific factual knowledge and domain-specific skills of web design were considered as individual learning outcomes that were measured during post test 2. The two dimensions of individual learning outcomes were assessed through the 7th phase of learning phases (post-test and debriefing; see section 6.3.7). The individual acquisition of domain-specific factual knowledge and domain-specific skills of web design were assessed in an individual post-test. The factual knowledge test consisted of 66 multiple choice questions directed towards the functionalities of FrontPage (see appendix B). One exemplary item of the factual knowledge test was "To get help in FrontPage you can press key (a) *F1*, (b) *F3*, (c) *F4*, or (d) *F8*". The domain-specific factual knowledge was reliable with Cronbach's $\alpha = .72$.

The application-oriented knowledge test assessed the students' Web-design skills when using FrontPage software. To that end, students were asked to demonstrate all 292 web design features of FrontPage (e.g., changing text font, adding frames to the web page, inserting flash files, or creating hyperlinks; see appendix C) and could reach between 0 (the action could not be performed) and 2 points (the action was performed correctly) per feature. All the students' actions during performing web design skills were captured in the form of video files. The total video files were 200 (100 videos for pre-test and 100 videos for post-test). Next, two raters were trained to identify the web design skills by processing 20 videos (ten videos from pre-test and ten videos form post-test) that were randomly selected from different conditions. After that, the inter-rater reliability was determined, which was measured with Cohen's Kappa, was $\kappa = .84$ for pre-test and $\kappa = .82$ for post-test. The assessment of domain-specific skills turned out to be sufficiently reliable (Cronbach's $\alpha = .91$ for pre-test and $\alpha = .96$ for post-test).

6.6. Statistical analyses

With respect to the research questions that investigated the effects of the collaboration script and incomplete concept maps on the collaborative learning outcomes, several ANCOVAs analyses were conducted. Regarding the first research question that concerned the content-related discourse quality employed in the final unstructured chat session (near transfer task), an ANCOVA with the collaboration script and the incomplete concept maps as independent factors and the *domain-specific discourse quality* as dependent variable as well as duration of the final unstructured chat sessions as a control variable was conducted. The second research question examined the effects of both treatments and their combination on *collaboration skills* (the high level of questions, answers, and reactions to answers) that were suggested by the collaboration script during the final chat discussion were tested separately by using univariate ANCOVA and using duration of the final unstructured chat sessions as a covariate. In addition, an ANCOVA with the collaboration script and the incomplete concept maps as independent factors and *the quality of published websites* as dependent variable as well as duration of the final chat sessions as a control variable was used.

Regarding the research questions that tested the effects of the collaboration script and incomplete concept maps on the individual learning outcomes, two separate ANCOVAs with the collaboration scripts and incomplete concept maps and group membership as further independent variable nested within the experimental conditions and *domain-specific factual knowledge and domain-specific skills* on web design as dependent variables as well as the pre test scores as a covariate were conducted. For all analyses, the alpha level was set to 5%.

To ensure the normal distribution of data, which is one of the three underlying assumption for the statistics techniques to be used for the data analysis, a check for outliers in each condition separately have been conducted with the help of interquartile range. In case such outliers could be found, they have been removed from the sample and then the standard deviation have been calculated from the results that have been obtained after removing the outliers. Removed outliers have been referred to in the robustness of each computed analysis.

6.7. Control Variables

The data for the control variables were collected prior to the experiment except duration of the final chat sessions, which was measured after "redesigning, rebuilding, or/and republishing the websites" phase in order to check whether there was a difference between the four experimental conditions regarding the time of the task or not; since that variable is expected to lead to other differences between the experimental conditions regarding the collaborative learning outcomes. The control variables included:

(1) Demographic data. Several demographic variables, namely gender, age, and first language have been assessed with a questionnaire (see table 6.1a).

(2) Prior domain-specific knowledge and skills have been assessed with two tests (multiple choice test and application-oriented knowledge test) that were analogous tests to the post-tests. All reliabilities of the two tests were sufficient (see section 6.5.2).

(3) Duration of the final chat sessions that have been used for measuring the collaborative learning outcomes, which was assessed by identifying exactly how many minutes the students used to conduct their final discussions.

6.8. Case Studies

In addition to the quantitative analyses, case studies with detailed descriptions and interpretations of selected excerpts from different experimental conditions were realized. Presenting case studies aims to illustrate how the independent variables affected collaborative learning outcomes shown in a subsequent collaborative transfer task through the chat sessions, which in turn may facilitate the acquisition of individual learning outcomes on web design. The case studies may explain more clearly why and how the collaboration script and incomplete concept maps were more or less essential components for the acquisition of domain-specific discourse quality and the collaboration skills. The case studies serve further to more generally evaluate discourse structures regarding web design concepts and the different kinds of questions, answers, and reactions to answers that were suggested by the collaboration script in different experimental conditions.

In order to select typical dyads, excerpts of the dyads' discourse that well represented effects of the collaboration script and incomplete concept maps were chosen to show clearly how exactly the treatments changed students' discussions through the final chat sessions, where the small groups had one opportunity to improve their websites before the final publishing.

7. Results

This chapter presents the results of the study. The experimental conditions will be abbreviated with DWS for discourse without structure (= control group), CSO for collaboration script only, ICMO for incomplete concept maps only, and CSICM for the combination of both collaboration script and incomplete concept maps. The chapter begins with a comparison of individual learning prerequisites in the different conditions. Then, the results related to each research question will be reported. Next, all the results will be summarized. Finally, four case studies (one dyad from each experimental condition) will be presented to provide more in-depth explanations for the results of the quantitative analyses.

7.1. Comparison of Individual Learning Prerequisites

Prior domain-specific knowledge and skills were assessed with two tests (multiple choice test and application-oriented knowledge test).

The descriptive raw data indicated that there are no large differences between the students in all four experimental conditions regarding prior individuals' domain-specific factual knowledge and skills on web design (see table 7.1).

Table 7.1: *Mean scores (standard deviations in brackets) on individuals' domain-specific factual knowledge and skills of web design in the pre test*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)
Domain specific knowledge	17.55 (*4.95*)	15.29 (*5.43*)	16.54 (*3.24*)	14.78 (*6.88*)
Domain specific skills	13.65 (*5.60*)	15.50 (*9.71*)	14.87 (*8.92*)	16.56 (*10.14*)

To determine whether the four experimental groups differed in their learning prerequisites, two separate ANOVAs for prior domain-specific factual knowledge and prior domain-specific web design skills were conducted. Neither for factual knowledge, nor for web design skills, any significant differences could be detected ($F(1,96) < 3.30$, *n.s.*).

Furthermore, to examine whether the four experimental groups differed in their demographic data, three separated ANOVAs for gender, age, and first language were conducted. The results showed that there is no significant differences could be found ($F(1,96) < 1.66$, *n.s.*).

In summary, the collected data before the experiment indicate that the experimental conditions did not differ systematically with respect to gender, age, first language, or prior knowledge and skills related to web design.

7.2. Effects of Collaboration Script and Incomplete Concept Maps on Collaborative Learning Outcomes

A strength of the current study is that the collaborative learning outcomes were measured in a further collaborative task, which has not been extensively done before. In this section, effects of both factors and their combination with regard to content-related discourse quality and collaboration skills in the last (unstructured) chat session, as well as the quality of published websites as collaborative learning outcomes will be examined.

7.2.1. Preliminary analyses

In order to obtain results that reveal accurate effects of the treatments on collaborative learning outcomes, effects of other variables rather than the treatments that are expected to influence dependent variables should be excluded. During collecting data, it was clear that there was a difference between the four experimental conditions regarding the duration of the final collaborative transfer task. Most of dyads did not complete the 90 minutes that were devoted to the final chat sessions. Therefore before analyzing the results related to each research questions, preliminary analyses for checking if there are main differences between the students in all four experimental conditions regarding the duration of the final unstructured chat sessions will be conducted.

With respect to the duration of the final unstructured discussion in each small group, which was realized without treatments, the descriptive values depicted in table 7.2.1 showed that students who had learned with the collaboration script took less time than students in the ICMO condition. However, the combination between collaboration script and incomplete concept maps led students to spend more time for conducting the discussions than in the other conditions.

Table 7.2.1: *Mean scores (standard deviations in brackets) on duration of the final collaborative transfer task for the four experimental conditions*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*
Time on task in the collaborative transfer task	52.40 (*14.11*)	66.83 (*14.78*)	59.50 (*17.95*)	71.00 (*16.63*)

With respect to the effect of the two treatments and their combination on the duration of the final unstructured discussions, an ANOVA with the collaboration script and the incomplete concept maps as fixed factors, and the duration of the final unstructured chat sessions as dependent variable was conducted. The results showed that there was no significant effect of the collaboration script ($F(1,46) = 1.49$, *n.s.*), a medium-size effect of incomplete concept maps ($F(1,46) = 7.90$, $p < .001$, $Eta^2 = .15$), and no interaction effect ($F(1,46) < 1$, *n.s.*) can be seen (see figure 7.2.1). In this way, there were significant differences between the four experimental conditions regarding the duration of the final unstructured chat sessions. Therefore, in all analyses that refer to data from the final unstructured chat sessions the duration of such sessions will be used as control variable.

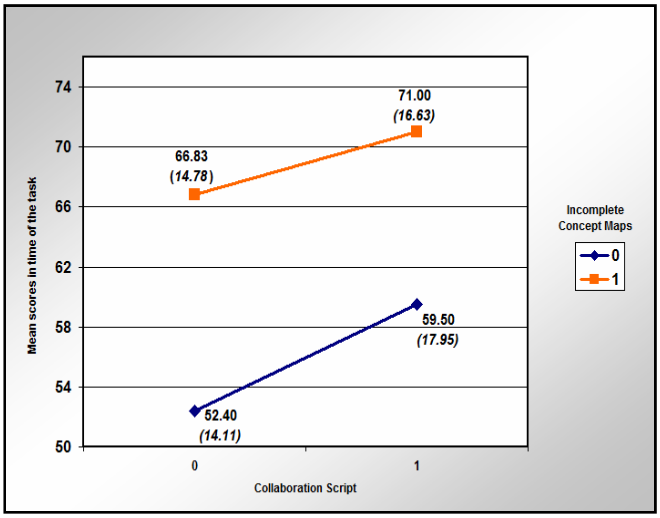

Figure 7.2.1: Mean numbers (standard deviations in brackets) of duration of the final collaborative transfer task in the four experimental conditions

7.2.2. Effects of collaboration script and incomplete concept maps on content-related discourse quality

The **first research question** was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *content-related discourse quality* shown in a subsequent collaborative transfer task in online DBL environments? As noted in Chapter 6, the data for this research question came from a final unstructured chat session that was conducted in the groups learning in each of the four experimental conditions. The content-related discourse quality was measured by the frequency with which web design concepts were used within each single dyad. The total number of web design concepts that were involved in all concept maps is (224) concepts. In the following, the results of the statistical analyses will be reported to test the following hypotheses:

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *content-related discourse quality* in their final unstructured chats than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *content-related discourse quality* in their final unstructured chats than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher *content-related discourse quality* in their final unstructured chats compared to all other three conditions.

For all analyses, each concept was counted only once, namely, repetitions of single concepts were not included in the analyses. The collaboration script was able to improve the content-related discourse quality. However, the students in the ICMO engaged in high quality of content-related discussions more than those in the CSO condition. Students in the CSICM condition were able to use web design concepts more than students in other conditions. Most web design concepts were used by students in the CSICM condition, which was followed by students in the ICMO condition. Next were students in the CSO condition, followed by students in the control condition (see table 7.2.2).

Table 7.2.2: *Mean scores (standard deviations in brackets) on content-related discourse quality in the final collaborative transfer task for the four experimental conditions*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*
Content-related discourse quality	16.00 (*4.83*)	18.50 (*2.71*)	17.08 (*1.62*)	21.25 (*2.49*)

With respect to the effects of the two factors and their combination on domain-specific discourse quality, an ANCOVA with the collaboration script and the incomplete concept maps as fixed factors and the *content-related discourse quality* as dependent variable as well as the duration of the final unstructured chat sessions as covariate was conducted. An effect of the collaboration script ($F(1,45) = 5.36$, $p < .001$, $Eta^2 = .11$) could be found, as well as an effect of incomplete concept maps ($F(1.45) = 14.81$, $p < .001$, $Eta^2 = .25$), but no interaction effect was observable ($F(1,45) < 1$, *n.s.*) for a graphical representations of results see (figure 7.2.2). However, from Post-hoc-tests (LSD) there was no significant difference between the students who had learned with collaboration script only and those who had learned without using any treatments during the experiment ($p = .40$), whereas it was found that students who had learned with incomplete concept maps only slightly outperformed students in the DWS condition ($p = .06$). In addition, students in the CSICM condition outperformed all the other three conditions (compared to the DWS condition: $p < .01$; compared to the CSO condition: $p < .01$; compared to the ICMO condition: $p = .02$). Overall regarding the hypotheses that concern content-related discourse quality, the first hypothesis was not confirmed, whereas the second and third hypotheses were supported.

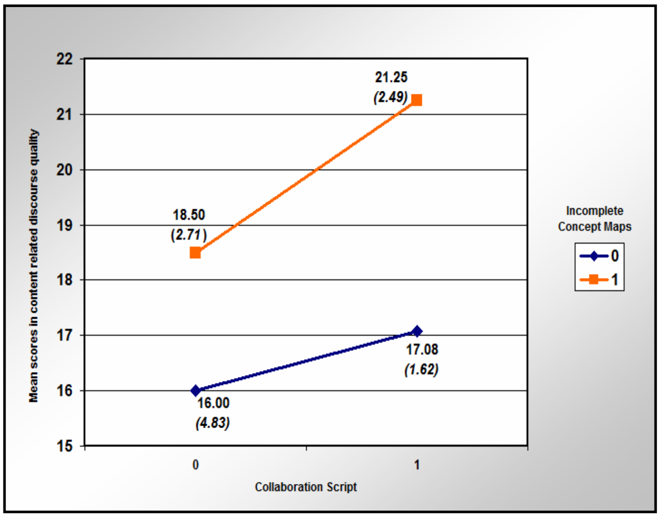

Figure 7.2.2: Content-related discourse quality (mean frequencies of used concepts and standard deviations) in the four experimental conditions

7.2.3. Effects of collaboration script and incomplete concept maps on collaboration skills

The **second research question** was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *collaboration skills* shown in a subsequent collaborative transfer task in online DBL environments? As for the content-related discourse quality, the data for this research question were collected from the last (unstructured) chat sessions, which were conducted between dyads in each small group. In order to measure collaboration skills, the frequencies of high level questions, answers, and reactions to answers were counted (see chapter 6 section 6.5.1.2). This section will focus on reporting the statistical analyses that identify to what extent the following hypotheses can be accepted:

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *collaboration skills* in their final unstructured chats than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *collaboration skills* in their final unstructured chats than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher *collaboration skills* in their final unstructured chats compared to all other three conditions.

The descriptive values depicted in Table 7.2.3 showed that utterances that represented high levels in all three dimensions of collaboration skills appeared in a most pronounced way in the conditions in which the collaboration script was used (the CSO and the CSICM conditions). The collaboration script substantially facilitated the acquisition of all dimensions of collaboration skills more than incomplete concept maps. However, students who had learned with incomplete concept maps only were less able to show high levels in all three dimensions of collaboration skills when compared to those in the CSO condition. The combination between the collaboration script and incomplete concept maps enabled the students to engage in high level collaboration more than all other conditions. Overall, the students in the CSICM condition were better than others regarding the three dimensions of the collaboration skills. Next were students in the CSO condition, followed by students who had learned with incomplete concept maps only and students in the DWS condition.

Table 7.2.3: *Mean scores (standard deviations in brackets) on the dimensions of collaboration skills in the subsequent collaborative transfer task for the four experimental conditions*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*
High level questions	10.00 *(1.25)*	12.08 *(1.56)*	14.42 *(3.83)*	15.29 *(3.07)*
High level answers	9.90 *(1.79)*	13.17 *(1.70)*	15.50 *(7.08)*	16.56 *(3.10)*
High level reaction to answers	12.50 *(2.64)*	16.33 *(1.92)*	17.80 *(2.49)*	25.00 *(9.40)*

To test the effects of the two treatments and their combination on collaboration skills, a MANCOVA with the collaboration script and the incomplete concept maps as fixed factors and all three dimensions of collaboration skills (high level questions, high level answers, and high level reactions to answers) as dependent variables as well as the duration of the final unstructured chat sessions as covariate was conducted. Overall, the MANCOVA results showed a substantial main effect of the collaboration script on collaboration skills ($F(1,45) < 18.74$, $p < .001$, $Eta^2 = .35$), whereas the results showed the overall incomplete concept maps effect was non-significant for collaboration skills ($F(1,45) < 3.84$, *n.s.*). The overall interaction effect on collaboration skills ($F(1,45) < 1.02$, *n.s.*) did not reach statistical significance (see figure 7.2.3).

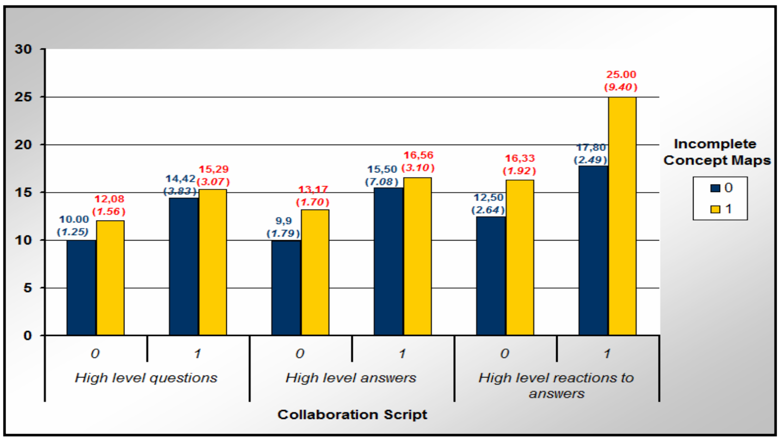

Figure 7.2 .3: Three dimensions of collaboration skills (mean frequencies of each dimension and standard deviations) in the four experimental conditions

In addition, effects of the two treatments on each single dimension of collaboration skills were measured by using separated ANCOVAs as following:

With respect to high level questions, two groups in the combined condition were identified as outliers. Therefore, these groups were removed from the analysis concerning the effects of the two treatments on the high level questions. Next, an ANCOVA with the collaboration script and the incomplete concept maps as fixed factors and the *high level questions* as dependent variable as well as the duration of the final unstructured chat sessions as covariate was conducted. A significant effect of the collaboration script ($F(1,43) = 18.74$, $p < .001$, Eta^2=.29) could be seen. However, no significant effect of incomplete concept maps ($F(1,43) = 3.84$, *n.s.*) and no interaction effect ($F(1,43) < 1$, *n.s.*) could be observed (see figure 7.2.3.1).

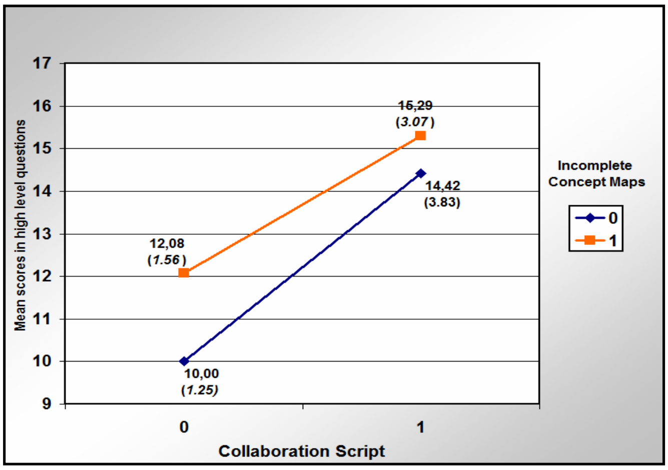

Figure 7.2 .3.1: Effects of collaboration script and incomplete concept maps on high level questions

From Post-hoc-tests (LSD), it was found that the high level questions that were asked by the students in the CSO condition were substantially higher than in the control condition ($p = .01$). Regarding the effect of incomplete concept maps on high level questions, there was no statistically significant difference between the students in the ICMO and the unstructured condition, where the students worked through the experiment without treatment ($p = .18$). In addition, students in the CSICM condition outperformed the ICMO and the DWS conditions (compared to the DWS condition: $p<.01$; compared to the ICMO condition: $p < .01$) but there was no statistically significant difference between students in the CSICM and the CSO conditions ($p = .09$).

Regarding *high level answers*, another an ANCOVA with the collaboration script and the incomplete concept maps as fixed factors and the *high level answers* as dependent variable as well as the duration of the final unstructured chat sessions as a covariate was conducted. The results indicated a significant effect of both the collaboration script ($F(1,45) = 16.30$, $p < .001$, $Eta^2 = .27$) and incomplete concept maps ($F(1,45) = 4.78$, $p < .001$, $Eta^2 = .10$), but no interaction effect ($F(1,45) = 1.02$, *n.s.*) can be observed (see figure 7.2.3.2).

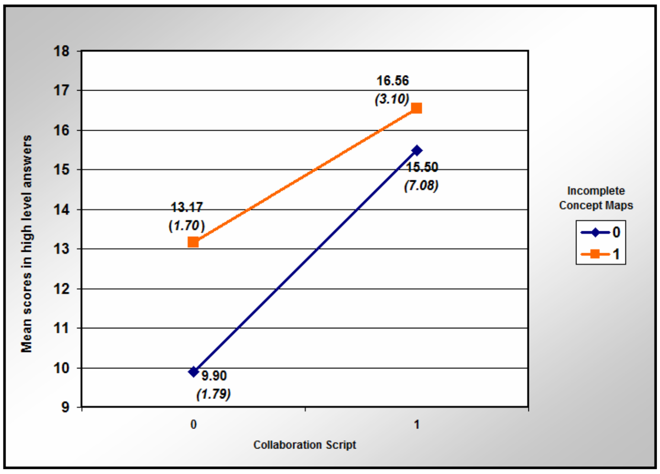

Figure 7.2.3.2: Effects of collaboration script and incomplete concept maps on high level answers

From Post-hoc-tests (LSD), it was found that the high level answers that were given by the students in the CSO condition were substantially higher than those given by students in the DWS condition ($p < .01$). There was also no statistically significant difference between students in the ICMO condition and students in the DWS condition ($p = .10$). Furthermore, students in the CSICM condition outperformed the ICMO and the DWS conditions (compared to the DWS condition: $p < .01$; compared to the ICMO condition: $p = .03$) but here was no statistically significant difference between students in the CSICM and the CSO conditions ($p = .50$).

With respect to *high level reactions to answers*, checking for outliers in the different conditions led to remove two groups from the CSO condition only before examining effects of the two treatments on the high level reactions to answer. After that, an ANCOVA with the collaboration script and the incomplete concept maps as independent variables and the *high level reactions to answers* as dependent variable as well as duration of the final unstructured chat sessions as a covariate was conducted. The results revealed a substantial effect of the collaboration script ($F(1,44) = 18.24$, $p < .001$, $Eta^2 = .29$) and . There was also a significant effect of incomplete concept maps ($F(1,44) = 1.75$, $Eta^2 = .19$). However, the interaction effect did not reach statistical significance ($F(1,44) = .18$, *n.s.*; see figure 7.2.3.3). However, Post-hoc-tests (LSD) showed that the high level reactions to answers of the students in the CSO condition were substantially higher than in the DWS condition ($p = .01$). In addition, there was no significant difference between the students who had learned with incomplete concept maps only and those who did not receive any treatments during the experiment ($p=.16$). Indeed, it was shown that the combined condition was significantly different from all other conditions (compared to the DWS condition: $p < .01$; compared to the CSO condition: $p = .05$; compared to the ICMO condition: $p < .01$). Therefore, testing the hypotheses that concern effects of the independent variables on collaboration skills confirmed the first hypothesis and partially the third hypothesis. However, the second hypothesis was not supported.

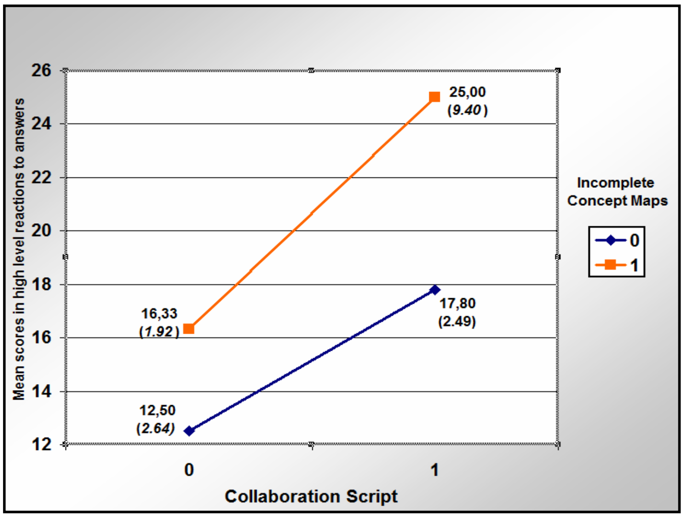

Figure 7.2.3.3: Effects of collaboration script and incomplete concept maps on high level reactions to answers

7.2.4. Effects of collaboration script and incomplete concept maps on quality of websites

The **third research question** was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *quality of published websites* in an online DBL environment? The quality of websites was measured by assessing the published websites according to the constructive standards for designing websites, which were included and learned in the tutorial lessons that were provided through the 3rd learning phase (see chapter 6 section 6.2.2.3). In this section, the results of the statistical analyses will be presented to test the following hypotheses:

Hypothesis 1: Students who had been provided with a collaboration script during treatment will not be able to improve the *quality of published websites* in an online DBL environment compared to students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will not be able to improve the *quality of published websites* in an online DBL environment compared to students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will be able to improve the *quality of published websites* in an online DBL environment compared to all other three conditions.

Descriptive analysis showed that the students in the CSO condition were able to publish high quality websites more often than the students in the ICMO condition. Yet, the quality of published websites could be improved more when the collaboration script and incomplete concept maps were combined. Websites of lowest quality levels were produced in the unstructured control condition (see table 7.2.4).

Table 7.2.4: *Mean scores (standard deviations in brackets) on quality of published websites*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*
Quality of published websites	72.00 (*15.20*)	79.17 *(20.72)*	85.33 *(19.40)*	97.31 *(13.39)*

In order to test the effect of the treatments and their combination on quality of published websites, an ANCOVA with the collaboration script and the incomplete concept maps as fixed factors and quality of published websites as dependent variable as well as duration of the final unstructured chat sessions as covariate was conducted. The results showed that the collaboration script had a positive medium-sized effect ($F(1.45) = 9.19$, $p < .001$, $Eta^2 = .17$), but there was neither a significant effect for incomplete concept maps ($F(1.45) = 2.58$, *n.s.*) nor a significant interaction effect ($F(1.45) = .25$, *n.s.*; see figure 7.2.4).

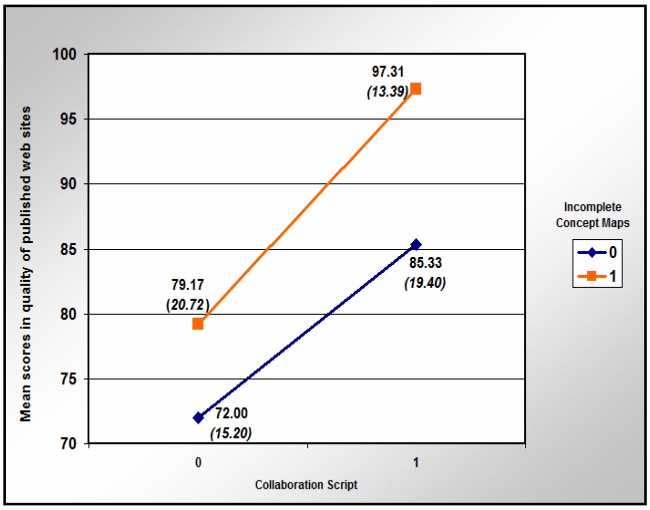

Figure 7.2.4: Mean scores (standard deviations in brackets) in the test on the quality of published websites

From Post-hoc-tests (LSD), it was found that students who had learned with the collaboration script only slightly outperformed students, who had learned without any treatments ($p = .08$). There was no statistically significant difference between the incomplete concept maps only and the control condition ($p = .34$). Indeed, the students in the CSICM condition outperformed all other three conditions (compared to the DWS condition: $p < .01$; compared to the CSO condition: $p = .05$; compared to the ICMO condition: $p = .01$). In this way, such results rejected the first hypothesis, since using the collaboration script only enabled the students to improve their published websites compared to the control condition. However, the second and third hypotheses were supported.

7.3. Effects of Collaboration Script and Incomplete Concept Maps on Individual Learning Outcomes

In this section, the results of the statistical analyses concerning the effects of the two treatments and their combination regarding domain-specific factual knowledge and domain-specific skills of web design will be reported. In contrast to the dependent variables reported so far, which were all measured on the group level, domain-specific factual knowledge and domain-specific web design skills were measured on the individual level.

Effects of collaboration script and incomplete concept maps on individuals' factual knowledge on web design

The **fourth research question** was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *acquisition of domain-specific knowledge* related to the design and building of websites in an online DBL environment? The data to answer this question were collected by the factual knowledge test that was described in chapter 6 (section 6.5.2). In this section, the following hypotheses will be tested.

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *domain-specific knowledge* in an online design-based learning than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *domain-specific knowledge* in an online design-based learning than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher *domain-specific knowledge* in an online design-based learning compared to all other three conditions.

The descriptive raw data showed that both treatments individually facilitated the acquisition of factual knowledge on web design. However, the students who had learned with incomplete concept maps only outperformed students who had learned with the collaboration script only. Furthermore, both treatments seemed to add up. The combination between collaboration script and incomplete concept maps enabled the students to acquired factual knowledge on web design more than the other three conditions. As the table 7.3.1 shows, students in the CSICM condition acquired the highest levels of factual knowledge on web design, then students in the ICMO condition, followed by students in the CSO condition and students in the DWS condition.

Table 7.3.1: *Mean scores (standard deviations in brackets) on individuals' domain-specific factual knowledge of web design in the pre and post tests*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*
Pre test domain-specific factual knowledge	17.55 (*4.95*)	15.29 (*5.43*)	16.54 (*3.24*)	14.78 (*6.88*)
Post test domain-specific factual knowledge	42.95 (*4.07*)	45.92 *(4.82)*	44.08 *(4.84)*	49.88 *(4.94)*

To account for interdependencies between the data of the two students from each dyad, group membership was used as a further independent variable nested within the experimental conditions. To that end, a new variable was created, called "group no.", and each dyad received a distinct number on this variable. After that, an ANCOVA with the collaboration script and the incomplete concept maps as fixed factors, group membership as further independent factor nested within the experimental conditions, the post test scores in the factual knowledge test as dependent variable and the pre test scores as a covariate was conducted. The results revealed a positive small effect size for the collaboration script ($F(1,95) = 5.55$, $p < .001$, $Eta^2 = .07$), a positive medium-sized main effect of incomplete concept maps ($F(1,95) = 16.27$, $p < .001$, $Eta^2 = .18$), but no interaction effect ($F(1,95) = 1.64$; *n.s.*; see figure 7.3.1).

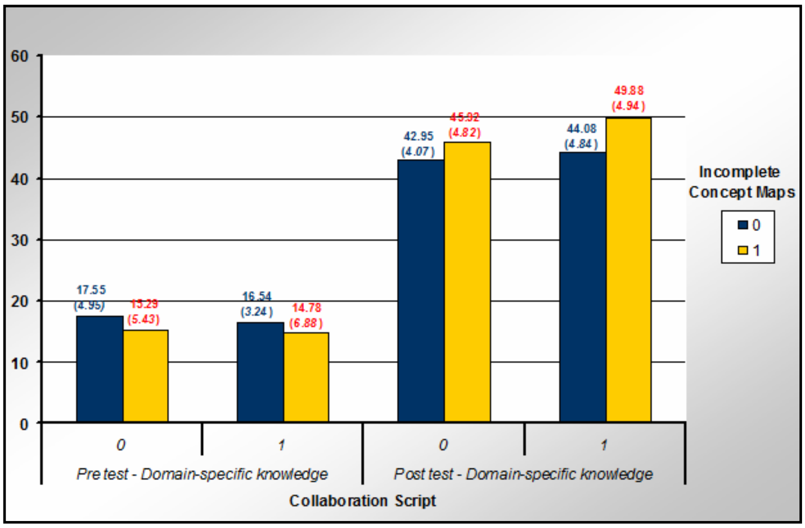

Figure 7.3.1: Mean scores (standard deviations in brackets) in the pre and post tests on domain-specific knowledge across the four experimental conditions

Post-hoc-tests (LSD) showed that the students in the CSO condition slightly outperformed those in the DWS condition ($p = .06$). In addition, the students who had learned with incomplete concept maps only outperformed students in the control condition ($p < .04$).

Furthermore, students in the CSICM condition outperformed students in all other three conditions (compared to the DWS condition: $p < .01$; compared to the CSO condition: $p < .01$; compared to the ICMO condition: $p < .01$). In this way, testing all three hypotheses that concern the acquisition of domain- specific knowledge related to the design and building of websites supported all three hypotheses.

Effects of collaboration script and incomplete concept maps on individuals' skills on web design

The **fifth research question** was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *acquisition of domain-specific skills* related to the design and building of websites in an online DBL environment? The students' web design skills were assessed by using the application-oriented knowledge test described in chapter 6 (section 6.5.2). This section was devoted to determine to what extent the hypotheses that concern such this research question are true.

Hypothesis 1: Students who had been provided with a collaboration script during treatment will show higher *domain-specific skills* in an online design-based learning than students who did not receive a collaboration script during treatment.

Hypothesis 2: Students who had been provided with incomplete concept maps during treatment will show higher *domain-specific skills* in an online design-based learning than students who did not receive incomplete concept maps during treatment.

Hypothesis 3: Students who had been provided with a collaboration script and incomplete concept maps during treatment will show higher level *domain-specific skills* in an online design-based learning compared to all other three conditions.

Descriptively, the collaboration script seemed to facilitate more the acquisition of web design skills compared to incomplete concept maps. The students in the CSO condition were able to demonstrate more web design skills than those in the ICMO condition. In addition, the students who had learned with the collaboration script and incomplete concept maps together outperformed the students in all other conditions with reference to domain-specific skills. Overall, students in the combined condition acquired the highest level web design skills, followed by students in the CSO condition, then students in the ICMO condition, and finally students in the DWS condition (see table 7.3.2).

Table 7.3.2: *Mean scores (standard deviations in brackets) on individuals' domain-specific skills of web design*

	Without collaboration script		With collaboration script	
	Without incomplete concept maps	With incomplete concept maps	Without incomplete concept maps	With incomplete concept maps
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*
Pre test domain-specific skills	13.65 (*5.60*)	15.50 (*9.71*)	14.87 (*8.92*)	16.56 (*10.14*)
Post test domain-specific skills	197.65 (*23.36*)	224.46 (*30.85*)	226.13 (*29.86*)	250.47 (*31.54*)

With respect to the effects of the two treatments and their combination on individuals' web design skills, an ANCOVA with the collaboration script and the incomplete concept map as fixed factors, group membership as a further independent factor nested within the experimental conditions, the post test scores in the web design skills test as dependent variable and the pre test scores as a covariate was conducted. The results showed significant and positive main effects for both treatments ($F(1.95) = 17.35$, $p<.001$, $Eta^2 = .19$ for the collaboration script, and $F(1.95) = 14.05$, $p < .001$, $Eta^2 = .16$ for incomplete concept maps), but no significant interaction effect ($F(1.95) < 1$; *n.s.;* see figure 7.3.2).

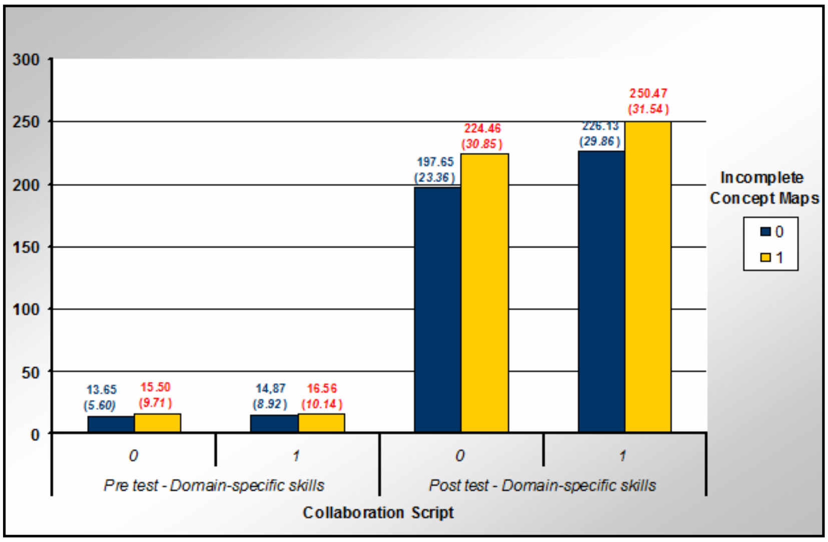

Figure 7.3.2: Mean scores (standard deviations in brackets) in the pre and post tests on domain-specific skills across the four experimental conditions

From Post-hoc-tests (LSD), it was found that the students in the CSO condition outperformed students in the control condition ($p < .01$). Students in the ICMO condition also performed better than those who had learned without any treatments ($p < .01$). In addition, it was shown that only the combined condition was significantly different from all other conditions, (compared to the DWS condition: $p < .01$; compared to the CSO condition: $p < .01$; compared to the ICMO condition: $p < .01$). Thus, all three hypotheses that concern the acquisition of skills related to design and building of websites were confirmed.

7.4. Summary of Results

The results of the current study were built around the three main research questions and nine hypotheses concerning collaborative learning outcomes as well as the two main research questions and six hypotheses regarding individual learning outcomes. In this section, the findings for each research question and hypothesis will be summarized.

Effects of Collaboration Script and Incomplete Concept Maps on Collaborative Learning Outcomes

The first research question was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *content-related discourse quality* shown in a subsequent collaborative transfer task in online DBL environments?

The *first hypothesis* posited that students who learned with collaboration scripts would show higher level content-related discourse quality than students in the control condition. Results of an ANCOVA and the Post-hoc-tests (LSD) analysis did not support this hypothesis. Although the collaboration script had a medium-sized positive effect on the content-related discourse quality that was exhibited in an unstructured chat session realized at the end of the online DBL course, there was no significant difference between students in the CSO condition and those who participated in the DWS condition. The *second hypothesis* predicted that participants who had learned with incomplete concept maps would use more web design concepts in the final chat session than students in the control condition. Results of an ANCOVA showed substantial positive effect for the incomplete concept maps on the content-related discourse quality. Moreover, the comparison between the students in the ICMO and the DWS conditions revealed a slightly significant positive effect in favour of the students in the ICMO condition. They used more web design concepts in their discussions than students in the DWS condition. Therefore, this hypothesis was supported. The *third hypothesis* expected that the combination between the two treatments would lead to the most positive outcomes regarding the content-related discourse quality when compared to all other three conditions. Although the results of an ANCOVA showed that there was no interaction effect between the two treatments, results of the Post-hoc-tests (LSD) supported that hypothesis. The comparison between the students in the CSICM condition and the other three conditions showed that the students in the CSICM condition outperformed the students in all other three conditions. In this way, the collaboration script showed its potential only when it was combined with the concept maps.

The second research question of this study was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect *the collaboration skills* shown in a subsequent collaborative transfer task in online DBL environments?

The *first hypothesis* predicted that the students who had learned with the collaboration script would show higher collaboration skills than the students in the unstructured condition. Results of MANCOVA showed an overall effect of the collaboration script on collaboration skills. Furthermore, conducting ANCOVAs on each single dimension of collaboration skills revealed a positive effect of the collaboration script on all three dimensions of collaboration skills. Also, results of comparing means of the students in the CSO condition and students in the DWS condition supported this hypothesis. The collaboration script encouraged the students to ask more high level questions, give more high level answers, and engage in more high level discussions supported with comments and justifications compared to students in the control condition. The *second hypothesis* posited that the students who had learned with incomplete concept maps would collaborate more skilfully than the students who had learned without any treatment. First, conducting MANCOVA showed that the overall effect of incomplete concept maps on collaboration skills was non-significant. Moreover, using ANCOVAs to identify effect of incomplete concept maps on each single dimension of collaboration skills showed significant effect of incomplete concept maps only on high level answers. Three Post-hoc-tests (LSD) analyses were conducted to test this hypothesis by comparing means of the students in the ICMO condition and students in the control condition regarding all three dimensions of the collaboration skills. The results showed that there was no statistically significant difference between the ICMO condition and the DWS condition with respect to all three dimensions of the collaboration skills. Overall, incomplete concept maps could not facilitate the acquisition of collaboration skills compared to the control condition. Therefore, this hypothesis was not accepted. The *third hypothesis* expected that the students who had learned with the collaboration script and incomplete concept maps together would show higher collaboration skills compared to all other conditions. Results of MANCOVA showed that no overall interaction effect between both treatments on collaboration skills can be found. In addition, results of ANCOVAs on all three dimensions of collaboration skills confirmed that the interaction effect on collaboration skills did not reach statistical significance. Results of the Post-hoc-tests (LSD) analysis partially supported this hypothesis, since the students in the CSICM condition outperformed all other three conditions only regarding the frequencies of high level reactions to answers. With respect to high level questions and high level answers, the students who had participated in the combined condition outperformed only the students in the ICMO and the DWS conditions, but not the students in the CSO condition. There was no statistically significant difference between the students in the CSICM condition and those in the CSO conditions.

The third research question of this study was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *quality of published websites* in an online DBL environment? Results indicated that:

The *first hypothesis* predicted that the collaboration script would not be able to improve the quality of published websites when compared to the control condition. However, an ANCOVA analysis showed that the collaboration script had a positive effect on the quality of published websites. Moreover, comparing mean scores of the students in the CSO condition and the DWS condition showed that a slightly significant difference. Therefore, the first hypothesis was not supported. The *second hypothesis* posited that the students who had learned with incomplete concept maps would not be able to publish high quality websites compared to the students who had learned without any treatments. The results of an ANCOVA analysis revealed that there was no significant effect of incomplete concept maps on the quality of published websites. Moreover, the results of the Post-hoc-tests (LSD) analysis did not show any significant difference between the students in the ICMO condition and those in the DWS condition. Thus, this hypothesis was supported. The *third hypothesis* predicted that the students who learned with both treatments together would publish higher quality websites compared to students in all other three conditions. Results of an ANCOVA showed that there was no interaction effect between the collaboration script and incomplete concept maps on the quality of published websites. The results of the Post-hoc-tests (LSD) showed that the students in the CSICM conditions could publish higher quality websites compared to the students in all other three conditions. Thus, this hypothesis was confirmed.

Effects of Collaboration Script and Incomplete Concept Maps on Individual Learning Outcomes

The fourth research question of this study was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *acquisition of domain-specific knowledge* related to the design and building of websites in an online DBL environment?

Regarding the *first hypothesis*, it was predicted that the collaboration script would enable the students to acquire more domain-specific knowledge than the students who learned without any treatments. An ANCOVA analysis revealed a positive effect of the collaboration script on the acquisition of domain-specific knowledge. Moreover, investigating the differences between means scores of the students in the CSO condition and those in the DWS condition showed that the students who had learned with the collaboration script were slightly higher than the students in the control condition. Therefore, this hypothesis was supported. The *second hypothesis* expected that students who had learned with incomplete concept maps would show higher domain-specific knowledge than those in the unstructured condition. The results of an ANCOVA analysis showed a significant effect of incomplete concept maps on the acquisition of factual knowledge. Moreover, the Post-hoc-tests (LSD) analysis indicated that the students in the ICMO condition outperformed those in the DWS condition. Thus, this hypothesis was supported. The third hypothesis posited that the combination between the collaboration script and incomplete concept maps would show higher domain-specific knowledge compared to all other three conditions. Results of an ANCOVA showed no interaction effect between both treatments, whereas the results of the Post-hoc-tests (LSD) analysis also supported this hypothesis. The students in the CSICM condition acquired domain-specific knowledge related to design and building websites more than students from all other conditions.

The fifth research question of this study was: To what extent do a collaboration script and incomplete concept maps as well as their combination affect the *acquisition of domain-specific skills* related to the design and building of websites in an online DBL environment?

The *first hypothesis* predicted that the students who had been provided with collaboration script would show higher domain-specific skills compared to the students in the control condition. The results of the analyses supported this hypothesis, since an ANCOVA indicated that there was a main effect for collaboration script on students' acquisition of domain-specific skills. The students in the CSO condition were substantially higher than the students in the control condition. Overall, students in the CSO condition could obviously practice web design more skilfully than students in the DWS condition. The *second hypothesis* was that the students who had learned with incomplete concept maps would show higher domain-specific skills compared to the control condition. An ANCOVA analysis showed a positive main effect of incomplete concept maps on the acquisition of domain-specific skills related to design and building websites. Furthermore, Post-hoc-tests (LSD) indicated that students in the ICMO condition performed better than students from the DWS condition Therefore, the second hypothesis was confirmed. Regarding the *third hypothesis*, the students who had been provided with a collaboration script and incomplete concept maps would show higher domain-specific skills more than those who had learned without the both treatments. The results of an ANCOVA showed that the interaction between the collaboration script and incomplete concept maps did not reach statistical significance. The results of the Post-hoc-tests (LSD) analysis showed that students who had learned with both the collaboration script and incomplete concept maps were better able to show different web design skills than those from all three other conditions. Thus also the third hypothesis was confirmed.

7.5. Case Studies

Overall, the results largely supported what was expected regarding the potentials of using the collaboration script as social scaffolding and using incomplete concept maps as content scaffolding through online DBL. Furthermore, such results confirmed that combination of the two scaffolds can enable the students to acquire higher level domain-general and domain-specific knowledge in online DBL. In the following sections, excerpts from the dyads' discourse from different experimental conditions, which can serve as illustrations for the differences revealed by statistical analysis, will be presented. All excerpts were taken from the final chat session concerning discussions about the modifications that each dyad had to conduct without any treatments to improve their websites before final publishing. All conversational activities that will be presented were translated from Arabic and appear in normal print, while the web design concepts that were used during the dyads' discussions are printed in italics. First of all, an example of discourse without collaboration script and incomplete concept maps (DWS) will be presented. After that, an example of discourse that was facilitated with the collaboration script only (CSO), and another example of discourse that was facilitated with the incomplete concept maps only (ICMO) are shown. Finally, an excerpt of discourse that was facilitated with both collaboration script and incomplete concept maps (CSICM) will be discussed. Subsequently, the domain-specific discourse quality and the collaboration skills observable in the discourse will be analyzed and the data of each case study will be interpreted.

DWS - discourse without Structure

First of all, an example of a small group discourse that was not supported with collaboration script or incomplete concept maps will be analyzed. This example shows how the dyad discussed two problems concerning the organization of contents and the images in their websites.

Data of the conversational activities

The following excerpt shows a part of a discussion with ten messages from *student 1* and eleven messages from *student 2*.

St1:	What are the modifications that you have identified?
St2:	I don't like the organization of the contents.
St1:	Me neither.
St2:	I suggest to use *tables* for organizing the contents.
St1:	Yes I agree.
St2:	So we have to apply them on all *web pages*.
St1:	Ok.
St2	I think we have also another problem related to the *images*.
St1:	That is true
St2:	The *images* did not appear correctly.
St1:	Right with me also
St2:	I think we have to change them.
St1:	I suggest first to use English names for the *images*' files instead of Arabic names.
St2:	I will try to do that
St2:	There is also another problem concerning their position.
St1:	You are right.
St2:	The *images* usually appear in different positions.
St1:	Right
St2:	Did you find a solution for that?
St1:	No
St2:	Let's try *tables* may be it will be a good solution.

First, *student 1* started this discussion by asking a question to his partner that requires just remembering specific modifications, which had already been prepared by *student 2* before the chat session, and was coded as knowledge question. Next, *student 2* posted a message as a complete answer to this question that was classified as high quality answer.

Messages		Codes
St1**:**	What are the modifications that you have identified?	Knowledge question
St2**:**	I don't like the organization of the contents.	High level answer

Then, *student 1* accepted this answer without any comment (low level reaction). After that, *student 2* gave a new idea as a solution for this problem, which was coded as suggestion. Again, *student 1* accepted his partner's solution without comment, which was considered as low level reaction.

Messages		Codes
St1:	Me too.	Accepting without comment(s)
St2:	I suggest to use *tables* for organizing the contents.	Suggestion
St1:	Yes I agree.	Accepting without comment(s)

After that, *student 2* suggested applying this solution on all web pages and again, *student 1* accepted that suggestion with a low level reaction, which was acceptance without comment.

Messages		Codes
St2**:**	So we have to apply them on all *web pages*.	Suggestion
St1**:**	Ok.	Accepting without comment(s)

Afterwards, *student* 2 sent a message, which was coded as comment. This was followed by *student* 1 accepting this comment without a further comment (low level reaction). Again, *student* 2 added another comment with more details about the problem, which was followed by a low level reaction (acceptance without comment) from *student* 1.

Messages		Codes
St2	I think we have also another problem related to the *images*.	Comment
St1:	That is true	Accepting without comment
St2:	The *images* did not appear correctly.	Comment
St1:	Right with me also	Accepting without comment

Subsequently, *student* 2 suggested a solution for the problem, which was followed by another suggestion from *student* 1. This message was responded to by *student* 2 by giving a general comment.

	Messages	Codes
St2:	I think we have to change them.	Suggestion
St1:	I suggest first to use English names for the *images*' files instead of Arabic names.	Suggestion
St2:	I will try to do that	Comment

Next, *student* 2 sent another comment concerning the position of the images in his/her website. *Student* 1 accepted this comment without adding further comments (low level reaction), which was followed by a general comment from *student* 2. Then, *student* 1 gave a low level reaction in the form of accepting the answer without comment.

	Messages	Codes
St2:	There is also another problem concerning its position.	Comment
St1:	You are right.	Accepting without comment
St2:	The *images* usually appear in different positions.	Comment
St1:	Right	Accepting without comment(s)

Again, *student* 2 repeated his/her question in a different way that required *student 1* to remember specific information (if s/he found or not found a solution for the problem before that chat session) and then to give direct answer to that question. Thus, this question was coded as knowledge question. *Student* 1 answered this question by giving a low level answer (answer without comment(s). Finally, *student 2* ended the discussion about this problem by suggesting a solution for that problem.

	Messages	Codes
St2:	Did you find solution for that?	Knowledge question
St1:	No	Low level answer
St2:	Let's try *tables* may be it will be good solution.	Suggestion

In this case study, the two students used seven web design concepts in total (*student* 1 used one concept, and *student* 2 used six web design concepts), which equal three concepts without repetition, which were classified as general concepts (tables, web pages, and images). They did not use any specific (e.g., bookmarks, hotspot area, DHTML effects) or intermediate (e.g., hyperlinks, Marque, jump menus) concepts in their discourse. Regarding the collaboration skills, a clear lack of using the collaborative activities is apparent in this discussion. In this dyad, only two low level questions (compared to zero high level questions), two answers (one high level and one low level answers), and seven low level reactions to answers (compared to zero high level reactions) could be found.

Interpretation of the discourse data

As can be seen from this excerpt, the discourse as a whole appears to be quick and superficial with regard to how the dyad addressed the two design problems they identified. Regarding the domain-specific discourse quality demonstrated in this excerpt, this discourse reveals a lack of web design concepts acquired and used. Intermediate and specific web design concepts were completely ignored by the two students. In addition, with respect to the collaboration skills that were demonstrated by the two students, consensus was built quickly and the overall quality of discussion was rather low. The dyad did not address any details about the problems, the solutions, the comments, and the suggestions at all. Overall, only few questions, answers, and reactions were presented, and the ones that were produced typically were on a rather low level. Generally, the fact that students did not encounter any structuring facilities in the eleven chat sessions before seems to have led or at least did not prevent students from appearing in a hurry to some extent with solving the design problems.

CSO – discourse with collaboration script only

In this section, a discourse that was facilitated with the collaboration script only will be discussed. Again, another example of students' discourse in the CSO condition about improving the organization of the website will be analyzed.

Data of the conversational activities

The following discourse involves 16 messages from the dyad (nine messages for *student 1* and seven messages for *student 2*).

St1:	From your perspective, what we should do to improve our *website*?
St2:	I think we have a clear problem concerning formatting and organizing the *website.*
St1:	Actually, this is the main problem.
St1:	Regarding the *website*, Are there differences between what we planned and what we published?
St2:	Yes, there are many differences appeared after *publishing*.
St1:	What is your suggestion to solve this problem?
St2:	Do you think our website needs *frames*?
St1:	*Frames* are one solution but I prefer to use *tables* because they are more easy to use more than *frames* and also could organize all contents well.
St2:	I disagree, because *frames* can do that and also enable the users to move between different sections of the *website* easily.
St1:	Could you explain how the frames do that?
St2:	From my perspective, it's supposed to have three frames. First one for *the title*,

	second one for main menu, and third one for the content of different *web pages*.
St1:	Do you mean the user will remain in the *homepage*?
St2:	Exactly and the *navigation* can be done by main menu.
St1:	I agree but we need long time to do that because I think in this case we have to rebuild the whole *website* again.
St2:	No of course, we have to create a new *homepage* with *frames* only and after that we can create *hyperlinks* to other *web pages*.
St1:	Ok I think it will be great if we can apply them correctly.

This example shows how the dyad from the CSO condition discussed one of the main problems in their websites. The discussion started by asking a high level question (planning question) by *student 1*. Then, *student 2* responded to this question by giving a high level answer. After that, *student 1* accepted this answer and posted a comment.

	Messages	**Codes**
St1:	From your perspective, what we should do to improve our *website*?	Planning question
St2:	I think we have a clear problem concerning formatting and organizing the *website.*	High level answer
St1:	Actually, this is the main problem.	Accepting with comment

Again, *student 1* asked a high level question, which was coded as analysis question and the answer to this question, which was classified as high level answer, was sent by *student 2*.

	Messages	**Codes**
St1:	Regarding the *website*, Are there differences between what we planned and what we published?	Analysis question
St2:	Yes, there are many differences appeared after *publishing*.	High level answer

Subsequently, *student 1* posted a message, which was coded as planning question. *Student 2* did not answer this question but asked another high level question (evaluation question). This question was responded by *student 1*, who posted a message classified as high level answer. However, *student 2* refused this answer and provided a justification; therefore, this reaction was classified as high level reaction.

	Messages	**Codes**
St1:	What is your suggestion to solve this problem?	Planning question
St2:	Do you think our website needs *frames*?	Evaluation question
St1:	*Frames* are one solution but I prefer to use *tables* because they are more easy to use more than *frames* and also could organize all contents well.	High level answer

St2:	I disagree, because *frames* can do that and also enable the users to move between different sections of the *website* easily.	Refusing with justifications

After that, *student 1* asked a question for further explanation; thus, this question was classified as comprehension question. *Student 2* replied to this question by giving another high quality answer.

Messages		Codes
St1:	Could you explain how the frames do that?	Comprehension question
St2:	From my perspective, it's supposed to have three frames. First one for *the title*, second one for main menu, and third one for the content of different *web pages*.	High level answer

Furthermore, *student 1* asked a probing question for further clarification and *student 2* responded to this question by giving high level answer. Next, *student 1* supported this answer and added a comment; therefore, this reaction was classified as high level reaction. Then, *student 2* gave another high level reaction in the form of refusing with justification. Finally, this discourse was ended by *student 1*, who had a high level reaction in the form of accepting her partner's reaction with comment.

Messages		Codes
St1:	Do you mean the user will remain in the *homepage*?	Probing question
St2:	Exactly and the *navigation* can be done by main menu.	High level answer
St1:	I agree but we need long time to do that because I think in this case we have to rebuild the whole *website* again.	Accepting with comment
St2:	No of course, we have to create a new *homepage* with *frames* only and after that we can create *hyperlinks* to other *web pages*.	Refusing with justification
St1:	Ok I think it will be great if we can apply them correctly.	Accepting with comment

In contrast to the DWS condition, students in the CSO condition conducted a deep discussion about the design problem. In addition, some prompts concerning questions (e.g., what is your suggestion to…), answers (e.g., from my perspective….), and reactions to answers (e.g., I agree but…), which were included in the collaboration script, transferred into the dyad's discourse. With respect to the domain-specific discourse quality, the dyad used 19 web design concepts in total (seven for *student 1* and 12 for *student 2*), which equal nine concepts without repetition for concepts. Five general concepts (e.g., homepage, frames, tables, web pages and website), four intermediate concepts (hyperlinks, publishing, title of website and navigation) were used during the discussion, but no specific web design concepts can be found. However, this excerpt reveals that the two students participated in high level collaborative activities. The dyad asked six high level questions, five high level answers, and five high level reactions. There were no questions, answers, or reactions in low level.

Interpretation of the discourse data

The students have reproduced the exact discourse structure provided by the collaboration script. Overall, the discourse represents high level collaborative activities. It can be seen that students in the CSO condition have not only responded to each other, but have also operated on and shared each others' ideas and answers to build better discussion about the design problem. The dyad was able to productively apply the different dimension of the collaboration script. The scripted roles were used flexibly. The dyad exchanged the role of asking questions, giving answers, and giving reactions during their discussion easily and without conflict. The collaboration script apparently facilitated students to apply the collaborative activities in the final discussion, which was realized without treatment. There are indications, however, that students may not be able to acquire and use the specific web design concepts, which were provided in the content. The case study shows that students used only some general and intermediate concepts, but failed to use any specific concepts. In this way, inadequate content scaffolds were integrated in this condition, which in turn did not lead to high quality of the domain-specific discourse. In contrast, the collaboration script led to many discussions about the design problem and enabled the students to engage in high level collaborative activities.

ICMO – discourse with incomplete concept maps only

The third example derives from the condition with incomplete concept maps only. In this section, an excerpt from students' discourse in the ICMO condition demonstrates how the dyad discussed different aspects concerning the images of their website.

Data of the conversational activities

This example presents 13 messages from *student 1* and 12 messages from *student 2*.

St1:	Do you still have further modifications for our *website* have been identified?
St2:	Yes, most of *images* in our *website* didn't appear after *publishing* the *website*.
St1:	Right, because *images*' files must be in English not in Arabic.
St2:	Why we have to do that?
St1:	I read in Wiki that someone solved this problem by changing names of *images*' files to English.
St2:	Ok
St1:	I have a suggestion for the *images* in all *web pages*.
St2:	What is your suggestion?
St1:	We have to add *captions* for all *images* in our *website*.

St2:	Why?
St1:	Because each *web page* involves a lot of *images* about the same town, thus we have to give short description about all *images*.
St2:	Good Idea
St2:	I think the dimensions of all *images* should be equal.
St1:	Do you mean *widths* and *heights* of *images*?
St2:	Exactly.
St1:	Ok.
St1:	I prefer to use *Gif* files instead of other types of *images* to reduce the *size of images*' files.
St2:	I think we can reduce the number of *images* in all *web pages* and create a *photo gallery* includes most of theses *images*.
St1:	Good Idea.
St1:	I suggest adding the *photo gallery in the homepage.*
St2:	I think we can create a new *web page* and devote it to *photo gallery*.
St2:	Did you see the Hong Kong's website example?
St1:	How the *navigation* to this *web page* will be done?
St2:	We have to add *hyperlinks* in all *web pages* to facilitate *navigation* to the *photo gallery*.
St1:	Ok and don't forget to add a new *interactive button* for *photo gallery* in the *homepage* like other *web pages*.
St2:	Of course.

This discourse is an example of students in the ICMO condition, who received only content scaffolding without receiving any support concerning collaborative activities. In the beginning, *student 1* started the discussion by asking a low level question (knowledge question) and s*tudent 2* responded to this question by giving a high level answer. Next, *student 1* accepted this answer and added a comment, so this segment was coded as high level reaction.

	Messages	**Codes**
St1:	Do you still have further modifications for our *website* have been identified?	Knowledge question
St2:	Yes, most of *images* in our *website* didn't appear after *publishing* the *website*.	High level answer
St1:	Right, because *images*' files must be in English not in Arabic.	Accepting with comment

After that, *student 2* asked a question for further explanation, therefore this question was classified as comprehension question. *Student 1* answered this question by giving a high level answer. Then *student 2* accepted this answer without any comment.

	Messages	Codes
St2:	Why we have to do that?	Comprehension question
St1:	I read in Wiki that someone solved this problem by changing names of *images*' files to English.	High level answer
St2:	Ok	Accepting without comment(s)

Subsequently, *student 1* posted a message, which was classified as comment; followed by a knowledge question from *student 2*. This question was responded to by *student 1*, who gave a high level answer.

	Messages	Codes
St1:	I have a suggestion for the *images* in all *web pages*.	Comment
St2:	What is your suggestion?	Knowledge question
St1:	We have to add *captions* for all *images* in our *website*.	High level answer

Again, *student 2* asked a comprehension question for further explanation and *student 1* answered this question with a high level answer. Next, *student 2* accepted this answer without comment.

	Messages	Codes
St2:	Why?	Comprehension question
St1:	Because each *web page* involves a lot of *images* about the same town, thus we have to give short description about all *images*.	High level answer
St2:	Good Idea	Accepting without comment(s)

Furthermore, *student 2* posted a message, which was coded as suggestion. This message was responded to by *student 1*, who asked a probing question for further clarification. *Student 2* answered this question by giving a low level answer and *student 1* accepted this answer without comment.

	Messages	Codes
St2:	I think the dimensions of all *images* should be equal.	Suggestion
St1:	Do you mean *widths* and *heights* of *images*?	Probing question
St2:	Exactly.	Low level answer

St1:	Ok.	Accepting without comment(s)

Next, *student 1* posted a new suggestion concerning size of images' files, but this suggestion was not responded to by *student 2*, who posted another suggestion concerning creating a photo gallery. *Student 1* responded to this suggestion by giving a low level reaction (accept without comment).

	Messages	**Codes**
St1:	I prefer to use *Gif* files instead of other types of *images* to reduce the *size of images*' files.	Suggestion
St2:	I think we can reduce the number of *images* in all *web pages* and create a *photo gallery* includes most of theses *images*.	Suggestion
St1:	Good Idea.	Accepting without comment(s)

Again *student 1* posted a new suggestion, but *student 2* responded to this suggestion by having a high level reaction (refusing with justification), followed by a knowledge question, which was not answered by *student 1*.

	Messages	**Codes**
St1:	I suggest adding the *photo gallery in the homepage.*	Suggestion
St2:	I think we can create a new *web page* and devote it to *photo gallery*.	refusing with justification
St2:	Did you see the Hong Kong's website example?	Knowledge question

Afterwards, *student 1* asked a comprehension question for further explanation about navigation to the photo gallery, which was responded to by *student 2*, who gave a high level answer. Finally, *student 1* had a high level reaction (accept with comment) with *student 2* having a low level reaction to that (acceptance without comment).

	Messages	**Codes**
St1:	How the *navigation* to this *web page* will be done?	Comprehension question
St2:	We have to add *hyperlinks* in all *web pages* to facilitate *navigation* to the *photo gallery*.	High level answer
St1:	Ok and don't forget to add a new *interactive button* for *photo gallery* in the *homepage* like other *web pages*.	Accepting with comment
St2:	Of course.	Accepting without comment

In this excerpt, each student engaged in different activities varying from asking questions, giving answers, giving reactions, to giving suggestion and comments. Regarding the domain-specific discourse quality, this discourse involved 39 web design concepts in total (24 for *student 1* and 15 for *student 2*) and 14 concepts without repetition for concepts, which varied from four general concepts (e.g., websites, images, and homepage), four intermediate concepts (e.g., publishing, hyperlinks, and photo gallery), to six specific concepts (e.g., caption, width, and Gif). With respect to collaboration skills, the dyad asked seven questions (three knowledge, three comprehensions, and one probing question). These questions can be classified as three questions in low level and four questions in high level, but all seven questions are cognitive questions. The students did not ask any metacognitive or coordinative questions. In addition, the dyad gave six answers (five high level answers and one low level answer) and the students gave seven reactions (five low level reactions and two high level reactions).

Interpretation of the discourse data

In general, the activities of the students in the ICMO-discourse took place without collaboration script. The collaborative activities varied greatly from high to low levels. In addition, students in the ICMO condition participated in intensive discussions about the design problem, but an overlap during the dyad's discourse can be identified. The students did not give answer to one question ("Do you still remember how to create it?"). It can be said that students in the ICMO condition were not able to adequately engage in higher level collaborative activities. However, it was clear that incomplete concept maps increased the quality of the domain-specific discourse. In the present case study, the dyads used all three levels of web design concepts (general, intermediate and specific concepts). Therefore, incomplete concept maps may not produce clear specific outcomes that are associated with all dimensions of collaboration skills, but they are able to lead the student to focus more on web design concepts compared to the CSO-student.

CSICM– discourse with collaboration script and incomplete concept maps

The last excerpt shows how a dyad from the condition with collaboration script and incomplete concept maps dealt with aspects concerning the improvement of the homepage of their website.

Data of the conversational activities

The following discourse shows intensive discussion between two students. Each student sent a large number of segments (16 messages for *student 1* and 15 messages for *student 2*):

St1: What is your perspective about our *website*?

St2: Generally, the *website* looks good but I think the *homepage* should be improved.

St1: I support your opinion because the *homepage* looks very traditional and isn't attractive for visitors.

St1: What we have to do to improve it?

St2: I think using *themes* may lead to make it better.

St1: I agree but we have to apply the *theme* on whole *website* not only the *homepage*.

St2: Yes of course, all *web pages* should appear in the same way.

St1: What is your opinion about "*Refined theme*"?

St2: I do not like because it is a dark *theme* and most of the *website's text* in black color.

St1: Ok but this *theme* looks good and I think there is no problem if we change the *text color*.

St2: No I prefer to use another light *theme* to save the time of modification.

St1: What is your opinion about "*Blends theme*"?

St2: I agree it looks good too and I think it fits the *website's text color* in all *web pages*.

St1: Right, it looks simple and attractive *theme*.

St2: What is your perspective about adding a *Marquee* in the *homepage*?

St1: Good idea to use *marquee* and to put the *sub title* of the *website* as a *marquee's text*.

St2: I have another perspective, which is keeping the *main title* and *sub title* without any changing and to add a welcome sentence includes the *main title* as a *marquee's text*.

St1: Ok I support this suggestion but the *marquee's text* has to be in dark color.

St2: Sure, and the *marquee's background color* has to be in light color.

St1: Should we change the *background color* of the *marquee's text*?

St2: I prefer to use the same *website's background color* because we don't need *marquee's background*.

St1: Me too I prefer to hide the *marquee's background.*

St2: What we have to do regarding the language of *marquee's text?*

St1: I prefer to write *marquee's text* in English language.

St2: I disagree I think it's better to write the *marquee's text* in both languages.

St1: Ok and in this case the *marquee's direction* will be from left to right.

St2: Exactly and I prefer to set the *marquee's behavior* as *alternate*.

St1: Right this option fit the two languages.

St2: What we have to do regarding *marquee's text speed*?

St1: I prefer to keep the default settings.

St2: Ok me too.

The following analysis of this excerpt shows the extent to which the combination between collaboration script and incomplete concept maps affected the dyad's discourse. The dyad's discourse started with an evaluation question by *student 1* which was then responded by *student 2*, who sent a high level answer. This answer was accepted with a comment from *student 1*.

	Messages	Codes
St1:	What is your perspective about our *website*?	Evaluation question
St2:	Generally, the *website* looks good but I think the *homepage* should be improved.	High level answer
St1:	I support your opinion because the *homepage* looks very traditional and isn't attractive for visitors.	Accepting with comment

Again, another planning question was asked by *student 1* to identify the suggestion for the homepage of the website. Next, *student 2* responded to by giving answer, which was coded as a high level answer. Then, *student 1* gave a high level reaction by accepting this answer with comment. Likewise, *student 2* accepted this reaction with another comment.

	Messages	Codes
St1:	What we have to do to improve it?	Planning question
St2:	I think using *themes* may lead to make it better.	High level answer
St1:	I agree but we have to apply the *theme* on whole *website* not only the *homepage*.	Accepting with comment
St2:	Yes of course, all *web pages* should appear in the same way.	Accepting with comment

The next message, posted by *student 1*, was a question including an idea for evaluating; thus, this question was classified as an evaluation question. *Student 2* reacted to this idea by refusing it and providing a justification. Similarly, *student 1* responded to this reaction by having another high level reaction (acceptance with comment). Again, *student 2* reacted to the partner's reaction by refusing it and providingl a justification.

	Messages	Codes
St1:	What is your opinion about "*Refined theme*"?	Evaluation question
St2:	I do not like because it is a dark *theme* and most of the *website's text* in black color.	Refusing with justification
St1:	Ok but this *theme* looks good and I think there is no problem if we change the *text color*.	Accepting with comment
St2:	No I prefer to use another light *theme* to save the time of modification.	Refusing with justification

Another evaluation question was asked by *student 1*. This question was responded to by *student 2*, who gave a high level reaction (acceptance with comment). In addition, *student 1* supported this reaction by accepting it with comment.

	Messages	Codes
St1:	What is your opinion about "*Blends theme*"?	Evaluation question
St2:	I agree it looks good too and I think it fits the *website's text color* in all *web pages*.	Accepting with comment
St1:	Right, it looks simple and attractive *theme*.	Accepting with comment

After that, *student 2* asked her partner to evaluate an idea concerning adding marquee in homepage. *Student 1* accepted this idea with comment. Next, *student 2* gave a high level reaction by refusing the partner's idea and providing a justification. This reaction was followed by two additional high level reactions first from *student 1* and then *student 2*.

	Messages	Codes
St2:	Do you think adding a *Marquee* meets the required standards of the *homepage*?	Evaluation question
St1:	Yes, I think it's a good idea to use *marquee* and to put the *sub title* of the *website* as a *marquee's text*.	High level answer
St2:	I have another perspective, which is keeping the *main title* and *sub title* without any changing and to add a welcome sentence includes the *main title* as a *marquee's text*.	Refusing with justification
St1:	Ok I support this suggestion but the *marquee's text* has to be in dark color.	Accepting with comment
St2:	Sure, and the *marquee's background color* has to be in light color.	Accepting with comment

Afterwards, s*tudent 1* attempted to coordinate the background colour regarding marquee's text with her partner by asking a coordinative question. *Student 2* responded to this question by giving a high level answer, which was accepted with comment by *student 1*.

	Messages	Codes
St1:	Should we change the *background color* of the *marquee's text*?	Coordinative question
St2:	I prefer to use the same *website's background color* because we don't need *marquee's background*.	High level answer
St1:	Me too I prefer to hide the *marquee's background.*	Accepting with

	comment

Furthermore, *student 2* asked a planning question concerning the language of marquee's text, which was responded to by *student 1*, who gave a high level answer. However, this answer was refused with justification by *student 2*. Then, *student 1* accepted this justification and gave a comment. *Student 2* supported the partner's reaction by having another high level reaction, which was supported also by *student 1*, who accepted this reaction with comment.

	Messages	**Codes**
St2:	What we have to do regarding the language of *marquee's text?*	Planning question
St1:	I prefer to write *marquee's text* in English language.	High level answer
St2:	I disagree I think it's better to write the *marquee's text* in both languages.	Refusing with justification
St1:	Ok and in this case the *marquee's direction* will be from left to right.	Accepting with comment
St2:	Exactly and I prefer to set the *marquee's behavior* as *alternate*.	Accepting with comment
St1:	Right this option fit the two languages.	Accepting with comment

Next, another planning question was asked by *student 2*, which was responded to by *student 1*, who gave a complete answer to this question. Finally, *student 2* accepted this answer, but without providing a comment.

	Messages	**Codes**
St2:	What we have to do regarding *marquee's text speed*?	Planning question
St1:	I prefer to keep the default settings.	High level answer
St2:	Ok me too.	Accepting without comment

According to the analysis of this example, the dyad's discourse could be described as an intensive and deep discussion about the design problems. This case study shows that the dyad used 43 web design concepts in total (20 for *student 1* and 23 for *student 2*) and 19 concepts without repetition for concepts, which varied among three general concepts (website, homepage, and web page), four intermediate concepts (theme, marquee, sub title, and main title), and 12 specific concepts (e.g., Refined theme, marquee's txt, and alternate). Regarding collaboration skills, this case study involved eight questions. All questions were classified as high level questions (three planning, four evaluating, and one coordinative question). As shown in this excerpt, the dyad did not ask any cognitive question. Moreover, all six answers of the dyad were coded as high level answers. Finally, students in the CSICM condition gave 17 high level reactions (12 accepted idea or answer with comment and four refused idea or answer with justifications) and one low level reaction.

Interpretation of the discourse data

In the CSICM-discourse, students were expected to follow a specific discourse structure according to the social script component equivalent to the CSO-discourse and focus on web design concepts equivalent to the ICMO-discourse. The data of the conversational activities showed that this was the case. An analysis of the individual messages revealed that the collaborative activities conducted in the final unstructured chat session had clearly matched the exact discourse structure provided by the collaboration script. In reference to a CSCL approach, which mainly aims to foster high level collaboration skills between learners, this discussion thread may be superficially considered as an example for practicing high level collaboration skills. The dyad had easily established consensus without overlap. Apparently, the learners did not suffer from communication channel of text-based chat, but could conduct a deep discussion about the design problem and agree on a joint solution. In addition, the students produced a large number of web design concepts in all three levels (general, intermediate, and specific concepts), which reveals a high quality of the domain-specific discourse. The present CSICM-case-study can be therefore regarded as an example of a high level domain-specific discourse and collaboration skills, where the students conducted intensive discussions involving a large number of the web design concepts by following the exact discourse structure, which was provided by the collaboration script through the learning phases.

Discussion

The purpose of this study was to investigate the effects of two types of scaffolding (social and content scaffolding) on collaborative learning and individual learning outcomes related to design and building of websites in an online DBL environment. Collaborative learning outcomes were measured according to three dependent variables: (a) content-related discourse quality, (b) collaboration skills, and (c) quality of published websites. Individual learning outcomes were measured with respect to: (1) factual knowledge on web design and standards for designing websites and (2) web design skills. In this chapter, the major findings of the study will be interpreted on the grounds of the conceptual framework of the study and prior findings. The results of the study are then summarized, followed by study limitations. Finally, implications for future research will be discussed.

This study aimed to engage the students in design tasks to plan, build, and publish websites, which is supposed to facilitate the acquisition of both domain-general and domain-specific knowledge (Kolodner, 2002; Puntambekar & Kolodner, 2005). However, design tasks are defined as ill-structured problems that encourage students to engage in design-based discussions, which involve asking questions, searching and giving answers, evaluating answers and engaging in discussions about the content. Therefore, both social and content learning processes may require additional support especially when such processes are conducted in an online context. Collaboration scripts are a promising social support that can improve students' collaboration and interaction (Kollar et al., 2007). They may also have the potential to facilitate the communicative-coordinative processes between students and guide them through complex processes, such as engaging them in high levels of discussions and social interactions (Hoppe et al., 2000). In addition, collaboration scripts have been successfully implemented into CSCL environments with the help of prompts (Nussbaum et al., 2002; Stegmann et al., 2007; Weinberger et al., 2010). Incomplete concept maps are another kind of scaffolding that focuses on supporting content learning by visualizing and managing necessary knowledge for the design task (Tergan & Keller, 2005), increasing and facilitating content-related discussions (Jacobson & Levin, 1995), and stimulating the students to think more about contents and their relationships (Schau et al., 1997). The combination of both collaboration scripts and incomplete concept maps has been argued to potentially facilitate both social and learning content processes of design and building websites. In this way, collaboration scripts and incomplete concept maps were used to foster students' discourse in order to engage them in higher levels of inquiry-based discussions and content-related discourses compared to the expected levels in the absence of those scaffolds.

The results of the study showed that supporting students through their design activities by the collaboration script and incomplete concept maps can lead to effective online DBL. Moreover, additional scaffolding can change the students' discourse and can be successfully directed to improve students' knowledge acquisition and skill development in online DBL. The combination between collaboration script and incomplete concept maps proved to substantially affect learning outcomes. Results showed that implementing social and content scaffolds in an online DBL environment revealed the efficiency of the scaffolding regarding content-related discourse quality, collaboration skills, and quality of published websites and the acquisition of both factual knowledge and skills on web design. Therefore, this study shows that prompt-based collaboration scripts and incomplete concept maps can be implemented in online DBL to support social and learning content activities related to design and building websites with comparable efficiency. It seems that the collaboration script and incomplete concept maps should be combined to lead to the highest learning gains. In the following sections, these results will be discussed and interpreted in more detail.

8.1. Social Support by Collaboration Script

First of all, the effects of the computer-supported collaboration script on collaborative learning outcomes and on individual learning outcomes related to design and building websites will be discussed.

8.1.1. Effects of collaboration script on collaborative learning outcome

Although the last (unstructured) chat session was conducting with the same goal, namely improving and republishing the websites, over the different conditions, students spent less time in conducting their discussions with the collaboration script compared to the students in the ICMO and the CSICM conditions. However, the results in particular showed that the collaboration script approach (Kollar et al., 2006) could partially improve the collaborative learning outcomes in the online DBL environment. Although the collaboration script did not show positive effects on content-related discourse quality, it had substantial effects on all three dimensions collaboration skills and a medium-sized positive effect on the quality of published websites.

The results concerning *content-related discourse quality* indicate that although the students in the CSO condition were supported with the collaboration script for longer time for supporting their online discussions during the treatment, the level of focusing on the content and the web design concepts during the unstructured chat session was not of adequate depth and span to improve the quality of content-related discourse processes. Probably, the collaboration script that was provided to the students in the CSO condition was not adequate to engage them in high level of content-related discourse processes through the unstructured chat session. Therefore, in the light of the “zone of proximal development” (ZPD) (Chang et al., 2002; Vygotsky, 1978), engaging the students in high levels of content-related discourse processes during the unstructured chat session may be too difficult (might be beyond their ZPD), which in turn may have hindered the students to discuss the content deeply and focus more on the web design concepts that would engage them in higher quality content-related discourse. This confirms Admiraal et al.’s (1998) findings that showed engaging students in online discussions without adequate content scaffolding may engage the students in superficial discussions about the content.

Regarding the results related to the *collaboration skills*, it is interesting to see that the collaboration script seemed to be internalized by the students to a relatively large extent, given that the effects on the discussions after the treatment were that strongly coined by the script instruction. Such effects may have probably been even stronger as long as the script was still present, but actually this study can not confirm that in absence of real process data. Therefore, it might be speculated that the positive effect of the collaboration script on *collaboration skills* may indicate that the prompt-based collaboration script seemed to engage the students in higher level inquiry-based discussions, which in turn seemed to help students lead more sophisticated discussions. This relates to findings from prior research that demonstrated that collaboration scripts can improve students' online discussions (e.g., Kollar et al, 2007; Schoonenboom, 2008). In addition, using the collaboration script that was based on ideas from the guided peer questioning approach seemed to engage the students in elaborative strategies of questioning, answering, and explaining, which may facilitate and guide the students to ask more questions, give more answers, and give more responds to answers in the form of higher level discussions. Similar findings were noted in prior research, such as King (1999) and O'Donnell and Dansereau (1992).

With regard to the *quality of published websites*, the results showed that the collaboration script enabled the students to improve the quality of published websites. This positive effect may be associated with effective communication and task coordination due to collaboration script , which may have also promoted high level online discussions., High level discussions may have probably help them to discuss and understand the constructive standards for designing websites in order to improve the quality of published websites. Another possible explanation for improving the quality of published websites can derive from the CSO case study. The collaboration script may have supported the students to critically evaluate their learning partners' contributions and to anticipate critical review on their own contributions. This may have fostered a more critical discourse between the dyads about their published websites and the constructive standards for designing websites. Finally, this may have helped the students to effectively improve their websites before getting at the stage of the final publishing.

8.1.2. Effects of collaboration script on individual learning outcomes

The collaboration script was designed intending to improve individual learning outcomes by using prompt-based collaboration scripts as tools for improving the quality of content-related discussions (King, 1999), as well as to structure the interactions between learning partners (Kollar et al., 2007; Weinberger et al., 2007) and facilitate communicative and coordinative processes between students (Hoppe et al., 2000), which may finally lead to the acquisition of domain-specific knowledge. However, this aim has proven difficult in earlier studies, but that it was reached in this study. In general, the computer-supported collaboration script that was used in this study had positive effects on individual knowledge outcomes both *factual knowledge on web design and standards for designing websites as well as web design skills*. A possible explanation for such results could be the extended timeframe of treatment. Perhaps, compared to early studies where the collaboration script was used for a shorter timeframe, the more extensive learning phase employed in this study may have promoted such positive effects. The students in the CSO condition worked with collaboration script through (12) chat sessions over (34) days before conducting the final unstructured chat session and the post-tests. In this way, the collaboration script may have been internalized and used as a tool toward substantial content-related discussions instead of long coordinative discussions about who does what, which in turn may facilitate the acquisition of both *factual knowledge and skills needed for designing websites*. Moreover, this might be explained by the different roles followed by the students in discussions. Such roles could be considered like roles of teacher and student that may have facilitated the construction of relations between the learned content and the achieved design problem. This relates to findings from prior studies that used role distribution as a way to structure CSCL (e.g., Strijbos, Martens, Jochems, & Boers, 2004).

8.2. Content Support by Incomplete Concept Maps

In this section, the effects of incomplete concept maps on collaborative and individual learning outcomes related to design and building websites will be discussed.

8.2.1. Effects of incomplete concept maps on collaborative learning outcomes

The results showed that the students in the ICMO condition were able to use web design concepts through the last unstructured chat session more than those in the CSO condition, but less than the students in the CSICM condition. Overall, the incomplete concept maps partially affected the collaborative learning outcomes. Incomplete concept maps showed substantial effects on content-related discourse quality. Conversely, incomplete concept maps produced no significant effects on all three dimensions of collaboration skills (high level questions, high level answers, and high level reactions to answers) and quality of published websites.

With regard to *content-related discourse quality* that refers to the number of web design concepts used during the final chat discussion without any treatments, a beneficial effect of incomplete concept maps could be demonstrated. Using the incomplete concept maps for longer time through the treatment may have provided content-related support, and that kind of support proved to be effective for content-related discussions (e.g., Fischer & Mandl, 2001; Novak, 1995; O'Donnel et al., 2002). Incomplete concept maps also seemed to engage the students in different activities, which may have encouraged the students to talk more about concepts and relations that existed and missed from maps. This may have enabled the students to learn the content deeply and focus more on the web design concepts, which in turn may have engaged the students in higher level content-related discussions when they worked without any treatments. Furthermore, a possible explanation for those results could be that the effect of the incomplete concept map may have been mediated by an increased attention to the contents of the learning modules outside of the chat sessions. For example, after the first couple of sessions, the students who were provided with incomplete concept maps may have more intensively studied the tutorial lessons that explained the different FrontPage functionalities, as they may have expected that they would (again) receive the task to complete an incomplete concept map, which may have encouraged the students to focus more on web design concepts and its relationships. Finally, this may have improved the quality of content-related discussions. However, such data was not checked due to the limitations of the current study that included only the processes-oriented outcomes and outcomes related to the design and building of websites in an online DBL environment. Although there are different possible explanations for its occurrence, the beneficial effect of incomplete concept maps on *content-related discourse quality* is in line with the findings of prior research on the effects of concept maps (Armstrong, 2003; Novak, 1998).

With respect to the *collaboration skills*, the students' discussions in the ICMO condition were supported with incomplete concept maps through several chat sessions, but through the unstructured chat session the students could not ask high level questions, give high level answers, or give high level reactions to answers when they were compared to the control condition, which led to low level of collaboration skills. Probably, the incomplete concept maps that were provided to the students through the treatment were not enough for improving the collaboration between the students. The nature of the design task, the online DBL context, students' engagement in that context without adequate support for collaboration, communication and interactions between the participants seemed to lead to low levels of student interaction in the unstructured chat session (Cohen, 1994; Teasley & Roschelle, 1993), which in turn may hamper students to apply what they learnt collaboratively to improve the *quality of their published websites.* These findings are in line with prior research that demonstrated that collaborative learning through computer-mediated learning environments does not guarantee successful interaction between learning partners, since they often face difficulties related to lower level of social interaction (Admiraal et al., 1998; Beuschel, 2003; Stahl, 2002) and how they interact with each other (Barron, 2000; Cartwright, 1968; Kiesler, 1992; Straus & McGrath, 1994), and the quality of discussions (Admiraal et al., 1998; Doise, 1990). For example, in the study of Admiraal et al. (1998; see chapter 3 section 3.5.3) the students who were engaged in web-based conferencing without appropriate social scaffolding produced low level of online discussions.

Although the results show that incomplete concept maps enabled the students to acquire knowledge and skills related to design and build websites, there is no positive effect for incomplete concept maps on the *quality of published websites*. The students in the ICMO condition produced lower quality websites compared to the students in the CSO and the CSICM conditions. This means that although the students understood the constructive standards for designing websites and acquired the content and skills necessary to build websites, they did not produce high quality websites. This may due to that the incomplete concept maps kept students discussing content on a more factual level, but kept them from talking about how to apply that knowledge to construct their websites.

8.2.2. Effects of incomplete concept maps on individual learning outcomes

The results regarding individual learning outcomes show that incomplete concept maps fostered the *individual acquisition of factual knowledge on web design and standards for designing websites as well as web design skills*. There was a substantial and significant positive effect of incomplete concept maps on both individual web design knowledge and skills. These effects are in the same line with the effects of the collaboration script regarding such learning outcomes. The students succeeded to acquire knowledge and standards related to the design and building of websites as well as to apply web design skills individually and independently of the collaboration script. It is possible that incomplete concept maps provided the students with visual representations that may have supported a deep understanding of the content, which finally may have facilitated the acquisition of factual knowledge and skills related to the design and building of websites. Furthermore, it might be speculated that incomplete concept maps encouraged the students to conduct more talk about concepts and its relations as well as to increase their discussions for seeking missing information in maps, which in turn may have positively affected the acquisition of web design knowledge and skills. These results contradict the findings by van Boxtel and her colleagues (2000). This may occur due to the fact that the incomplete concept maps in this study were used over a long time period in an asynchronous context for supporting the students' online discussions during the treatment. The students in the ICMO condition worked with incomplete concept maps through twelve chat sessions over 34 days before the final unstructured chat session and the post-tests. Perhaps, in contrast to the study by van Boxtel and her colleagues (2000), where the concept maps were used collaboratively for a shorter timeframe (maximum of 45 minutes), the more extensive use of incomplete concept maps in this study may have led to different results with respect to individual learning outcomes. However, similar findings have been reported by Barenholz and Tamir (1992) and Boujaoude and Attieh (2003), who argued that using concept maps as content scaffolding is likely to facilitate the acquisition of domain-specific knowledge, improve the retention, and understanding of information. In addition, these findings work in the same line with prior findings of Baker (2003), Suthers and Hundhausen (2003), Toth et al. (2002), and Wehry et al. (2010), who demonstrated that, engaging students in seeking missing information activities may increase their discussions about the content and encourage them to think more about the content, and finally also learn more individually.

8.3. Effects of the Combination of the Factors "Collaboration Script" and "Incomplete Concept Maps"

This study aimed to facilitate students' interactions by using computer-supported collaboration scripts (as social scaffolding), as well as content learning by using incomplete concept maps (as content scaffolding). Despite the lack of interaction effect with respect to collaborative and individual learning outcomes, when both treatments were combined, the collaborative and individual learning outcomes can be improved. The students who were provided with both treatments reached a higher level in different collaborative and individual learning outcomes compared to those in all other conditions.

One possible explanation for the missing interaction effect between the two treatments on the learning outcomes is the students seemed to face load (Sweller, 1988) by multi structures that existed especially in the combined condition. The two treatments together may have directed the attention of the students towards too many instructions in each learning phase, which in turn may have led to strain the cognitive load of students (e.g., Dansereau, 1988; Gräsel, Fischer, & Mandl, 2001). However, there are no further indications that the students could not use the collaboration script and incomplete concept maps simultaneously. Due to the instructions provided prior to the small group discussions (see section 6.2.2.3) and the unsystematic observation of participants' log files in all conditions, students in all experimental conditions were able to sufficiently handle the online learning environment. Further analyses and studies may be necessary to evaluate and identify to what extent a combination of different scaffolds may confuse the students through their discussions especially in the combined condition.

The combination of both scaffolds was supposed to result in a high quality discourse regarding content and collaboration. Basically, additive effects have been expected regarding collaborative and individual learning outcomes. Although the results showed there was no interaction effect between the collaboration script and incomplete concept maps, the combination of both scaffolding produced superior results more than those that could be achieved with the collaboration script and incomplete concept maps individually. In the following sections, I will elaborate on the effects of each combination of the treatments and provide the theoretical background related to each combination-effect found.

8.3.1. Effects of the combination of collaboration script and incomplete concept maps on collaborative learning outcomes

With respect to *content-related discourse quality*, no interaction effect could be found. It was shown that using only the collaboration script was not able to engage the students in higher level *content-related discourse quality,* whereas using only the incomplete concept maps enabled the students to engage in high-quality of content-related discussions compared to the control group. However, the combination of collaboration script and incomplete concept maps led to the greatest positive influence regarding the *content-related* *discourse quality.* It is possible that supporting the students both with the collaboration script and incomplete concept maps for a longer time may have enabled the students to internalize the collaboration script, which in turn may have led to the facilitation of communicative and coordinative processes taking place through the unstructured chat session (Hoppe et al., 2000). At the same time, using the incomplete concept maps simultaneously may have provided a conceptual support concerning the content, which may have encouraged the students to use more web design concepts when they worked without any support. In this way, combination between both treatments may have enabled the students to engage in higher level inquiry-based discussions, learn the content deeply, and address more web design concepts. Therefore, the students in the CSICM condition may have been able to engage in higher level *content-related discourse quality* more than those in the ICMO condition who had learned without social scaffolding.

Furthermore, the results regarding the collaborative learning outcomes showed that the collaboration script was able to improve every dimension of *collaboration skills*, whereas there was no positive effect of the incomplete concept maps on every dimension of *collaboration skills*. However, the combination between the two treatments improved the *collaboration skills* more than implementing any of the two treatments individually. Even though there was no interaction effect between both treatments, the students in the CSICM condition produced high levels in all dimensions of collaboration skills compared to the students in the ICMO and the DWS conditions. However, they outperformed the students in the CSO condition only regarding high level reactions to answers. The case studies suggest that although the students in the ICMO condition may not be able to engage in all dimensions of collaboration skills, they are able to engage in high level of content related discourse quality. In this way, supporting the students with the prompt-based collaboration script and incomplete concept maps together seemed to lead the students to conduct more elaborative discussions focusing on more elaboration of the content and enable the students to engage in strategies of questioning, answering, and giving reactions to answers, which at the end may have enabled the students in the CSICM condition to outperform the students in the ICMO and the DWS conditions in all three dimensions of collaboration skills. Moreover, such combination between the two treatments seemed to enable the students to increase their discussions about each single answer and support their reactions to answers with more comments and justifications compared to students in the CSO condition who did not receive conceptual support concerning the content. This may be the reason why the students in the CSICM condition outperformed those in the CSO condition only with respect to high level reactions to answers, but there was no statistically significant difference between the two conditions regarding high level questions and high level answers.

With respect to the *quality of published websites*, the results showed that the collaboration script can improve the quality of published websites more than the control condition. On the other hand, there is no significant difference between incomplete concept maps and unstructured condition. Moreover, the students in the CSICM condition more often produced high quality websites compared to all other conditions. The greatest positive influence of the combination between both treatments may be due to the collaboration script which may have been internalized and used for structuring the interactive processes between learning partners, which is in the same line with prior researches, such as (Kollar et al., 2006). Simultaneously, incomplete concept maps seemed to enable the students to improve knowledge retention and engage them in visual learning that is expected to improve creative thinking and deep understanding of the content. This in turn may facilitate the acquisition of knowledge and skills needed for building and publishing high quality websites, which confirms the findings of concept maps reported by Boujaoude and Attieh (2003), van Drie and van Boxtel (2003), and Williams (2004). Thus, supporting the students with collaboration scripts and incomplete concept maps may enable them to easily communicate, interact, and transfer their knowledge and experiences when discussing the problems and weaknesses of their websites, which at the end may also enable them to improve their websites more than any other condition.

8.3.2. Effects of the combination of collaboration script and incomplete concept maps on individual learning outcomes

Overall, no interaction effects can be identified with respect to the individual learning outcomes. In terms of both factual knowledge on web design and standards for designing websites, as well as web design skills, the results showed that the individual learning outcomes can be achieved by using any of the treatments individually. However, the combination of collaboration script and incomplete concept maps led to the greatest positive influence, going beyond what could be achieved by each of the two scaffolds individually. As both social and content scaffolding facilitated the acquisition of web design knowledge and skills, it might be expected that both treatments add up. A possible explanation is that the collaboration script probably fostered learning activities that would have led to the acquisition of domain-specific knowledge and domain-specific skills. The high levels of all three dimensions of collaboration skills and the consequence of having appropriate feedback during the dyads' discussions may have led to the improvement of the individual learning outcomes. In addition, the prompt-based collaboration script seemed to engage the students in a guided peer questioning strategy to ask more task-related, thought-provoking questions. The case studies showed that the students were able to ask this kind of questions through the unstructured chat session. Such kind of questions is likely to engage students in high-level interactions, which may facilitate the acquisition of the individual learning outcomes (King, 1990). On the other hand, simultaneous incomplete concept maps seemed to enable group members of the CSICM conditions to elaborate more deeply on contents and therefore better retain the knowledge acquired (see Hall et al., 2004). Moreover, this scaffold may encourage students to think more about concepts and relations in content (see Schau et al., 1997) and engage the students in meaningful content-based discussions, which in turn may lead to the facilitation of the acquisition of both factual knowledge on web design concepts and web design skills. This agrees with assumptions of Baker (2003); Suthers and Hundhausen (2003); Toth et al. (2002); Wehry et al. (2010).

8.4. Summary of the Results

The results of this study reflect a clear picture of process-oriented outcomes and outcomes related to the design and building of websites in an online DBL environment. Comparing the results in the unstructured control condition to the other three conditions confirms that additional scaffolding can improve the collaborative and individual learning outcomes in online DBL. As the current study indicates, implementing social and content scaffolds in an online DBL environment is adequate for improving content-related discourse quality, collaboration skills, and quality of published websites in a subsequent collaborative transfer task, as well as the acquisition of factual knowledge and skills on web design. Most results correspond to prior findings of collaboration scripts and concept maps that concern collaborative and individual outcomes. In line with prior research (Kollar et al., 2007; Weinberger et al., 2005), the prompt-based collaboration script seemingly helped learners lead more sophisticated discussions. Furthermore, in line with results of studies on the collaborative use of concept mapping techniques (e.g., Fischer et al., 2002), the incomplete concept maps provided the students with effective conceptual support concerning the domain-specific content of the task. With respect to how collaboration scripts and incomplete concept maps work together in online DBL, the combination of collaboration script and incomplete concept maps evoked the most favourable results on all dependent variables, going beyond what could be achieved by each of the two scaffolds alone. In the current section, the results of the collaboration script and incomplete concept maps will be summarized.

The collaboration script seemed to be an appropriate scaffold in the online DBL environment that supported the students to achieve both collaborative and individual outcomes. Although the collaboration script could not improve content-related discourse quality, it seemed to be an adequate scaffold to support all dimensions of collaboration skills of the participants in the online DBL. In addition, although not expected, the collaboration script was able to support the students to publish high-quality websites. Regarding the individual learning outcomes, the results showed that the use of the collaboration script for a long learning period seemed to be an adequate scaffold for the individual acquisition of web design knowledge and skills. Furthermore, the combination between the collaboration script and incomplete concept maps led to more promising collaborative and individual outcomes compared to using the collaboration script individually.

Overall, *incomplete concept maps* may work well as content-scaffolding on the collaborative level of outcomes through online DBL. The incomplete concept maps showed positive effect only on content-related discourse quality. The students in the condition with incomplete concept maps seemed to focus on content-aspects of the learning task rather than to engage in transactive discourse (Dansereau, 1988; Teasley, 1997). Simultaneously, incomplete concept maps have not been considered as appropriate scaffolds for improving the quality of published websites. Regarding web design knowledge and skills, incomplete concept maps seemed to have acted as an appropriate support, which the students became dependent on for facilitating the accomplishment of individual learning outcomes. In this way, incomplete concept maps may highlight more individual approaches to the learning task. Combination between incomplete concept maps and the collaboration script may lead to greater improvement regarding domain-general knowledge. Also, this combination may be responsible for enabling students to acquire more factual knowledge on web design concepts and web design skills.

8.5. Limitations of the Study

The study has several limitations that need to be addressed in order to evaluate its implications for educational practice. These concern (a) the ecological validity, (b) the analysis of content-related discourse processes, and (c) the instructional approach of using collaboration scripts and incomplete concept maps.

Overall, the study was conducted in a generally ecologically valid setting. The students have engaged in the study as a preparation part for a mandatory web design course. The online DBL environment was used as a substitute context for the standard face-to-face course. On the grounds of prior findings and a constructivist perspective, it can be argued that the students have achieved collaborative and individual outcomes in a more active way than what it usually occurs in more traditional courses (Kern, 1995). However, the results need to be confirmed in a variety of settings with various learning materials, since it is still unclear to what extent the complexity of the design problem can be addressed in similar ways.

A problem of the current study refers to the measurement of web design knowledge and skills. Focusing on other perspectives of measuring design-knowledge is required in order to support the findings. For example, measuring the acquisition of design-knowledge according to different categories of knowledge, such as stages (i.e., ways to structure how design progresses through successive iteration and comprehensiveness of detail), values (i.e., personal values like social goals), roles (i.e., who rather than the how, like personas), principles (i.e., ways to solve particular design problems), patterns (i.e., templates to solve common problems), techniques (i.e., tips and tricks), and design psychology (i.e., cognitive tricks and traps of which designers should be aware), as suggested by Hoadley and Cox (2009), might be a valuable alternative to the approach adopted here.

The researcher encountered difficulty in using university labs for logging in the online DBL environment and conducting all the students' discussions. Some difficulties related to the labs (e.g., numbers of computers connected to the Internet in different labs and coordinating available times of labs with available free times for participants) and the participants (e.g., coordinating available times for the students in each dyad). Therefore, the teacher identified specific procedures that allowed the students to conduct some small groups' sessions at home and in different times according to the available time of each dyad (see chapter 6, section 6.2.2.3). Future studies should depend on full-time students and identify a controlled lab-environment for the study with all computers being connected to the Internet and to tests relevant to the study to ensure equivalency.

Furthermore, the students in the online DBL environment worked in dyads, which remained the same throughout the experiment. Therefore, it would be interesting to conduct further empirical studies regarding the facilitation of groups which 'meet' online by chance and only once. The effects of the collaboration script and incomplete concept maps just for a single collaboration session with different learning partners in each session needs to be examined, which may lead to different learning outcomes. It may be beneficial to investigate to what extent students' shared knowledge shifts from conducting the discussions with the same learning partner to initially anonymous online dyads.

Acceptance of computer-mediated learning (cf. Richter, Naumann, & Horz, 2001) is a problem that concerns CSCL environments. Through the current study, the students' access to the learning environment, apart from the small groups' discussions and the plenary sessions, have not been identified. Differences regarding acceptance of computer-mediated learning between the experimental conditions is unclear. Therefore, looking at how the students were online or using Likert-scale items (e.g., "I enjoyed working in the online DBL environment very much") for measuring the students' acceptance may be helpful for similar future studies.

Through the online DBL, despite the fact that using permanent scaffolds to support the students through their design activities led to substantial effects on collaborative and individual learning outcomes, the collaboration script and incomplete concept maps worked independently from each other. There was not any interaction effect regarding all dependent variables. An indication for that may be that using both treatments together led to students' cognitive load (Sweller, 1988), which may have appeared during the students' discussions. Therefore, conducting elaborated interviews with the participants may be needed for a more thorough understanding of what was observed in discourse, such as the cognitive load degree that may have appeared during the students' discussions, especially in the combined condition.

One main limitation of the current study is that the analyses that were conducted only addressed processes-oriented outcomes and outcomes related to the design and building of websites in an online DBL environment. The collaborative learning outcomes were measured in a further collaborative task through the unstructured chat session rather than with analyzing the process data.

8.6. Implications for Future Research

Based on the results of this study, there are at least three possible avenues for future research. First, the traditional scaffolding can be defined as a temporary structure that is used to support students and is gradually removed when learners are able to perform without it. This definition has been challenged (Puntambekar & Hübscher, 2005) due to the changes in and limitations of online tools. Traditional scaffolding is provided by an instructor or by peers according to the individual needs of each student, and at the end is faded away. In recent learning settings, the same type of scaffolding is usually provided to all students without customization for individuals and in most cases, support is permanent and unchanging. Regarding online DBL environments, it is unknown to what extent using prompts, which were integrated in the collaboration script as traditional (faded) scaffolding to solve ill-structured problems, will assist or hinder the students in similar or different problem-solving situations. In other words, do faded prompts of the collaboration script in an online DBL environment facilitate cognitive flexibility? Cognitive flexibility is a term which is used to describe the students' ability to switch their behavioural response according to the situational context (Spiro, Feltovich, Jacobson, & Coulson, 1991). An ideal problem-solver would be to find new strategies as solutions for new problems and modify existing strategies to fit the needs of the new problem. However, it would be difficult to provide an answer to this question above, constituting it an area of possible research. Faded prompts in online DBL may be an area of research that has not been previously considered. What differences in learners and instruction between traditional (faded) and permanent (non-faded) exist? Is faded scaffolding effective in the online DBL? How will traditional and/or permanent scaffolding affect the transfer of knowledge from one problem-solving situation to another?

Secondly, the impact of the prompt-based collaboration script on individual creativity is also a critical issue that could be examined in the online DBL context. In an ill-structured problem, the problem can be solved in many possible ways (Jonassen, 1997). Through design-based learning, the students have to provide several possible solutions for the problem, and then evaluate them to choose the best alternative. However, the use of prompt-based collaboration scripts may limit this creative process by making the dyads follow the best solution for the problem according to specific standards, which ultimately leads to improved overall performance in the areas identified as important by the instructor. In well-structured problems a solution to the problem may be required, but in ill-structured problems may not. Ge (2001) highlighted this aspect by illustrating the need for balance between task complexity and students' need for additional support or different types of scaffolding during problem-solving, such as peers' interactions and argumentative processes. This also coincides with Dillenbourg and Tchounikine (2007) who conducted a conceptual analysis of different types of flexibility that are required from teachers and students when using a CSCL script. This issue still needs further investigation.

Furthermore, there is a great deal of literature regarding the area of visual literacy. In educational settings, additional research on visual literacy would add to and support the acquisition of knowledge and skills in the field. In the current study, the students could respond to the visual elements and relationships of the incomplete concept maps, which indicated that visual components increased the understanding of content and facilitated the acquisition of web design knowledge and skills. Future studies focusing on linking incomplete concept maps to visual literacy may be required in the online DBL.

8.7. Implications for Educational Practice

This study suggests a number of implications for educational practice related to the use of computer-supported collaboration script as social scaffolding and incomplete concept maps as content scaffolding to support online DBL. The study showed that the use of collaboration scripts for a long learning and treatment period enabled the students to engage in higher level collaboration skills through the final chat sessions conducted in the absence of both the collaboration script and incomplete concept maps. Therefore, the collaboration script may be considered as advantageous compared to prior training of collaboration skills in CSCL environments, because the students may not be able to learn how to collaborate effectively. Prior training is costly and moderation of CSCL is particularly difficult requiring further qualification on the part of teachers (Clark, Weinberger, Jucks, Spitulnik, & Wallace, 2003). Prompt-based cooperation scripts for CSCL environments may be a promising way to warrant the quality of collaboration skills independently of the competencies of the students and teachers. Implementing the collaboration script in CSCL context for a long-term period may lead students to internalize the script and be engaged in higher levels of inquiry-based discussions through CSCL environment without the collaboration script.

In contrast to most of the previous studies on collaboration scripts, this study showed that the use of collaboration script in authentic learning situations for a long learning period may help the students to acquire higher levels of domain-specific knowledge, that were rarely achieved in previous studies. This type of support, which is oriented towards social processes, might promote individual learning outcomes. However, this claim should be further explored in other studies.

This study revealed an additional effect of collaboration scripts that may open new avenues for future researches concerning the effect of collaboration scripts on quality of collaborative products. This study showed a positive effect of the collaboration script on the quality of published websites, which were designed, built, and published collaboratively as the final product of each dyad. In this way, the new trends of using the collaboration script should be directed toward improving not only the quality of online discussions among students but also the final products that result from theses discussions.

Prior studies showed that incomplete concept maps are rarely investigated in CSCL environments and the effects of the use of incomplete concept maps in such a context are still unclear. The results of this study showed that incomplete concept maps can be successfully used as content scaffolding on an online DBL environment. In this way, incomplete concept maps can be used within a CSCL context to support students' learning of content and encourage them to focus more on scientific concepts at both the collaborative and individual levels.

The study also showed that combining the collaboration script and the incomplete concept maps had led to students' greater achievement effects regarding both collaborative and individual learning outcomes. In this way, the technique of adding content-related instructions to this sort of scripting is considered to be an idea with potential to engage the students in higher levels of collaborative and individual learning outcomes. However, investigating the effects of combining different content and social scaffolds in online DBL on such learning outcomes is still needed.

With respect to the online DBL environment, it is apparent that DBL can be successfully transferred into an online context, but it should be well-supported. The collaboration script and incomplete concept maps are examples with potentials that can be effectively used to support online DBL.

Moreover, the benefits of using an online DBL environment are not limited to students, as future versions of these environments might also provide teachers with better tools to monitor and scaffold multiple small groups of students simultaneously working on projects in an online DBL context. Teachers themselves could also be engaged in online DBL courses for design and building educational websites or online courses through pre- and in-service teacher education programmes that may positively affect the widespread use of online learning on different levels of the education system.

8.8. Conclusion

This study explored the effects of two types of scaffolding, namely collaboration scripts and incomplete concept maps, and their combination to support students in an online DBL environment to facilitate the acquisition of domain-specific and domain-general knowledge related to the design and building of websites. Overall, the results support quite clearly the initial expectation that online DBL can be improved by adequate scaffolding. The significance of this study lies on the fact that that it focuses on transferring design-based learning to an online learning context, an area that has not been widely explored.

This study provided an insight into the extent to which an online DBL environment can be facilitated by collaboration script and incomplete concept maps. Obviously, the collaboration script appeared to be a potential scaffolding for the online DBL. Positive results of the collaboration script on collaborative (except for content-related discourse quality) and individual learning outcomes have been evident. The positive effects of the collaboration script on more domain-specific knowledge are promising findings not presented in previous studies on collaboration scripts within the CSCL context. The incomplete concept maps supported the learning process of content and enabled the students to acquire content-related discourse quality and both factual knowledge on web design concepts and web design skills. Despite the positive effects regarding incomplete concept maps, some critical issues occurred. The incomplete concept maps partially affected collaboration skills, which may reveal low levels of discussion and collaboration. Another issue was considered in the combined condition, where the two treatments did not reveal any interaction effect, which may be an indication for a high degree of load (Sweller, 1988) that have been occurred due to the combination between the collaboration script and incomplete concept maps. Although not all hypotheses of this study were verified, the results of this study confirmed that implementing both social and content scaffolds in an online DBL environment is a powerful means to improve content-related discourse quality, collaboration skills, and quality of published websites in a subsequent collaborative transfer task as well as the acquisition of factual knowledge and skills on web design. In sum, the study demonstrated that DBL can be realized online and the educators in this case have to consider supporting the online DBL environment with appropriate scaffolding which affords unique opportunities for collaborative learning. In this study, the collaboration script and incomplete concept maps proved to be promising scaffolds for facilitating the acquisition of domain-general and domain-specific knowledge through the online DBL.

The results of the study suggest that the online DBL environment needs to be carefully designed in order not to address the complexity of the design task. In addition, the instructional support that will be used for supporting the online DBL should be carefully designed to maintain the complexity of tasks and at the same time to support the structure of the discourse. Future studies on online DBL may further investigate what aspects of domain-general and domain-specific knowledge instructional support should focus on, such as how the interaction effect between instructional supports should be increased and what other kinds of content scaffolds can work more effective in the online DBL especially regarding the acquisition of collaboration skills. These studies should be based on theory rather than on the available capabilities of technology.

In sum, this study provides evidence that online DBL can be optimized in real-world settings and through a long learning period by using adequate scaffolds. Apparently, by using the collaboration script and incomplete concept maps it is possible to create a zone of proximal development and thereby help students to acquire both domain-general and domain-specific knowledge. In addition, the results of the present study showed that supported online DBL can contribute to a major transformation within mass university teaching shifting from teacher-centred to more student-centred approaches. Both the successful implementation of the collaboration script and use of incomplete concept maps collaboratively is expected to encourage students to look at their partners as important sources of information and learning, and to increasingly consider the teacher as a facilitator for the learning process.

9. References

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