Computer-supported collaborative learning and gender

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CHAPTER ONE

Introduction

1.1 Computer-Supported Collaborative Learning and Gender Differences

One of the long standing goals of science education is to enable students to become high-order problem solvers (UNESCO, 2004). Physics education needs to be geared toward helping students develop a more flexible understanding of concepts and principles in order to solve novel problems (Henderson & Dancy, 2004). In high schools, students are often found to have trouble in solving novel problems although they know how to solve standard textbook problems. Sometimes, their prior knowledge is sufficient, but they still lack the skills in analysing, making representations, planning and monitoring their solution process when encountering new problems (De Jong & Van Joolingen, 1998; McDermott & van Zee, 1985). Many students tend to solve science problems mechanically, focusing on sample problems, searching for the correct formula or simply plugging numbers into a formula (Sherin, 2001). Based on a comprehensive review of research on problem-solving in physics, Maloney (1994) summarized that successful students' problem-solving strategies at least contain a conscious qualitative analysis of the problem, making a sketch of the problem, restating the problem in one's own words and conscious review of equations or theorems that fit the problem. However, students, on their own, do not spontaneously generate highly elaborate analyses of the problem information (King, 1990).

In classroom practice, the value of collaborative learning is widely recognized due to the notion that while explaining a problem to peer learner students can gain conceptual clarity for themselves (Damon & Phelps, 1989; Johnson & Johnson, 1990; 1993). Collaborative learning refers to a heuristic methodology that students engage in a common task, working jointly to co-construct the meaning or solve the problem. The theory of collaborative problem solving basically hinges on the idea that learners influence one another when learning together (e.g., De Lisi & Goldbeck, 1999). In order to accomplish a given task and achieve a joint product, two or more students work together, and they have to listen to their partners' perspective and negotiate with each other to arrive at a mutual understanding. Interpersonal interaction exposes participants to different perspectives (Miyake, 2006), and makes difficulties in solving problems clearer for students to see and more open to interactive problem solving (Heller & Hollabaugh, 1992). Learners can elaborate their partners' ideas, elicit cognitively-oriented self-explanations and jointly make sense of the task (Nastasi &

Clements, 1992). Hence, knowledge can be meaningfully constructed when students cognitively engage in collaboration. As Teasley and Rochelle (1993) have concluded: “Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem.”

Empirical studies have shown that collaborative learning can have profound effects on students learning achievement (e.g. Johnson & Johnson, 1990; Teasley, 1995). Blaye, Light, Joiner and Sheldon (1991) showed that students who had previously worked as collaborative pairs on problem-solving in physics were more successful on a knowledge test than those who had had the same amount of experience working alone. The researchers concluded that within a small group that works as a team, students tend to spend more time on reflecting and discussing the suggested solution than when students work individually. Nelson (1999) pointed out that, if students are frequently engaged in constructive dialogue, their procedural knowledge will retain longer and their problem-solving skills in physics will improve more than when they learn individually. Positive results of collaborative learning have been explained by the notion that interaction stimulates the elaboration of knowledge and hence adds individual cognitive gains (van Boxtel, Van der Linden & Kanselaar, 2000)

Some researchers claim that collaborative learning appeals to both male and female students (Heller & Lin, 1992; Johnson & Johnson, 1993; Kahle & Meece, 1994). But according to Underwood, Underwood and Wood (2001), collaborative learning carries risks, and these risks are particularly high when computer and gender are involved. For instance, some studies have clearly addressed that female and male students have different communication styles (Lakoff, 1973; Lay, 1992; Li, 2002), and simply pairing them will not guarantee an expected increase in learning achievement.

For example, male students tend to give their opinions more directly than female students. Females are more likely to initiate conversation by asking questions and establishing a common ground among participants whereas males start discussions on a problem right away by putting forward ideas and suggestions.

Computer-supported collaborative learning (CSCL) was developed in the 1990s, with the promising potential of internet connecting isolated learners in an innovative way (Stahl, Koschmann & Suthers, 2006). CSCL makes it possible to collaborate while students are at different places. Some studies have pronounced the gender difference in collaboration (Prinsen, Volman & Terwel, 2007), and stressed that the gender problems which we are familiar with in the face-to-face collaboration will remain in the CSCL setting. Nevertheless, previous studies did not offer clear empirical evidence concerning gender differences in communication, cognitive processing of knowledge and the elaboration process in CSCL. The aim of this dissertation is to explore gender differences in physics problem solving learning in a synchronous learning environment. The general research questions of this dissertation are:

- *How do female and male students learn in a collaborative setting and do they both profit more from a collaborative than in an individual setting?*

Based on the findings of previous research that has revealed that collaborative learning can generally improve students' problem-solving learning (Cohen, 1994; Johnson & Johnson, 1993; Scanlon, 2000; Schwartz, 1995; Sharan & Shachar, 1988; Slavin, 1983), it is hypothesized that both female and male students will profit more from collaborative learning than from individual learning.

- *Are there gender differences with respect to students' communication style, cognitive representations and knowledge elaboration process in collaboration?*

Previous studies on communication styles have demonstrated a gender difference (Lakoff, 1973; Lay, 1992; Li, 2002, Webb, 1984). For instance, females are more likely to initiate the conversation with questions while males tend to express their opinions directly. Besides, they may also have different ways to represent knowledge while solving a physics problem. Kellogg (1995) has found that males outperform females on the tests of visual-spatial ability and tend to convey information in a pictorial way. All these may result in a discrepancy in elaborating knowledge.

- *Is there a relationship between students' knowledge elaboration process and their learning outcomes in synchronous Computer-Supported Collaborative Learning (CSCL), and is this influenced by gender?*

So far, very little research in CSCL has pointed to the relationship between students' learning achievement and their knowledge elaboration process. Studies involving CSCL have often focused on the individual learner and his/her learning activities. However, theories of collaborative learning foreground the role of interaction between learner and his/her partner(s) and how the interactions influence the knowledge elaboration process (Weinberger, Stegmann & Fischer, 2007). With respect to gender issues, it is predicted that there exists a gender difference in the relationship between learning achievement and the elaboration process in CSCL.

1.2 Organization of the Thesis

The thesis consists of six studies. Chapter 2 to 7 are empirical studies that have been submitted to international journals. Three (Chapter 2, 4 and 6) were published; the others were in review (Chapter 3, 5 and 7).

In *Chapter 2*, a general comparison between individual learning and collaborative learning is discussed. This is a pilot-study, serving to provide background information for the following study.

Chapter 3 focuses on the gender differences in both individual and collaborative learning settings. It further explores whether collaborative learning with hints may help to close the gender gap in problem-solving achievement.

Chapter 4 studies gender differences in the communication styles in collaborative learning. The research question is whether female and male students' communication styles are sensitive to their partner's gender.

Chapter 5 looks beyond the surface features of collaborative learning and advances with an insight into different ways of knowledge representations. It examines the gender differences in visual and verbal representations. It arises out of the question whether female and male students use different ways to represent knowledge cognitively while solving a physics problem jointly and whether this varies depending on the partner gender.

Although Chapter 4 and 5 present some information about the process of collaborative learning, how students elaborate their knowledge cognitively during the collaboration process is still a "black box". In *Chapter 6*, a new method (so-called "*Elaboration Value*") to look into students' elaboration process is pilot-studied. The interactions of three dyads are intensively studied as an ongoing process in an attempt. It bears the opportunity to unravel the knowledge elaboration process in CSCL. This study sheds light on the process of joint and individual knowledge elaboration in CSCL.

Using the "*Elaboration Value*" method developed in Chapter 6, a large study with 96 participants is presented in *Chapter 7*. The aim is to find out whether there is a gender difference in the knowledge elaboration process in CSCL and whether this is related to students' learning achievement.

1.3 Some Considerations

As aforementioned, the gender issue has been scarcely explored in CSCL research, particularly where it concerns the knowledge elaboration process. Given that the computer itself may impose an influence on students' interactions, the first four studies were conducted in a computer-alike experimental setting within which students were randomly paired and sat together, but they were not allowed to talk with each other. Each dyad was overseen by an observer to ensure that communication only occurred on the log sheets. In the coming computer-supported learning setting students were geographically dispersed. Constructing the computer-alike experimental setting aimed at capturing students' collaboration process and their cognitive activities. Having collected sufficient knowledge about students' communication and knowledge elaboration, the research was shifted to the computer-supported learning environment.

In order to gain insight into students' cognitive processes, this research rests mainly upon dyadic collaboration. The initial idea is that dyadic collaboration facilitates a close-up of students' participation and knowledge elaboration activities. It also affords the opportunities to trace how individual students cognitively process the information, respond to peer learner's ideas, and how students co-construct the knowledge.

In addition, although CSCL takes many forms, this research focuses on the synchronous computer-supported problem solving learning. In comparison to gender-focused studies in asynchronous CSCL, there are still many gender-related questions that need to be answered in synchronous CSCL (Heller, 2000).

Finally, as for the distinction between the terms "cooperative learning" and "collaborative learning" there are no established or definitive labels in this field. The term "cooperative" is often used interchangeably with "collaborative", but the terms may have different meanings (Olguin, Delgardo & Ricarte, 2000). Some researchers prefer using the term "collaboration" as a general concept (O'Donnell & King, 1999) while others tend to distinguish between "cooperation" and "collaboration" (Kneser & Ploetzner, 2001). According to Dillenbourg (1999), it correlates with the degree to which a learning task involves a prescribed division of labour among participants. Cooperation then is defined as individuals working in a group with each one solving a portion of the problem by dividing up the work. For instance, if a dyad is given a problem to solve, it could assign each participant a portion of the problem and then stitching the results together. In contrast, collaboration is the interdependence of the individuals as they share ideas and reach a conclusion or produce a product. In collaborative problem solving, students share their comments and doubts, contribute their ideas and negotiate with each other until they arrive at a consensus.

Cooperative learning can be seen as a specific type of collaborative learning. It highlights structured labour in a joint project. Each participant is individually accountable for own work, and in addition the work of the group is assessed as a whole. By contrast, collaborative learning suggests a sharing of authority and acceptance of responsibility among group members. Theoretically, collaborative learning fits well in a constructivist approach in which students are required to actively define objects and working out answers jointly rather than elaborate on the work individually. In this dissertation, the term "collaborative learning" has been used as an umbrella definition. During the empirical studies, there is no fixed instruction asking students to divide their tasks evenly. Instead, students' are allowed to decide when to work together and when to divide the task.