# The Impact of Knowledge Awareness and Peer Talk on a Cognitive Conflict Task

# Der Einfluss von Knowledge Awareness und Peer Talk auf eine kognitive Konfliktaufgabe

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Dipl.-Psych. Antonia Elisabeth Enikö Baumeister

aus Klausenburg (Rumänien)

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*“Do what you love, and you never work again.”*

(Confucius, 551-479 BC)

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# 1 Introduction and General Overview

In times of globalization and the information and knowledge society (van Weert, 2006; Webster, 2006), being informed about the knowledge or expertise of spatially distributed persons is highly relevant for many areas of research and practical life, for example, educational, social and organizational research and practice, including knowledge management in computer-supported cooperative work (CSCW), and computer-supported collaborative learning (CSCL). As humans are social beings, learning is driven mostly by social processes, for example, by comparing one's own knowledge or expertise to that of other people (Festinger, 1954).

Further, the *task solutions* that learners create in an elaborate way (i.e., not by mere guessing) can be regarded as externalizations of their knowledge ("sediments of cognitive activity"; Rindermann, 2013, p. 190). Thus, *different solutions* regarding the *same task* indicate different knowledge. In such a situation, we would like to know whether we have solved the task correctly or whether the other producer of a divergent solution has solved it correctly (Mugny, Butera, Sanchez-Mazas, & Pérez, 1995). This special learning situation is called a *cognitive conflict* (Lee et al., 2003): becoming aware that what we know differs from the information provided by the outside world (Piaget, 1950). If the outside world consists of another learner, for example, this situation is called a *socio-cognitive conflict* (Mugny & Doise, 1978). Since human beings have a rich repertoire of communicational strategies, such socio-cognitive conflicts can take on very different forms, as the following two short examples of a fictitious conversation of a

learning dyad, taken from Darnon, Doll, and Butera (2007, p. 228), illustrate (Table 1):

***Table 1***

*Two Examples of a Fictitious Conversation of a Learning Dyad, Taken From Darnon and Colleagues (2007, p. 228)*

| *Example 1*<br>*(Focus on Task Solution)* | *Example 2*<br>*(Focus on Social Comparison of Ability)* |
|---|---|
| "M: What was your answer for question 2?<br>K: I answered "X"<br>M: Hum. I thought the answer was "Y".<br>K: I don't think so because…<br>M: I see. Then how come…?<br>K: Probably because…". | "M: What was your answer for question 2?<br>K: "X" of course, the answer is obvious.<br>M: Hum. I thought the answer was "Y".<br>K: How can you think the answer is "Y"? You should know that…<br>M: I see. Then how come…?<br>K: If you had listened to what the teacher said, you would know that…" |

The question of how learners react if they are confronted with a task solution of either a source that is of equally low or higher competence than they are and that deviates from their own solution is the focus of the present dissertation.

## 1.1 Core Concepts

As this dissertation unifies concepts from different subdisciplines of psychology and related research areas, it is unavoidable that different expressions for the same

underlying concept are taken up, in this case, *knowledge*, *expertise*, *competence* (Klieme, 2004), *ability* (Rindermann, Ceci, & Williams, 2013), and *aptitude* (Quiamzade & Mugny, 2001). The concept of ability is more often used in psychology, whereas the concept of competence is more common in educational science (Rindermann et al., 2013). Research on conflict elaboration theory (e.g., Mugny et al., 1995), which is one focus of this dissertation, often uses the psychologically broad concepts of *competence* and *aptitude.* In psychological research on expertise and expert performance (Ericsson, Charness, Feltovich, & Hoffman, 2006), the concepts o*f knowledge* and *expertise* are more focused on cognitive aspects, and the level of specialization a person has reached (e.g., Chi, 2006; Feltovich, Prietula, & Ericsson, 2006).

Further, studies on conflict elaboration theory differentiate between the starting point of a cognitive conflict, called *source* (e.g., a learner who has produced a task solution which deviates from one's own solution), and the *target person* whose reaction to this cognitive conflict is under investigation (e.g., Buchs, Butera, Mugny, & Darnon, 2004b; Butera, Caverni, & Rossi, 2005; Darnon et al., 2007; Quiamzade, Mugny, & Darnon, 2009).

## 1.2 Core Research Areas

Psychological theories and models explain why it is useful to be informed about others' knowledge or expertise (e.g. Clark & Murphy, 1982; Nickerson, Butler, & Carlin, 2009; Stewart & Stasser, 1995; Wegner, 1995) and why people still sometimes are not willing to share their knowledge and information with others

(e.g. Cabrera & Cabrera, 2002; Cress & Kimmerle, 2013). For example, computer-mediated communication (e.g. Nückles & Stürz, 2006) and computer-supported collaborative learning (e.g. Dehler-Zufferey, Bodemer, Buder, & Hesse, 2011) become more effective and efficient if we have an accurate idea of our counterpart's knowledge or expertise and can adapt our explanations accordingly (Clark & Murphy, 1982). In addition, group members manage their knowledge and information more effectively and efficiently if they are informed about who is expert in a certain area and, thus, responsible for storing and retrieving information in this area (e.g. Schreiber & Engelmann, 2010; Stewart & Stasser, 1995; Wegner, 1995). However, sharing one's knowledge and expertise often is associated with "psychological costs", such as loss of time, privacy, and "knowledge superiority" (e.g. Cabrera & Cabrera, 2002; Cress & Kimmerle, 2013; Reichling & Wulf, 2009). Therefore, a lot of different computer-supported applications have been developed for supporting distributed knowledge exchange in CSCL and CSCW respecting users' privacy (e.g. Hsi & Hoadley, 1997; Maybury, D'Amore, & House, 2002).

Being aware of others' knowledge or expertise can change a learner's behavior in many ways. As positive examples, previous studies have shown that it both supports collaborative learning and problem solving (Engelmann, Dehler, Bodemer, & Buder, 2009; Engelmann & Hesse, 2010) by improving peer explanations (e.g., Dehler-Zufferey et al., 2011), for example. As a negative example, however, comparing one's own knowledge to that of other people can result in unfavorable social influence dynamics such as reduced information sharing with a peer due to seeking self-enhancement (Ray, Neugebauer, Sassenberg, Buder, & Hesse, 2013). Further, learning from a high competent partner can threaten a learner's self-esteem which often results in quickly and

uncritically imitating the partner's solution without understanding it deeply (*competence threat*; Quiamzade & Mugny, 2001).

In the present dissertation, two research areas are integrated and extended: (1) research on *knowledge awareness* (Engelmann et al., 2009), a strand of research on *group awareness* (Gross, Stary, & Totter, 2005; Gutwin & Greenberg, 1995) aiming to provide computer-supported external representations of learners' knowledge or expertise which enhance collaborative learning and problem solving (Engelmann et al., 2009); (2) research on the *conflict elaboration theory* which deals with *social influence dynamics* in the context of knowledge exchange (Mugny et al., 1995). In the following sections, these two research areas will be introduced in brief.

### 1.2.1 Group Awareness Research as the Origins of Research on Knowledge and Expertise Awareness

Research on group awareness aims at investigating and supporting "consciousness and information of various aspects of the group and its members" (Gross et al., 2005, p. 327). Gutwin and Greenberg (1995, p. 1) define group awareness as "the up-to-the-minute knowledge of other people's activities that is required for an individual to coordinate and complete their part of a group task". This means that group members know, for example, what the others are doing (Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). Group awareness has to be established in virtual teams for CSCL and CSCW by means of groupware because group members who are spatially separated do not receive the social cues casually transmitted face-to-face which facilitate knowledge exchange and

coordination of task completion (e.g., seeing a group member nodding his or her head; Gutwin & Greenberg, 1995).

Bodemer and Buder (2006; see also Janssen & Bodemer, 2013) argue that technologies for supporting group awareness have an even higher potential beyond re-establishing in virtual systems the environmental cues naturally occurring face-to-face, based on the group members' observable activities: *Cognitive group awareness tools* (Janssen & Bodemer, 2013) inform about past or present cognitive aspects (e.g. knowledge, opinion, preference) of individuals or groups which often are not directly observable because they first need to be externalized; this cognitive awareness information supports groups in their self-regulation of social interaction and knowledge exchange (cf. Bodemer & Buder, 2006; Buder, Bodemer, Dehler, & Engelmann, 2009; Janssen & Bodemer, 2013).

*Knowledge awareness* (Engelmann et al., 2009) is a type of cognitive group awareness (Janssen & Bodemer, 2013) defined as "an individual's state of being informed and having perceived information about others' knowledge", that is, especially others' *externalized task-relevant knowledge* (Engelmann et al., 2009, p. 950). Similarly, *expertise awareness* can be defined as being informed about various aspects of others' expertise, for example, their "type and level of expertise" (Maybury et al., 2002, p. 204), their activities in their area of expertise, and changes to their area of expertise (Dörner, Pipek & Won, 2007; Reichling & Wulf, 2009; Vivacqua, 1999).

In this dissertation, CSCL studies in which the distributed participants interacted with and learned from partners who had an equal level of expertise[1] regarding the subject matter domain of the task conducted in the studies are categorized as researching knowledge awareness (e.g. Bodemer, 2011), including this dissertation's both experimental studies. In contrast, CSCW studies which involved distributed professional cooperation with or help seeking between interaction partners who showed a larger asymmetry of the level of expertise regarding the subject-matter domain of the task conducted in the studies are categorized as researching expertise awareness (e.g. Nückles & Stürz, 2006; Reichling & Wulf, 2009).

Two basic processes result in the formation of knowledge or expertise awareness: (1) people explicitly provide information about their knowledge or expertise, and (2) people extract from their environment information about other's knowledge (cf. Engelmann et al., 2009) or expertise (cf. Maybury et al., 2002). For example, labels of the *level of expertise* (i.e., the continuum of "layperson – novice – intermediate – expert", Bromme, Jucks, & Rambow, 2004; Bromme, Rambow, & Nückles, 2001; or the categories of "student vs. professor"; cf. Mugny, Tafani, Butera, & Pigière, 1998) can be awarded either by other people or institutions, they can be statistically generated by means of data mining (e.g. Afzal et al., 2009; Mattox, Maybury, & Morey, 1999; Yimam & Kobsa, 2000; Yimam-Seid & Kobsa, 2003), or people can self-label their level of expertise and understanding of a topic (cf. Dehler, Bodemer, Buder, & Hesse, 2009; Dehler-Zufferey et al., 2011).

[1] In one experimental condition of this dissertation's Study 1, the learning partner was indicated as a supposed "textbook of the subject-matter domain"; however, the presented task solution in fact had been created by a former participant of a pilot study who had an equally low level of expertise in the task domain like the authentic participants. Therefore, the term "knowledge awareness" is used in the context of Study 1, and not "expertise awareness".

*Computer-based external representations* can enable people to compare their own knowledge or expertise with other persons' knowledge or expertise (cf. Engelmann et al., 2009). Several studies have consistently shown that approaches for fostering knowledge or expertise awareness by means of external representations improve computer-supported learning and distributed collaboration (e.g., Engelmann et al., 2009; Nückles & Stürz, 2006; Sangin, Molinari, Nüssli, & Dillenbourg, 2011).

Until now, the following classifications of knowledge awareness exist in CSCL: Engelmann and colleagues (2009) introduced a dimension of knowledge awareness with the three subcategories *context-based*, *hybrid*, and *content-based* knowledge awareness. Further, Sangin and colleagues (2011) suggested distinguishing between *activity-based* (cf. Ogata, Matsuura, & Yano, 2000; Ogata & Yano, 1998, 2000), *subjective*, and *objective* knowledge awareness. In addition, in CSCW research and development, the related concept of *expertise awareness* is often used (e.g. Chen, Tao, Yan, Anerousis, & Shao, 2010; Dörner et al., 2007; Maybury et al., 2002), and several features of the awareness information (i.e. *explicit* vs. *implicit*, *static* vs. *dynamic information*) are considered to be especially relevant (Maybury et al., 2002). The present dissertation aims at contributing to research on knowledge and expertise awareness in a conceptual way, and, regarding knowledge awareness, also in an empirical way:

(1) *Conceptual contribution:* Since knowledge awareness and expertise awareness are related concepts (cf. Janssen & Bodemer, 2013) which have commonalities and differences, a possible distinction is presented. Further, a *combined classification of knowledge and expertise awareness for CSCL and CSCW* is introduced in order to highlight their commonalities, describe the possible

types of knowledge or expertise awareness, and their psychological functions for CSCL and CSCW comprehensively. Based on the awareness features presented by Maybury and colleagues (2002), this dissertation suggests (1) to determine both for knowledge and expertise awareness whether the awareness information comprises an *explicit* versus an *implicit level of expertise*, and (2) to take dynamic changes of the external representation for supporting knowledge or expertise awareness into account by differentiating between *static* versus *dynamic knowledge or expertise awareness information* (cf. Engelmann et al., 2009; Maybury et al., 2002). In addition, based on a literature review, this dissertation provides an overview of 30 computer-mediated applications developed for supporting knowledge management by knowledge or expertise awareness information, and an overview of 22 studies conducted in the past 16 years applying different configurations of knowledge or expertise awareness, the latter being categorized according to the suggested combined classification.

(2) *Empirical contribution:* In two experimental studies, a computer-based external representation for supporting knowledge awareness is used in order to make task-relevant diversity between learning partners visually salient (cf. Bodemer, 2011; Engelmann et al., 2009) which should increase the probability of experiencing a *socio-cognitive conflict* (Quiamzade & Mugny, 2001). This dissertation argues that the *comparison processes* activated by knowledge awareness information, that is, comparison of *task solutions* (Bodemer, 2011) and social comparison of the *level of expertise* (Quiamzade & Mugny, 2001), are highly relevant in a cognitive conflict paradigm, for example. Therefore, in two experimental studies, assumptions of the currently most comprehensive theory on

socio-cognitive conflict, the conflict elaboration theory (Mugny et al., 1995), will be tested and extended. In the next section, this theory is briefly outlined.

### 1.2.2 Conflict Elaboration Theory

Conflict Elaboration Theory (Pérez & Mugny, 1992; Mugny et al., 1995) integrates both cognitive developmental approaches to *peer learning* (cf. Mugny & Doise, 1978) as well as social psychological theories and findings (e.g. evidence on majority vs. minority influence; Deutsch & Gerard, 1955; Moscovici & Personnaz, 1986) for predicting learners' behavior (e.g., in inductive reasoning tasks; Legrenzi, Butera, Mugny, & Pérez, 1991). In the following, this theory will be introduced briefly, presenting assumptions, an example of an empirical study, and limitations.

#### *1.2.2.1 Origins of Conflict Elaboration Theory*

Conflict elaboration theory integrates several areas of research, namely research on cognitive development (Piaget, 1950), especially by means of socio-cognitive conflicts (e.g., Mugny & Doise, 1978), and research on social influence, especially majority vs. minority influence and source credibility on learners' behavior (e.g., Asch, 1956; Deutsch & Gerard, 1955; Moscovici & Personnaz, 1986; Mugny, 1984; Nemeth, 1986). This theory aims at predicting under which conditions social influence can support or hinder learning processes.

Piaget (1950) argued that cognitive conflicts trigger human cognitive development (cf. Marchand, 2012). "Cognitive conflict is a perceptual state in which one notices the discrepancy between one's cognitive structure and the environment (external information) …" (Lee et al., 2003, p. 585). Inspired by his

early scientific experiences as a biologist, Piaget (1950) postulated a motive to achieve cognitive balance through *adaptation* to new information: Intellectual development occurs through *conflict resolution*, namely, if new information is either integrated in existing schemata (*assimilation*) or if new schemata are acquired (*accommodation*).

Some neo-Piagetian approaches focus on *socio-cognitive conflicts*, that is, on situations in which the new information is introduced by another person. According to Tudge and Rogoff (1989), *peer learning*, that is, learning from a person who is *equally competent than oneself* is, should be more fruitful than learning from more or less competent partners because peers would "(…) attribute the same meanings to the same terms." (O'Donnell & O'Kelly, 1994, p. 337).

Further, conflict elaboration theory is concerned with social influence dynamics in the context of different cognitive tasks, for example, hypothesis testing, inductive reasoning, anagram tasks etc. (e.g. Butera et al., 2005; Quiamzade et al., 2009).

#### *1.2.2.2 Assumptions of Conflict Elaboration Theory*

One motivation to develop conflict elaboration theory was that Mugny and colleagues (1995) noted controversies among theories of social influence (e.g., majority-minority controversy; Deutsch & Gerrard, 1955; Moscovici, 1980): These theories made different predictions because they focused on different tasks and sources of social influence. Therefore, conflict elaboration theory aimed at explaining "the multiple types of tasks, sources, levels of influence and processes through which social influence operates" by means of the postulated unifying and underlying concept of *conflict elaboration* (Mugny et al., 1995, p. 161).

The starting point is a situation in which a person solves a task or gives his or her opinion and, after this, is confronted with a task solution or opinion of another source (e.g., a person or a group) which deviates from the person's solution or opinion. With regard to this basic situation, three core assumptions are (Mugny et al., 1995, p. 162):

1) Different sources of deviating solutions or opinions will result in different conflict elaborations, even if the degree of divergence between these different sources is similar.
2) Different tasks will result in different kinds of conflict elaborations, even if the source of the deviating solution or opinion and the degree of deviation are held constant.
3) Different ways of conflict elaboration result in different patterns of manifest or latent social influence.

*Relevance for this dissertation:* In Study 1, the first assumption of conflict elaboration theory will be tested directly by varying the level of expertise of the source (i.e. high competent or equally low competent) of a solution which deviates from the learner's solution, while keeping the presented deviating solution constant.

Further, by means of this dissertation's Study 1, the second assumption of this theory will be investigated indirectly by applying a more knowledge-rich inductive reasoning task (i.e. identifying structural similarities between law cases; Nievelstein, van Gog, Boshuizen, & Prins, 2010) than the tasks used in previous studies on conflict elaboration theory (e.g. hypothesis testing; Butera et al., 2005), while the source of the deviating solution or strategy as the experimental factor is similar in Study 1 of this dissertation and in Study 1 by Butera and colleagues

(2005). In this way, it can be at least indirectly concluded whether equally low competent sources of cognitive conflict support learning of well-defined tasks more (result of Study 1 by Butera et al., 2005) than they support learning of knowledge-rich tasks (Study 1 of present dissertation).

The different ways of conflict elaboration and patterns of social influence (assumption 3) will be examined by assessing various cognitive, personality-related, and both individual and collaborative performance-related aspects of the learners, for example, *perceived cognitive conflict* (Studies 1 & 2), *rating* of own versus partner's *task-relevant competence* (Study 2), *need for socially comparing one's abilities* (Study 1), *correctness* of task solutions and *adaptation* to the presented deviating solution (Studies 1 & 2), and *quality of peer talk* (Study 2).

In addition, conflict elaboration theory distinguishes tasks according to two dimensions: (1) *relevance of error* and (2) *social relevance* (cf. Mugny et al., 1995). Relevance of error is given if the task has only one correct solution which is objectively measureable. Social relevance is given if the task defines membership to a social category or group, or a person's rank position within a category. Both dimensions can be crossed, resulting in four types of tasks which are described in detail by Mugny and colleagues (1995, e.g. Figure 2, p. 162). Only the following type of task is relevant for the present dissertation: *high relevance of error*, *socially anchoring task* (TAP, Tasks: Aptitudes; Mugny et al., 1995). Such tasks are used as aptitude tests for evaluating abilities and ranking people. The foci of conflict elaboration are (1.) to increase judgments' correctness, and (2.) to give the best self-image (cf. social comparison theory; Festinger, 1954). Examples of these

aptitude tasks are problem solving tasks which require higher order thinking skills (e.g., inductive reasoning; Butera et al., 2005).

*Relevance for this dissertation:* In both experimental studies of this dissertation, the same aptitude task will be applied, an inductive reasoning task (i.e. identifying structural similarities between law cases; Nievelstein et al., 2010) which is more *knowledge-rich* than, for example, the inductive reasoning task used in the studies by Butera and colleagues (2005). Thus, both a high relevance of error and a socially anchoring task will be realized which should increase the probability of experiencing a cognitive conflict when the learner is confronted with a solution which deviates from his or her solution.

#### *1.2.2.3 A Study Example*

Butera and colleagues (2005) examined the impact of a high- versus low-competence source of a cognitive conflict in the context of an inductive reasoning task (i.e., testing hypotheses in Wason's 2-4-6 problem; Wason, 1960). Competence of the learning partner, who in fact was a confederate of the experimenter, was varied by either presenting the partner as a *novice* in this task or as an *expert*. In Study 1, problem solvers were more likely to acquire a new and rare strategy (i.e., disconfirmation strategy) when they perceived a low-competence partner using this strategy compared to a high-competence partner using this strategy. One interpretation of this result was that since the credibility of the low-competence partner was low, the learners tested more alternatives in order to find a good strategy (Chaiken, 1980). Thus, a low-competence partner would not threaten their self-esteem, thus, enabling an *epistemic conflict resolution*. In

contrast, the high-competence partner activated a *relational conflict*, that is, a social comparison of ability which distracted learners' attention from the core task.

#### *1.2.2.4 A Critical Appraisal of Conflict Elaboration Theory*

Studies conducted in the context of conflict elaboration theory have focused mainly on conditions under which *peer learning* is advantageous (e.g., Buchs & Butera, 2009; Quiamzade et al., 2009). The first experimental study of the present dissertation shows that in the context of a *knowledge-rich task*, learners improve their task solutions more if confronted with a more competent source than with an equally low competent source.

Further, assumptions of the theory have not been completely empirically validated because in most studies, it was not assessed whether learners actually had experienced a cognitive conflict (e.g., Quiamzade, 2007). Therefore, in the present dissertation, *perceived cognitive conflict* will be measured by means of subjective rating scales (e.g., Darnon et al., 2007; Lee et al., 2003).

Moreover, in the first study of this dissertation, it is argued that there is a personality trait, the *need for socially comparing one's abilities* (Festinger, 1954; Gibbons & Buunk, 1999), which is an important moderator for explaining social influence on learners' behavior while solving a cognitive conflict task. This personality trait has not been included in previous studies on conflict elaboration theory before.

In addition, most studies on this theory excluded *authentic interaction* between the target person and the source of the deviating solution (e.g., Quiamzade, 2007). Consequently, previous studies did not clarify the impact of *peer talk* on conflict elaboration (Mercer, 1995, 1996). For this reason, the second

experimental study of the present dissertation aimed at examining whether computer-supported peer talk increases or helps to resolve cognitive conflict compared to no peer talk (Harmon, 1998).

## 1.3 General Overview of This Dissertation‘s Aims and Research Program

In Chapter 2, a combined classification of knowledge awareness in CSCL and expertise awareness in CSCW will be introduced in detail. Subsequently, this dissertation’s two experimental studies will be presented in Chapters 3 and 4. These studies aimed at answering the following questions:

Study 1 (cf. Chapter 3):

- What impact does a more *highly competent* producer of a deviating task solution have compared to an *equally low competent* producer on experiencing a cognitive conflict and on completing a knowledge-rich cognitive conflict task?
- Is *perceived cognitive conflict* a mediator of learners’ adaptation of task solutions to the presented deviating solution?
- Is learners’ *need for socially comparing their abilities* a moderator of their adaptation of task solutions to the presented deviating solution?

One core assumption of Study 1 is that for knowledge-rich tasks in which no interaction between the source of a cognitive conflict and the target person takes place (e.g. identifying structural similarities between law cases; Nievelstein et al., 2010), an equally low competent producer of a deviating task solution will have a

much weaker social influence on conflict elaboration than usually postulated by studies on conflict elaboration theory applying less knowledge-rich tasks (e.g. anagram tasks; Quiamzade et al., 2009). Therefore, in comparison to Study 1, the aim of Study 2 is to strengthen the influence of the equally low competent source of the cognitive conflict by enabling computer-mediated *peer talk* in dyads of learners who initially generated largely deviating task solutions. It is assumed that peer talk helps to understand the peer's deviating solution better and, thus, to reduce doubts about its correctness (Harmon, 1998). This could result in more frequently adopting aspects of the peer's task solution compared to the condition of Study 2 without peer talk and compared to the similar condition of Study 1 without peer talk. However, only high quality peer talk (Mercer, 1995, 1996, 2000) should support a superior correctness of task solutions compared to no peer talk (Teasley, 1995, 1997; Webb, Troper, & Fall, 1995).

In addition, *static knowledge awareness* information will be provided in Study 1, whereas *dynamic knowledge awareness* information will be presented in Study 2 in order to descriptively compare across both studies whether these two subcategories of knowledge awareness may have different psychological effects (cf. *technology affordances* & *representational guidance*; Suthers, 2006), according to the combined classification proposed in Chapter 2. Therefore, the research questions of Study 2 are:

Study 2 (cf. Chapter 4):

- Does *peer talk* help to reduce cognitive conflict and to improve the correctness of task solutions compared to no peer talk?

- What role does the *quality* and *content* of peer talk play for improving task solutions?
- Does *dynamic knowledge awareness* (Study 2) result in different psychological effects on learners who do not communicate compared to *static knowledge awareness* (Study 1)?

Table 2 provides an overview of the experimental factors, the subcategories of knowledge awareness implemented, and further factors investigated in the context of the two studies of this dissertation. According to previous CSCL classifications of knowledge awareness, both studies applied *hybrid knowledge awareness* information (Engelmann et al., 2009) because the external representation provided a combination of both context-based (e.g., information on whether a learner did or did not complete the task) and content-based (i.e., concrete task solution) knowledge awareness information. Further, *subjective knowledge awareness* information (Sangin et al., 2011) was applied because the learners' self-created task solution was displayed. According to the combined classification of knowledge awareness presented in Chapter 2, in both studies, an *explicit level of expertise* was realized because the presented task solution which always had been generated by an equally low competent peer learner was either labeled as the solution of "a peer layperson" (Study 1 & 2) or as the solution of "a textbook of the subject-matter domain" (Study 1). Further, according to the combined classification, in Study 1, *static knowledge awareness* information was provided because the learners were informed once about a task solution that deviated from their own task solution. In contrast, in Study 2, the learners received *dynamic knowledge awareness* information because the computer-based external

representation displayed in real-time which changes their learning partner made to his or her task solution.

***Table 2***

*Overview of Both Experimental Studies: Subcategories of Knowledge Awareness and Further Factors Investigated*

<table>
<tr><th colspan="2">Study 1<br>(N = 59 Participants)</th><th colspan="2">Study 2<br>(N = 58 Participants)</th></tr>
<tr><td colspan="4">Hybrid Knowledge Awareness</td></tr>
<tr><td colspan="4">Subjective Knowledge Awareness</td></tr>
<tr><td colspan="2">Static Knowledge Awareness</td><td colspan="2">Dynamic Knowledge Awareness</td></tr>
<tr><td colspan="4">Explicit Level of Expertise:</td></tr>
<tr><td colspan="2" rowspan="2">Varied<br>= Experimental Factor:<br>Experimental Condition 1 ($n_t$ = 20):<br>“Textbook of Subject-Matter Domain”<br>= High Competent<br><br>Experimental Condition 2($n_p$ = 20):<br>“Peer Layperson”<br>= Equally Low Competent</td><td colspan="2" rowspan="2">Constant:<br><br>Both Experimental Conditions:<br>“Peer Layperson”<br>= Equally Low Competent</td></tr>
<tr><td colspan="2">Baseline Condition<br>($n_b$ = 19):<br>Without Knowledge Awareness</td></tr>
<tr><td colspan="4">Further Factors:</td></tr>
<tr><td colspan="2" rowspan="2">Individual Differences Regarding<br>Need for Socially Comparing Abilities<br>= Moderator</td><td colspan="2">Peer Talk<br>= Experimental Factor</td></tr>
<tr><td>With Peer Talk<br>($n_{pt}$ = 26)</td><td>Without Peer Talk<br>($n_{npt}$ = 32)</td></tr>
</table>

In Chapter 5, the results and methods of both experimental studies will be discussed, and their implications for future studies will be presented.

## 1.4 Prepared and Submitted Manuscripts for Publication

The reader should note that the conceptual Chapter 2 and the two experimental studies (Chapters 3 & 4) were designed as consecutive steps of the current dissertation project. However, Chapters 2 to 4 were written in a way that they can be published independently of each other. Thus, the empirical Chapters 3 and 4 each include a theoretical introduction, a method and a results part as well as a discussion section. As the studies are partly based on similar assumptions, some overlap was unavoidable. In the following, the publication manuscripts and conference contributions are listed on which this dissertation is based. The order reflects the chronology of the chapters within this dissertation.

Baumeister, A. E. E., Engelmann, T., Cress, U., & Hesse, F. W. (in prep.). *Knowledge and expertise awareness in CSCL and CSCW: Theories, applications, and their psychological implications.* Manuscript in preparation.

Baumeister, A. E. E., Engelmann, T., & Hesse, F. W. (subm. a). *One task, divergent solutions: Source labels and social comparison guide adaptation in a cognitive conflict task.* Manuscript submitted for publication.

Baumeister, A. E. E., Engelmann, T., & Hesse, F. W. (subm. b). *Impact of peer talk in a computer-supported cognitive conflict task.* Manuscript submitted for publication.

## 1.5 Conference Contributions

Baumeister, A., Engelmann, T., & Hesse, F. W. (2013, July). Peer talk in a cognitive conflict task. [Talk]. *The 13th European Congress of Psychology (ECP)*. Stockholm, Sweden.

Baumeister, A., Engelmann, T., & Hesse, F. W. (2009, September). Der Einfluss von "Knowledge Awareness" auf die individuelle ähnlichkeitsbasierte Fallzuordnung [Poster; Abstract]. Universität des Saarlandes, Fr 5.1 Erziehungswissenschaft (Hrsg.), *12. Fachtagung Pädagogische Psychologie der Deutschen Gesellschaft für Psychologie* (S. 114). Saarbrücken: Digitaldruck Pirrot.

Baumeister, A., Engelmann, T., & Hesse, F. W. (2008, July). *Can knowledge awareness enhance computer-supported dyadic analogical problem solving?* [Talk]. 11th Conference of Junior Researchers of EARLI. Leuven, Belgium.

Baumeister, A., Engelmann, T., & Hesse, F. W. (2008, July). Impact of computer-supported collaboration and knowledge awareness on analogical problem solving [Poster; Abstract]. In C. Dalbert (Hrsg.), *Abstracts of the XXIX International Congress of Psychology* (S. 666). Essex, UK: Psychology Press.

Baumeister, A., Engelmann, T., & Hesse, F. W. (2008, June). *Can knowledge awareness enhance computer-supported dyadic analogical problem solving?* [Talk]. Doctoral Consortium Workshop of the Eighth International Conference of the Learning Sciences. Utrecht, the Netherlands.

Baumeister, A., Engelmann, T., & Hesse, F. W. (2008, June). *The potential of computer-supported collaboration and knowledge awareness for supporting analogical problem solving* [Poster]. Eighth International Conference of the Learning Sciences. Utrecht, the Netherlands.

# 2 Knowledge and Expertise Awareness in CSCL and CSCW: Theories, Applications, and Their Psychological Implications

**This chapter is based on:**

Baumeister, A. E. E., Engelmann, T., Cress, U., & Hesse, F. W. (in prep.). *Knowledge and expertise awareness in CSCL and CSCW: Theories, applications, and their psychological implications.* Manuscript in preparation.

## 2.1 Introduction

The question of how people can be informed about others' knowledge or expertise is highly relevant both for organizational but also for educational research and practice, for example, computer-supported cooperative work (CSCW) and computer-supported collaborative learning (CSCL). Being aware of others' knowledge or expertise can change a person's behavior in many ways. This chapter introduces theories relevant for explaining the psychological impact of knowledge and expertise awareness in CSCL and CSCW, examples of applications for supporting knowledge and expertise awareness, and psychological implications of knowledge and expertise awareness as identified by several studies in the past years. The chapter is structured as follows:

- *WHAT is knowledge awareness or expertise awareness?* – These concepts are introduced.
- *WHY is knowledge awareness or expertise awareness important?* – Theories and models are outlined which describe and explain different psychological aspects of knowledge exchange and the role of knowledge or expertise awareness.
- *WHICH APPLICATIONS for supporting knowledge awareness or expertise awareness do exist?* – An overview of example applications in CSCL and CSCW is provided based on a literature review.
- *HOW does knowledge awareness or expertise awareness work?* – A classification is introduced for describing the core features of representations for supporting knowledge and expertise awareness. In addition, a literature review is presented on studies which contributed to understanding the psychological effects of knowledge awareness or expertise awareness and which were conducted in the past 16 years. Further, psychological functions of the different subcategory of knowledge or expertise awareness for CSCL and CSCW are described.

## 2.2 WHAT is Knowledge Awareness or Expertise Awareness?

The term ‘knowledge awareness’ was first used in the context of CSCL environments that provided “information about the activities of the learners within the shared knowledge space” (Ogata & Yano, 1998, p. 219). That is, knowledge awareness was conceptualized in the sense of *behavioral action awareness*

(Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003; Engelmann, Dehler, Bodemer, & Buder, 2009). According to a more recent definition, knowledge awareness is *"an individual's state of being informed and having perceived information about others' knowledge"*, that is, especially others' externalized task-relevant knowledge (Engelmann et al., 2009, p. 950).

Knowledge awareness is a strand of research on *group awareness* (Gross, Stary, & Totter, 2005; Gutwin & Greenberg, 1995). The aim of group awareness research is to support virtual teams in CSCL and CSCW by providing them with task-relevant information about the group members (Gross et al., 2005) because spatially separated group members do not receive the social cues casually transmitted face-to-face which facilitate knowledge exchange (e.g., seeing a group member nodding his or her head) and coordination of task completion (Gutwin & Greenberg, 1995). Research on knowledge awareness aims at providing computer-supported external representations of the users' knowledge that enhance learning and distributed collaboration (Engelmann et al., 2009; Janssen & Bodemer, 2013). More specifically, knowledge awareness is a type of *cognitive group awareness* (Janssen & Bodemer, 2013). In contrast to classical group awareness (e.g., action awareness; Carroll et al., 2003), *cognitive group awareness* aims at capturing cognitive variables that are usually not directly observable in face-to-face or computer-mediated situations (Janssen & Bodemer, 2013).

*Expertise awareness* means that people are informed about various aspects of others' expertise, for example, their "type and level of expertise" (Maybury, D'Amore, & House, 2002, p. 204), their activities in their area of expertise, and changes to their area of expertise (Dörner, Pipek & Won, 2007; Reichling & Wulf,

2009; Vivacqua, 1999). Expertise awareness is an important goal of distributed knowledge management in order “to enable innovation, integration and collaboration” both within and across organizations (Maybury et al., 2002, p. 201).

Knowledge and expertise are related concepts, however, some distinctions can be made: “Knowledge is information which has been cognitively processed” (Tergan & Keller, 2005, p. 3). Expertise means that a person has gained both highly specialized knowledge regarding a subject-matter domain (Bromme, Jucks, & Rambow, 2004; Bromme, Rambow, & Nückles, 2001) and general problem solving competence (Sassenberg, Boos, & Klapproth, 2001) by means of prolonged and intensive deliberate practice (Ericsson, 2006). Due to pattern learning and automaticity, experts own informal and tacit knowledge (Scardamalia & Bereiter, 1994) which is difficult to elicit (Hoffman & Lintern, 2006). In addition, expertise (similarly like the concept of ‘competence’) also involves motivational and volitional aspects (Klieme, 2004).

In CSCL and CSCW, no strict distinction between the concepts of knowledge or expertise awareness is made (e.g. Janssen & Bodemer, 2013). However, the term knowledge awareness is more common in CSCL settings which involve distributed persons with an equal level of expertise in the subject-matter domain of a task (cf. Engelmann et al., 2009), whereas expertise awareness is more common in CSCW settings which involve a stronger asymmetry regarding the level of domain-specific expertise, in case of distributed professional cooperation or help seeking from an expert, for example (cf. Maybury et al., 2002).

One commonality of knowledge awareness and expertise awareness is that each concept can exist on the level of individual persons without having to be

shared on a group level (cf. Engelmann et al., 2009), in contrast to related group level concepts such as common ground (Clark & Brennan, 1991).

## 2.3 WHY is Knowledge Awareness or Expertise Awareness Important?

In the following, theories and models from different areas of research are outlined in brief which explain the potential of and the barriers to knowledge exchange as well as the role of knowledge or expertise awareness.

***Knowledge projection.*** As long as people do not have an accurate idea of others' knowledge, they tend to use stereotypes and their own knowledge as a basis for judging what others might know (cf. Nickerson, 1999; Nickerson, Baddeley, & Freeman, 1987; Nickerson, Butler, & Carlin, 2009). However, this heuristic can result, for example, in the "illusion of simplicity" (Krauss & Fussell, 1991; Nickerson, 1999), that is, overestimating the comprehensibility of one's own explanations for others (Nickerson, 1999).

*Role of knowledge or expertise awareness.* Computer-mediated communication becomes more effective and efficient if collaboration partners have an accurate idea of each other's knowledge because they can adapt their verbal explanations to their partners' current level of understanding (*audience design*; Clark & Murphy, 1982) which is an important process in computer-supported collaborative learning (e.g., Dehler-Zufferey, Bodemer, Buder, & Hesse, 2011; Fussell & Krauss, 1989a,b).

***Collective information sampling model.*** In most situations of group decision making, groups first have to share the members' diverse knowledge in order to reach good decisions which are potentially superior to individual decisions (Wittenbaum, Hollingshead, & Botero 2004). However, a special challenge is an information distribution called *hidden profile* (e.g. Stasser & Stewart, 1992): The majority of group members shares information supporting a less optimal decision whereas only a minority has information needed in order to reach the optimal decision. Information which is known to most members right from the start will be mentioned more probably and will exert a stronger influence on members' preferences (Gigone & Hastie, 1993, 1997) than information which is known to only one member (Stasser & Titus, 1985, 1987; Stasser, 1992).

*Role of knowledge or expertise awareness.* Studies have shown that if members know their expertise distribution, unshared information is discussed more often and, thus, the hidden profile can be solved correctly (e.g. Stasser, Stewart, & Wittenbaum, 1995; Stasser, Vaughan, & Stewart, 2000; Stewart & Stasser, 1995) and more efficiently (Schreiber & Engelmann, 2010). Further, members in the role of experts do not only take the responsibility for bringing in their own information but they also remember previously unshared information which was mentioned by other members more often than if all members have the role of non-experts (Stewart & Stasser, 1995). However, perceived status differences can compromise information sharing of low status members (Hollingshead, 1996; Wittenbaum, 1998, 2000). In addition, Sassenberg and colleagues (2001) have shown that expertise awareness resulted in improved information sharing by virtual groups only if expertise was interpreted as unique knowledge and not as general problem solving competence.

***Transactive memory system.*** Wegner (1986, 1995) developed a model of how "individual human memory systems are linked into group memory systems" using a computer network metaphor (Wegner, 1995; p. 319). This model explains how information is assigned to an expert within the group who is responsible for storing this information and how information retrieval is coordinated. Further, it explains why teams who are informed about their distribution of expertise work more efficiently than teams who are not informed about this.

*Role of knowledge or expertise awareness.* Recent studies on TMS have extended this concept by (1) arguing that both individual-level and collective awareness of the knowledge or expertise distribution exist independently of each other (Engelmann et al., 2009; Schreiber & Engelmann, 2010; Yuan, Monge, & Fulk, 2005), (2) by showing that being aware of others' concrete knowledge elements and information resources results in a superior team performance than only being aware of others' areas of expertise without more concrete information (Engelmann & Hesse, 2011) and by (3) showing that not only expertise awareness but also social and technological accessibility of experts contribute to expertise retrieval in large teams (Yuan, Carboni, & Ehrlich, 2010).

***Social dilemma.*** Contributing to a shared database which was supposed to be used for knowledge management actually represents a social dilemma situation (Cabrera & Cabrera, 2002; Cress, Kimmerle, & Hesse, 2006; Cress & Kimmerle, 2013; Thorn & Connolly, 1987): The more one contributes to the database, the higher the individual costs are (e.g. loss of time & of "knowledge superiority" in relation to those who receive one's knowledge), whereas the more the other group

members contribute, the higher the individual benefit is of having all the information available in the database (Cress, 2005). Therefore, the least costs would be associated with contributing nothing and exploiting others' information in the database. However, if all group members showed this kind of social loafing and free riding (Karau & Williams, 1993), the database would remain empty and useless for all (Dawes, 2000). This dilemma can be overcome by a combination of psychological and structural interventions (see Cress & Kimmerle, 2013, for an overview), for example, by informing the group members which of their potential contribution is important for others and by changing the payoff function (e.g. use-related bonus system; Cress et al., 2006).

*Role of knowledge or expertise awareness.* People who have relatively less knowledge pursue a *proportionality norm*, that is, they expect from more knowledgable ones that they share their knowledge and contribute more (cf. Cress & Kimmerle, 2008, 2013; Rapoport & Suleiman, 1993), whereas people who think that they have more knowledge than others do not feel more obliged to share it (Cress & Kimmerle, 2008). Although the proportionality norm is reduced for privileged people, they still contribute more in comparison to those who think that they have less knowledge (Cress & Kimmerle, 2008). Thus, knowledge or expertise awareness activates social norms relevant for contributing to a public good such as a shared database (Connolly & Thorn, 1990; Fulk, Flanagan, Kalman, Monge, & Ryan, 1996).

***Conflict elaboration theory.*** Exchanging one's knowledge with others often sparks socio-cognitive conflicts if learners experience discrepancies between their own versus others' knowledge and understanding (Doise & Mugny, 1984; Lee et

al., 2003). Conflict Elaboration Theory (Pérez & Mugny, 1992; Mugny, Butera, Sanchez-Mazas, & Pérez, 1995) integrates both cognitive developmental approaches to peer learning (e.g. Doise & Mugny, 1984) and evidence on social influence (e.g. Deutsch & Gerard, 1955; Moscovici & Personnaz, 1986) for predicting learners' behavior in socio-cognitive conflict situations (Buchs, Butera, Mugny, & Darnon, 2004b). The starting point is a situation in which a person solves a task, and is confronted with a task solution of another source (e.g., a person or a group) which deviates from the person's solution. This theory aims at predicting under which conditions social influence can support or hinder knowledge acquisition and exchange.

*Role of knowledge or expertise awareness.* According to this theory, learning from a high competent partner is more likely to cause a competence threat than learning from an equally low competent partner (e.g. Butera, Caverni, & Rossi, 2005). A competence threat can result in uncritically imitating the partner's solution without elaborating it further (Quiamzade & Mugny, 2001).

***Communities of practice.*** Core features of work practice are *narration*, that is, story-telling as accumulated knowledge of past similar cases in order to solve current problems, *collaboration* and *social construction* (Brown & Duguid, 1991). Becoming an insider and practitioner of a community can be described as a process of *legitimate peripheral participation* (Lave & Wenger, 1991). That is, by means of *modeling*, *scaffolding*, *coaching*, and *fading* (Collins, Brown, & Newman, 1989), newcomers receive an increasing level of legitimate access to the ongoing community practice (Lave & Wenger, 1991).

*Role of knowledge or expertise awareness.* The meaning of the concepts of knowledge or expertise is not fixed but it has to be negotiated socially depending on the current situation (Lave, 1991). It is neither enough for knowledge acquisition to know who the experts are in an organization, nor to receive only abstract instructions from experts, nor to be only allowed to observe an expert model, but novices should also be actively engaged in the implicit practices in situ (Brown & Duguid, 1991; Lave, 1991). Communities of practice in large companies usually engage in various activities aimed at supporting knowledge or expertise awareness, for example, maintaining discussion forums, or employing content managers who provide meta-data about the authors of documents in a shared database (Lesser & Storck, 2001).

***Knowledge building communities.*** This concept emerged from the notion of "intentional learning" (Bereiter & Scardamalia, 1989), that is, learners pursue both their individual learning agenda and collaborative learning goals (Scardamalia & Bereiter, 2006). One aim was to restructure classroom activities towards a "peer review system" by means of a computer-supported intentional learning environment (CSILE; Scardamalia & Bereiter, 1994). Later, the concept of knowledge-building communities was used as a model for developing "knowledge-networking tools" for educational technology users, researchers, and businesspeople (CILT Knowledge Network; Hoadley & Pea, 2002; Knowledge Forum®; Scardamalia, 2004). A decentralized open knowledge environment serves as a communal multimedia database for collective understanding (Scardamalia & Bereiter, 1994).

*Role of knowledge or expertise awareness.* Although knowledge building communities are a learner-centered and constructivist approach to education, the importance of *authoritative information* is clearly acknowledged (Scardamalia & Bereiter, 2006). Students should judge the quality of expert information by using arguments instead of absorbing them uncritically or passively (Scardamalia & Bereiter, 1994, 2006). Knowledge building communities use networking tools including functionalities some of which support knowledge or expertise awareness (see Table 3).

***Organizational knowledge creation.*** According to Nonaka (1994), new organizational knowledge evolves as a result of four modes of a dynamic interaction between *tacit* and *explicit knowledge*: Tacit knowledge is created either by sharing experience in the course of *socialization* or by learning in general (*internalization*), whereas explicit knowledge results from either *externalizing* tacit knowledge or from *combining* (i.e., adding, recategorizing) several aspects of already existing explicit knowledge. Nonaka (1994) describes organizational knowledge creation as “an upward spiral process” (p. 20) in which the interactions between tacit and explicit knowledge extend to involve an increasing number of actors and become faster. In order to support organizational knowledge creation, he recommends that *self-organizing teams* cooperate flexibly horizontally and vertically in the context of a “hypertext organization”. Whether the knowledge spiral increases or decreases depends on the incentive system for motivating individuals to share their knowledge, the corporate culture (e.g. trust, commitment), and further factors (Nonaka, Toyama, & Nagata, 2000).

*Role of knowledge or expertise awareness.* Awareness of other people's knowledge and expertise is crucial for several processes of organizational knowledge management (Maybury et al., 2002). One aim of applications in CSCW is to create an organizational memory (Walsh & Unger, 1991). Since it is problematic for experts to constantly externalize their tacit knowledge, automatic approaches have been developed (Marwick, 2001): Technologies are used to infer the authors' expertise from documents or from the questions answered in discussion forums (e.g. Ackerman & McDonald, 1996; Autonomy Corporation, 2002; Yimam & Kobsa, 2000; Yimam-Seid & Kobsa, 2003).

## 2.4 WHICH APPLICATIONS for Supporting Knowledge Awareness or Expertise Awareness do exist?

In order to provide an overview of applications for supporting knowledge and expertise awareness in CSCL and CSCW, a literature search was conducted for the terms "knowledge awareness", "expertise awareness", "awareness of competence", "knowledge sharing", "knowledge building (community)", "knowledge representation", "visualization of expertise", "expertise map", "knowledge map", "expert finding", "expert locating", "expert(ise) recommender", and "knowledge management (system)" in online databases (PsycARTICLES, PsycINFO, SciVerse SCOPUS), and in the Internet search engine Goggle. Further, the cross-references of publications on these search terms were also searched. Table 3 provides this overview of 30 applications which is not exhaustive because examples were not included if no sufficient information was found on the Internet (e.g. Abuzz "Ask

Anything", cf. Maybury et al., 2002). These applications were developed for different areas (e.g. research networks, K-12 education, public sector agencies), and are based on data and profiles which were either generated by the users themselves (e.g. MII Expert Finder; Mattox, Maybury, & Morey, 1999; Mattox, Smith, & Seligman, 1998), generated automatically (e.g. MIT ExpertFinder; Vivacqua, 1999) or semi-automatically (e.g. ExpertFinding System; Reichling & Wulf, 2009). The methods used for knowledge management and identification of expertise include, for example, publishing (Autonomy Corporation, 2002), self-nomination (Walther, 1997), database search (Mattox et al., 1999), tagging (Walther, 1997), ontology (Ackerman & McDonald, 1996) vs. user-generated hypotheses about expertise (e.g. Expertise Awareness Client; Dörner et al., 2007), recommender systems (McDonald & Ackerman, 2000; Reichling & Wulf, 2009; Vivacqua, 1999), statistical ranking and clustering techniques such as social network analysis (cf. Maybury et al., 2002), and visualization techniques (e.g. Afzal et al., 2009; Mockus & Herbsleb, 2002; Walter, 1997) for knowledge and information (cf. Tergan & Keller, 2005).

In order to understand how knowledge or expertise awareness works from a psychological perspective, it is important to consider the whole process of generating, perceiving, and reacting to knowledge or expertise information which will be done in the following sections.

***Table 3***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

| |
|---|
| ***Assessment of Expertise Awareness in Resolution Networks*** (Chen, Tao, Yan, Anerousis, & Shao, 2010)<br>– application area: IT service industry, resolution social networks: routing of users' problem tickets to the right expert groups; tickets are transferred from one expert group to the next if the previous expert group cannot solve the problem<br>– resolution social network (cf. Chen et al., 2010): nodes represent expert groups, edges represent ticket transfer relationships between groups; measures: number of resolved and transferred tickets of a group; expertise awareness between two groups = transfer effectiveness<br>– provides ticket routing recommendations based on majority of past decisions (transition probability; Chen et al., 2010); further aim: training program for improving the awareness of other groups' expertise |
| ***Autonomy Technology*** (http://www.autonomy.com/, Autonomy, 2013; Autonomy Corporation, 2002)<br>– application area: Hewlett Packard company for the automation of business operations, e.g., knowledge management, content publishing, e-commerce, electronic customer relationship management, Internet portals, etc.<br>– extracts areas of expertise from users' search & publication histories; helps to find users with similar interests & experts in a field (http://www.autonomy.com/, Autonomy, 2013; Autonomy Corporation, 2002)<br>– privacy: not all items in a results list can be viewed by all users, & not all documents in a results list can be opened by all users (http://www.autonomy.com/, Autonomy, 2013; Autonomy Corporation, 2002) |
| ***CILTKN*** (The Center for Innovative Learning Technologies Knowledge Network; e.g. Hoadley & Pea, 2002)<br>– application area: research networks; tools for "know-who": recommender engines, & visualizations of social information (see ReferralWeb; Kautz, Selman, & Shah, 1997); the center was closed in 2004<br>– community software: collaborative workspace, bulletin board, daily news publishing system (Hoadley & Pea, 2002)<br>– information about: people (contact, interests), projects (research & implementation), places (Universities, organizations, labs, K-12 schools), papers (bibliographic information about important papers in the field of learning technology), syllabi (courses, learning technology), collaboration notices (jobs, conferences, etc.; Hoadley & Pea, 2002) |
| ***CONNEX*** ("connection to experts", Hewlett-Packard; cf. Bouthillier & Shearer, 2002)<br>– application area: Intranet of Hewlett-Packard<br>– directory of expert profiles (Bouthillier & Shearer, 2002) & Web browser interface for searching profiles (Becerra-Fernandez, 2000) |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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|---|
| ***ContactFinder*** (Krulwich & Burkey, 1996)<br>– application area: learning from bulletin boards, e.g. large-scale technology-related bulletin board<br>– agent monitors discussion boards & identifies authors; responds to questions with a referral to an expert (i.e. contact information); operates conservatively (i.e. more often fails to extract contacts than to erroneously indicate experts; Krulwich & Burkey, 1996) |
| ***CSILE*** (e.g. Scardamalia, 2004; Scardamalia & Bereiter, 1991, 1994)<br>see: ***Knowledge Forum®*** |
| ***Dataware Knowledge Management Systems*** (Walter, 1997)<br>– application area: software solution for organizational knowledge management<br>– ***Dataware II Knowledge Directory*** (Walter, 1997): based on keyword tagging; expertise discovery by directory search; self-nomination of experts or nomination by administrators; user receives expert's contact information; various search options (e.g. navigating the categories of a "knowledge map" visualization, thesaurus, etc.) |
| ***DEMOIR Approach*** (Dynamic Expertise Modeling from Organizational Information Resources; Yimam & Kobsa, 2000)<br>– application area: organizational knowledge management<br>– "expertise information space": centralized expertise model (based on domain models / ontologies); "expert-related source gatherers": agents for memorizing names of experts & gathering documents; "source type identifiers": agents for analyzing documents; "source wrappers": agents specialized on domain knowledge driven extraction of expertise indicators (e.g. concepts) from documents; "expertise information space manager": integrates expertise indicators received from source wrappers; methods: matrix fusion (clustering on several tiers) & visualization (Yimam & Kobsa, 2000; Yimam-Seid & Kobsa, 2003) |
| ***Expertise Browser*** (ExB; Mockus & Herbsleb, 2002)<br>– application area: collaborative software engineering for change management systems<br>– displays relationship between software parts & domain experts; quantifies expertise based on change activity: levels & breadth of expertise based on changes which the person / organization made to the software; measures of expertise: e.g. area, technology used, purpose / type of change, productivity, external ratings of other developers, etc.; expertise profiles of individuals or organizations<br>– attributes of experts (individuals / organizations) are visualized, e.g. by a tree structure (SWING JTree; Zukowski, 2005); user browses through experts & can compare degree & breadth of expertise |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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|---|
| ***Expertise Discovery and Visualization in a Scientific Community*** (Afzal et al., 2009)<br>– application area: finding reviewers for a journal; finding potential collaboration partners<br>– applies citation mining technique; expertise measures: number of publications, number of citations received, extent & proportion of citations within particular area, expert profile records & experience; 2 categories of experts: (1) reviewers (manually assigned) & (2) high-profile authors (automatically flagged); calculates expertise' weights; hyperbolic tree visualization (hyperbolic browser; Lamping & Rao, 1996) of experts |
| ***ExpertFinding System*** (Reichling & Veith, 2005; Reichling, Veith, & Wulf, 2007; Reichling & Wulf, 2009)<br>– application area: organizational knowledge management; e.g. European industrial association; finding experts to handle incoming requests from member companies<br>– expert recommender system; combines self-reported information & keyword mining from users' personal files with their permission: users select documents from their own file system; system generates semi-automatic large scale keyword list from the selected documents; dynamic changes to users' expertise are captured by automatically extracting additional new keywords from the selected changed documents (Reichling et al., 2007; Reichling & Wulf, 2009)<br>– search results: expertise profiles, 2 components: (1) keyword profile, & (2) yellow pages (YP) profile: users enter contact information & information about their educational background, job description, qualifications etc. (Reichling et al., 2007; Reichling & Wulf, 2009)<br>– for study results (Reichling & Wulf, 2009), see Table 5 in this chapter |
| ***Expertise Map*** (Huang et al., 2006)<br>– application areas: research expertise of business school professors in Taiwan; different types of low-level domain-independent visual tasks according to cognitive fit theory (Vessey, 1991); especially suited for associate, compare, distinguish, & cluster tasks (Huang et al., 2006)<br>– applies dimensionality reduction visualization technique for expertise information space: self-organizing map (SOM) & multidimensional scaling (MDS); 2 types of maps generated: (1) expert map (grouping of experts according to overlapping research interests), & (2) expertise field map (grouping of expertise according to similarities of research fields); distance on map captures similarity (Huang et al., 2006) |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

| |
|---|
| ***Expertise Recommender*** (ER; McDonald & Ackerman, 2000)<br>– application area: organizational knowledge management<br>– applies recommender system; generates user profiles based on work products; users are clustered into groups having similar dis-/likes; expertise search based on topic areas & optional filters (e.g. social network selected by user); if recommended person also is logged into ER server, "contact" button establishes synchronous chat (McDonald & Ackerman, 2000) |
| ***HelpNet*** (Maron, Curry, & Thompson, 1986)<br>– application area: experimental system at first; implemented on IBM Personal Computer later<br>– provides access to a repository of expertise information; document retrieval system<br>– inductive search system: finds the best fit between information seeker & source of knowledge & information from a large class of objects or people; probability ranking: both information seeker & source of knowledge & information estimate probability of the source to satisfy seeker's query (Maron et al., 1986) |
| ***IHMC CmapTools*** (Institute for Human and Machine Cognition, 2013; http://ftp.ihmc.us/)<br>– application area: knowledge modeling software toolkit for individual & collaborative knowledge management (Novak & Cañas, 2006)<br>– knowledge modeling by means of digital concept maps (i.e. hierarchically ordered nodes & links between them); stored on "CmapServers" (Cañas, Hill, & Lott, 2003); users can link resources (e.g. image or text files, videos) to the concepts within the concept maps; several concept maps can be linked together (Cañas et al., 2003)<br>– collaboration functions (Cañas et al., 2004): concept maps can be shared; text chat function; multiple distributed users can edit a shared map synchronously: upon request, first author of a concept map can open up an "edit lock" to further users; color-coding of multiple users: anonymous or non-anonymous name labels are displayed together with a color code at the user's cursor position<br>– for study results (e.g. Engelmann, Tergan, & Hesse, 2010b), see Table 4 in this chapter |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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| ***Knowledge Forum®*** (www.knowledgeforum.com; Knowledge Building Concepts Inc., 2013)<br>– application area: group workspace for knowledge-building communities of various ages & contexts, e.g. K-12 schools, hospitals, research teams, other organizations<br>– formerly named ***Computer Supported Intentional Learning Environments*** *(CSILE;* e.g. Scardamalia, 2004; Scardamalia & Bereiter, 1991, 1994*;* current developers: The Institute for Knowledge Innovation and Technology, Toronto, Canada)<br>– knowledge base for sharing & searching information (e.g. posting text, graphics or videos, commenting on others' notes); offers flexible visual information displays (www.knowledgeforum.com; Knowledge Building Concepts Inc., 2013)<br>– features: text & graphical notes can only be edited by author; peer commentary & automatic notification of authors about comments; several communication modes: (a)synchronous, audio, video, etc.; default option: public-access material, but private material also possible (Scardamalia, 2004; Scardamalia & Bereiter, 1991, 1994) |
| ***LinkedIn*** (www.linkedin.com; LinkedIn Corporation, 2013)<br>– application area: professional social networking; open access<br>– users create own profile based on professional affiliation (Papacharissi, 2009); "gated-access approach" aims at supporting trust among members (Papacharissi, 2009): new connections are built (1) via pre-existing relationships or (2) by intervention of a mutual contact person |
| ***Mahara ePortfolio System*** (Kineo Pacific & Catalyst IT, 2013; Hand, Bell, & Kent, 2012; https://mahara.org/)<br>– application area: individual & collaborative knowledge management; example user: PH Heidelberg (https://eportfolio.ph-heidelberg.de)<br>– funders: New Zealand's Tertiary Education Commission's e-learning Collaborative Development Fund (eCDF), Massey University, Auckland University of Technology, The Open Polytechnic of New Zealand, & Victoria University of Wellington (Hand et al., 2012)<br>– personal learning environment: users create & share electronic portfolios (i.e. web pages showing their personal educational or work achievements), write (or comment on others') learning protocols (blogs), plan projects, upload files, embed social media resources, collaborate using shared files & forums, e.g. for peer assessment (Stevenson, 2006); personal profile can be exported (Hand et al., 2012)<br>– user decides which content is private vs. open for specific target groups (e.g. "my contacts", "my learning groups", etc.); users can decide for each blog post whether commenting is possible; user can invite new users (Hand et al., 2012) |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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| ***MIT ExpertFinder*** (Vivacqua, 1999)<br>– application area: networked community of experts in the domain of Java programming; educational (e.g. students' help seeking) or corporate settings; project aims at being domain independent<br>– agent creates personal profile of users' areas & level of expertise; made available to other expert finder agents upon request; profiles are recalculated periodically; level of expertise is classified by analyzing frequency of using specific methods, operations & libraries, & by comparison with the norms of general usage (Vivacqua, 1999)<br>– agent preferably recommends people who have a slightly higher level of expertise than the questioner (cf. Vygotsky, 1978)<br>– incentive for users: interface shows how many questions & answers users have contributed to the community (Vivacqua, 1999)<br>– system can only be used if users are willing to share their profiles; however, users can choose their public areas of expertise & self-correct own profile (Vivacqua, 1999) |
| ***Multimedia Forum Kiosk*** (MFK; Hsi & Hoadley, 1997)<br>– application area: electronic collaborative discussion tool for science classrooms; asynchronous text-based communication<br>– system provides multimedia information (e.g. videos, sound tracks etc.) about everyday scientific phenomena<br>– 3 formats of discussion (Hsi & Hoadley, 1997): (1) anonymous contribution, (2) contribution attributed to author, (3) contribution attributed to author plus authority participation (e.g. class teacher); 2 graphical representations of discourse: (1) "opinion area": students' initial statements plus contributor's photo (non-anonymous) or cartoon face (anonymous), & (2) "discussion area": argument map visualizing disagreements, questions, & lines of reasoning plus photo or cartoon face<br>– students ask questions, generate explanations for scientific phenomena, & revise others' ideas – also across different class periods<br>– for study results (Hsi & Hoadley, 1997), see Table 4 in this chapter |
| ***NewsMate*** (Fagrell, Forsberg, Johannesson, & Ljungberg, 2000; Forsberg, 2001)<br>– application area: PDA based application for knowledge sharing & expertise location; developed for mobile & distributed journalists<br>– features: personal to-do list; list of colleagues from the same radio station working on the same topic & who is online; SMS warning: "There is a risk of cross-reporting" (Forsberg, 2001, p. 51)<br>– ***FieldWise*** (Fagrell, 2000; Forsberg, 2001): generalized architecture based on *NewsMate* (Fagrell et al., 2000) |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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| ***ReferralWeb*** (AT & T Laboratories; Kautz, Selman, & Shah, 1997)<br>– application area: reconstructing, visualizing, & searching social networks of experts on the World Wide Web<br>– search engine retrieves Web documents mentioning the user; names of other individuals are extracted from the documents; individuals are matched to topic areas; results are merged into global network model; uncovers existing social networks based on bibliographic information, i.e., it visualizes connections between researchers based on coauthorship of papers (Kautz et al., 1997)<br>– provides referrals via chains of named individuals, i.e., transparency instead of anonymity; recommendations are generated by matching profiles (Kautz et al., 1997) |
| ***ResearchScorecard*** (www.researchscorecard.com, ResearchScorecard Inc., 2013; Committee on the Impact of Academic Research on Industrial Performance, 2003)<br>– application area: database & data mining tools for finding & evaluating biomedical scientists & technological experts<br>– established according to the recommendation of the "Committee on the Impact of Academic Research on Industrial Performance" of the US National Academy of Engineering in 2003<br>– offers researchers' & departmental profiles including their funding history; provides statistical reports of research productivity (e.g. patent & publication count), funding levels, research trends & product usage (www.researchscorecard.com, ResearchScorecard Inc., 2013) |
| ***SIGMA*** (Dörner, Pipek, & Won, 2007)<br>– application area: freelancer network of trainers & consultants<br>– ***Expertise Awareness Client*** (eXacT; Dörner et al., 2007): based on users' activities & hypotheses regarding indicators of expertise (i.e. decentralized expertise classification); expertise validation: visualization of trust into other users' shared hypothesis generator; notification service: semi-automated observation of activities indicating (gain of) expertise; privacy filter; organizational filter (i.e. expertise indicators according to organizational policy); interest filter (individualization); ***Expertise Awareness Manager*** (EAMa) for changing indicators; ***Expertise Awareness Monitor*** (EAMo) displays current changes in available expertise (Dörner et al., 2007) |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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| ***SPUD project*** ("Skills Planning und/and Development", Microsoft; cf. Davenport & Prusak, 1997)<br>– application area: organizational knowledge management, helping newcomers in the domain of system development finding experts in a geographically distributed company (Davenport & Prusak, 1997; Penuel & Cohen, 2003)<br>– "knowledge map": graphical representation (database) of distribution of knowledge in a company (Penuel & Cohen, 2003); supports matching persons to jobs & work teams<br>– community of practice approach (Lave & Wenger, 1991): newcomers engage in "practice on the periphery" (Lave & Wenger, 1991) by interacting with experts via simulations & modeling tools (Penuel & Cohen, 2003); online assistance provided by the experts |
| ***The Answer Garden*** (Ackerman & McDonald, 1996; Ackerman & Malone, 1990)<br>– application area: tool for supporting growth of organizational memory by means of databases containing commonly-asked questions (Ackerman & Malone, 1990); targeted at organizations with a help line for customers (Penuel & Cohen, 2003), e.g. domain of software engineering<br>– users are referred to experts who categorize users' questions into ontology (tree-branching strategy; Penuel & Cohen, 2003) which can be browsed by users to find questions & answers similar to their own question; if user doesn't find a good answer, s/he can send an anonymous email question to expert; new questions & answers are immediately integrated in the tree-branching structure; advantage: experts do not have to answer recurrent questions (Penuel & Cohen, 2003)<br>– expertise validation by tracking experts performance, user ratings & experts' response times |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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|---|
| ***The MITRE Corporation*** (cf. Maybury, D'Amore, & House, 2002)<br>– application area: public sector agencies<br>– ***Collaborative Virtual Workspace*** (CVW; Spellman, Mosier, Deus, & Carlson, 1997): "virtual building" metaphor; several groupware systems (e.g. workspace & social awareness); various interaction devices (e.g. chat, whiteboard, audio/video conferencing); contributions are attributable to individuals (e.g. cursors & annotations are identifiable)<br>– ***MII Expert Finder*** (Mattox, Maybury, & Morey, 1999; Mattox, Smith, & Seligman, 1998): employee sends query to search engine; expertise identification by data mining (e.g. newsletters, project descriptions, publications, home pages): system ranks employees' expertise by number of mentions of a concept, methods: (1) tagging, & (2) proximity of name and keywords; self-definitions (e.g. employee's resume) receive additional weight; search results: expert's contact information, hyperlinks to relevant documents<br>– ***MII XperNet*** (Maybury et al., 2002): works without user queries; expertise classification: (1) statistical clustering techniques, & (2) social network analysis (i.e., networks extracted from several activities & public share folders, e.g., projects, publications); assessment of level of expertise; uses domain-independent models of expertise (i.e., assessment based on document authorship, network centrality, personal Web pages, project membership); network expansion by dynamic merging of lower level clusters into larger core clusters; network visualization: map with nodes (people) and links between nodes (associations, strength of association); pilot system for extracting communities of practice (e.g. Lave & Wenger, 1991) & generating a "community card" (i.e. community name, central members, organizational unit, key projects, members working on overlapping projects) |
| ***Technorati*** (www.technorati.com; Technorati Media, 2013)<br>– application area: first Internet search engine for blogs; services for blogs & social media sites (e.g. BlogCritics.org: journalism publishing platform; Twittorati.com: shows tweets of top bloggers)<br>– indexes blogs & tagged social media written in English; provides a current index of the most popular people & topics in the Blogosphere (www.technorati.com; Technorati Media, 2013)<br>– open source software; tracks bloggers' tags; if a blog is not included in list of blogs, bloggers can "claim" their blog; users can personalize their search by means of "watchlists" (i.e. RSS feeds; Pikas, 2005)<br>– search areas: e.g. news, politics, business, technology, sports, entertainment, lifestyle etc. (www.technorati.com; Technorati Media, 2013) |

***Table 3 (Continued)***

*Examples of Applications for Supporting Knowledge Management by Knowledge and Expertise Awareness Information*

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| ***Whoknows*** (formerly named: ***Xperscore***; Whoknows, 2013; whoknows.com/app/index)<br>– application area: organizational knowledge management; automatic expertise discovery & collaboration platform<br>– system silently monitors employees non-confidential Internet & Intranet browsing; learns how employees use & distribute internal information, e.g. to external experts via web based forums, social networks etc.; creates a knowledge base of information & experts (www.xperscore.com; Xperscore, 2013) |
| ***Xpertfinder*** (Fraunhofer IPA; Sihn & Heeren, 2001)<br>– application area: organizational knowledge management & cooperation management<br>– aims at identifying experts in cooperating companies (Sihn & Heeren, 2001); creates expert profiles by analyzing e-mail communication or news group contributions of registered users (Sihn & Heeren, 2001)<br>– within a company: knowledge models of subject areas (“thematic field trees”) constantly developed & saved on a server; across companies: cooperation network server<br>– protection of personal data: experts are not named to the users directly; users send a query via e-mail; first query result is a graph of all company-wide anonymous experts; users can choose between companies and anonymous experts; system decodes selected experts & forwards message; experts can either reply to or ignore the question (Sihn & Heeren, 2001) |
| ***Xperscore*** (Xperscore Inc., 2013; www.xperscore.com)<br>see: ***Whoknows*** |
| ***Yenta*** (Foner, 1997)<br>– application area: developed for individual knowledge management; however, not yet been made available for widespread use on the Internet (Foner, 1997)<br>– expertise identification from e-mail message traffic & ubiquitous personal data (e.g. newsgroup articles read or written by the user, not explicitly asking about expertise only; Foner, 1997); matchmaker: identifies users interested in similar topics across the Internet (Foner, 1997) & enables one-to-one or group conversations; system compares agents’ information & transmits referrals from one agent to another (Foner, 1997); aim: finding relevant peers or experts<br>– system protects private user data by means of cryptography, decentralization & a peer-to-peer architecture (Foner, 1997) |

## 2.5 HOW does Knowledge Awareness or Expertise Awareness work?

Engelmann and colleagues (2009) have introduced a cyclic model which includes the four steps of (1) person A adding knowledge or expertise information to an interaction space, (2) person B extracting these information, (3) person B adding adaptive information, and (4) person A extracting adaptive information from the interaction space (Engelmann et al., 2009, Fig. 1, p. 953). The following process steps will be described which are similar to those by Engelmann and colleagues (2009): (1) sharing – (2) representing – (3) perceiving – (4) psychological effects of knowledge or expertise information.

### 2.5.1 Sharing Knowledge or Expertise Information

Vivacqua (1999) argues that three major motives for sharing one's knowledge and expertise exist: (1) expecting reciprocity in giving and receiving help, (2) being prosocial by answering others' requests, and (3) showing off by presenting an excellent expertise profile (Reichling & Wulf, 2009). Showing off, that is, pretending to be more expert than one actually is, is discussed controversially in the literature: some researchers and developers see this as a problem (e.g. Reichling & Wulf, 2009), others not (Vivacqua, 1999) because pretenders would receive questions they could not answer which subsequently would discourage them from continuing to show off (Vivacqua, 1999, p. 3).

Further problems of user-generated data are that they are quickly out-dated (Maybury et al., 2002), and that the users lack motivation for contributing for several reasons, for example, loss of time (Cress & Kimmerle, 2013), visibility of

incompetence (Dörner et al., 2007), and privacy concerns (Reichling & Wulf, 2009). Therefore, some knowledge management systems have built in incentives for knowledge sharing also recommended by empirical studies (see Cress & Kimmerle, 2013, for an overview). For example, electronic commerce systems could give those users „credits“ who answer others' questions. With these credits, users could "buy answers" to their own questions (Vivacqua, 1999[2]). Nevertheless, user-generated data are essential because one problem of automatically generated data is, for example, an erroneous classification of a person as an expert if the person has published content (e.g. as a web administrator) without being the author of this content (Maybury et al., 2002).

### 2.5.2 Representing Knowledge or Expertise Information

Several classifications for describing the way knowledge or expertise is externalized and represented have been introduced in the past which will be outlined in brief. First, classifications of knowledge awareness derived from CSCL research will be presented (i.e. Engelmann et al., 2009; Ogata & Yano, 1998, 2003; Sangin, Molinari, Nüssli, & Dillenbourg, 2011). After this, a description of general features of awareness derived from CSCW research will be introduced (i.e. Maybury et al., 2002) because these awareness features should be included in a combined classification of knowledge or expertise awareness for CSCL and CSCW in order to describe more comprehensively which subcategories of

[2] The examples by Vivacqua (1999, p.3) are not available on the Internet any more (e.g. Abuzz "Ask Anything").

knowledge or expertise awareness exist and which effects they have on the users' behavior.

Engelmann and colleagues (2009) introduced a classification of knowledge awareness in CSCL having three categories:

*Content-based knowledge awareness*. Information for supporting knowledge awareness is provided by directly visualizing the content of a person's knowledge concerning a subject-matter domain, for example, by means of digital concept mapping (e.g., Engelmann et al., 2010b; Engelmann & Hesse, 2011). The amount of content-based information about others' knowledge can vary from meta-knowledge about the domain of expertise only (Engelmann & Hesse, 2011) to more concrete knowledge elements and information resources (Engelmann et al., 2010b; Schreiber & Engelmann, 2010).

*Context-based knowledge awareness*. Information for supporting knowledge awareness is added as enrichment to the interaction space, in the context of a task that does not mirror the person's concrete knowledge content per se. For example, learners self-assess their understanding of text units of learning material by tagging small boxes next to each text unit that they referred to (*partner knowledge awareness tool*; Dehler, Bodemer, Buder, & Hesse, 2009; Dehler-Zufferey et al., 2011).

*Hybrid knowledge awareness*. In this case, an external representation provides a combination of both context-based and content-based knowledge awareness. For example, the individual task solutions of learners are visualized displaying both content elements of the learners' knowledge and contextual information regarding, for example, (un)shared knowledge gaps and conflicting knowledge (e.g. Bodemer, 2011).

In addition, Sangin and colleagues (2011) suggest distinguishing between *activity-based*, *subjective* and *objective knowledge awareness*. In the studies by Ogata and colleagues (e.g., Ogata, Matsuura, & Yano, 2000; Ogata & Yano, 1998, 2000), *activity-based knowledge awareness* was implemented by providing learners with a "knowledge awareness map" visualizing, for example, how often a learner had visited a web page or how often he or she had given correct answers on conceptual questions. In this way, the knowledge awareness map recommended learning partners based on a learner's current questions. Self-reports of understanding or expertise provide information for supporting *subjective knowledge awareness* (Sangin et al., 2011). These information can also encompass self-created task solutions because if learners create them in an elaborate way (i.e., not by mere guessing), these solutions represent the learners' knowledge (cf. Engelmann et al., 2009). *Objective knowledge awareness* can be supported, for example, by displaying objective performance scores, obtained in a prior knowledge test (Sangin et al., 2011).

In this chapter, it is argued that these classifications can also be used for describing expertise awareness information in CSCW contexts. Moreover, it is proposed that the following CSCW classification of awareness should be combined with these previous CSCL classifications of knowledge awareness: In describing general features of awareness, Maybury and colleagues (2002) distinguished between *explicit* versus *implicit* information and *static* versus *dynamic* information (pp. 199-200). In the following, these awareness features will be used in order to provide a combined classification of knowledge awareness in CSCL and expertise awareness in CSCW and in order to draw conclusions about the different

psychological effects and functions of each subcategory of knowledge or expertise awareness.

Based on the description of awareness features provided by Maybury and colleagues (2002), it is suggested (1) to additionally differentiate between an *explicit* versus *implicit level of expertise* and (2) to take *dynamic changes* of the external representation for supporting knowledge or expertise awareness into account by distinguishing between *static* versus *dynamic knowledge* or *expertise awareness* (cf. Engelmann et al., 2009).

Explicit information about the level of expertise is provided if, for example, persons are labeled as “layperson”, “novice”, or “expert” (Bromme et al., 2001; Mugny et al., 1995; Mugny, Tafani, Butera, & Pigière, 1998). This can be done by displaying these labels instead of or next to the names of the users of a shared interaction space (Baumeister, Engelmann, & Hesse, subm. a, b) or by labeling digital artifacts, for example, the individual concept maps of the collaborators as map of “expert a / b / c” (Engelmann et al., 2010b; Engelmann & Hesse, 2011). Further, the computer-supported environment can display the users’ self-ratings of their degree of understanding of a topic (Dehler-Zufferey et al., 2011; Nückles & Stürz, 2006; Ray, Neugebauer, Sassenberg, Buder, & Hesse, 2013) or their level of prior knowledge obtained by a test (Sangin et al., 2011).

For a comprehensive classification of knowledge or expertise awareness, it is important to distinguish between explicit or implicit information about others’ knowledge or expertise because being aware of others’ level of expertise and, thus, social status can activate strong social influence dynamics (e.g. Butera et al., 2005; Quiamzade, Mugny, & Darnon, 2009), for example, social comparison of one’s own status to that of the others (Festinger, 1954). In addition, providing

accurate information about users' level and areas of expertise is a core topic of knowledge management research and development (e.g. Dörner et al., 2007; Maybury et al., 2002; Reichling & Wulf, 2009; Vivacqua, 1999).

In contrast, sometimes the collaboration space only implicitly provides information about others' status of expertise, for example, by displaying the number of tasks worked on, the concrete task solutions (e.g., Bodemer, 2011), and by enabling communication.

However, the dimension of explicit versus implicit level of expertise should not be confused with disclosing the names of the users versus keeping them anonymous. Explicit means that the information is indicated on the computer screen, whereas implicit means that the users are left to infer the information regarding others' level of expertise.

In addition, differentiating between an explicit or implicit level of expertise is more precise than the term 'expertise awareness' (Maybury et al., 2002) because expertise awareness per se does not tell whether the level of expertise is provided *explicitly* within the collaboration space or whether this information exists only *implicitly* which should have different psychological effects on the users of this awareness information. Sometimes users of knowledge management systems are erroneously identified as experts (Maybury et al., 2002; Reichling & Wulf, 2009). In such cases, additionally providing explicit information about their level of expertise could help to reduce over- or underestimation of their expertise (Reichling & Wulf, 2009). Some knowledge management systems provide explicit rankings of expertise by means of data mining (e.g. Afzal et al., 2009), or the users themselves determine criteria of expertise (e.g. Dörner et al., 2006). However, in some collaboration platforms, an implicit level of expertise is implemented (e.g. Hoadley

& Pea, 2002), although the system has automatically ranked the users' level of expertise (e.g. MII Expert Finder; Mattox et al., 1998, 1999).

Moreover, external representations for supporting knowledge or expertise awareness should be categorized as *static* versus *dynamic* according to whether the users are informed about changes to the representation of knowledge or expertise of others in real-time (dynamic) or not (static). In the context of this dissertation, it is assumed that static knowledge or expertise awareness will have certain psychological effects other than dynamic knowledge or expertise awareness. For example, if we use a virtual learning environment and receive the information there that someone has recently read a short text about a complex subject-matter for the first time, we will assume that we can ask the person about the content of the text, but we will not assume that the person can answer all questions concerning this topic. Thus, we will consider this as an instance of static knowledge awareness, referring to a specific situation in a specific point in time ("has recently read this text"). However, if we observe in the virtual learning environment that this person has been learning about the topic for several months, becoming increasingly more knowledgeable, we will adapt our initial assumptions regarding this learner's level of expertise, and we will consider this as an instance of dynamic knowledge awareness.

The technical idea is not new that group awareness can support collaboration by storing and mirroring the users' activities (Gutwin & Greenberg, 2002), for example, by showing a timeline ('history awareness'; Kreijns & Kirschner, 2002). Further, in the research literature on CSCW and CSCL, there is a strong emphasis on "the dynamic nature of expertise information" (Huang et al., 2006, p. 1541; see also Engelmann et al., 2009, p. 951: "the dynamic nature of the

awareness concept"). However, as the overview of empirical studies presented in the next sections (Tables 4 & 5) will show, these studies in fact implemented either static or dynamic knowledge or expertise awareness. Thus, it seems possible that there might be a gap between the practices of using knowledge or expertise awareness information in the field (cf. Table 3) and empirical research on these concepts. Therefore, the distinction between static vs. dynamic knowledge or expertise awareness is a newly introduced dimension in CSCL and CSCW research. It is important to investigate whether these two subcategories (static vs. dynamic) of the dimension of presentation time are suitable for different purposes of CSCL and CSCW.

### 2.5.3 Psychological Studies on Knowledge or Expertise Awareness

In order to provide an overview of studies investigating the perception and psychological effects of knowledge or expertise awareness in CSCL and CSCW, a literature search was conducted using the same terms as for searching applications, that is, "knowledge awareness", "expertise awareness", "awareness of competence", "knowledge sharing", "knowledge building (community)", "knowledge representation", "visualization of expertise", "expertise map", "knowledge map", "expert finding", "expert locating", "expert(ise) recommender", "knowledge management (system)", and the additional term "expert-layperson communication" in online databases (PsycARTICLES, PsycINFO, SciVerse SCOPUS), and in the Internet search engine Goggle. Further, the cross-references of publications on these search terms were also searched. The overview of studies can be seen in Tables 4 and 5. Since the search focus was on psychological studies, research

results from other domains which also investigate representations of knowledge, for example, knowledge engineering and human-computer interaction, were not included. A special challenge was to identify suitable studies because not all studies reported in the following explicitly used the terms “knowledge or expertise awareness” for describing the concept under investigation (e.g., “the assessment tool”; Nückles & Stürz, 2006). However, these studies all have in common that they informed people about others’ knowledge or expertise. Also, all studies included in this review applied and tested a computer-based environment or tool for providing information about others’ knowledge or expertise, and they all assessed the effects of this knowledge or expertise information or of context factors combined with this information (e.g. anonymous vs. attributable comments; Hsi & Hoadley, 1997) on various psychological aspects (e.g. perception of knowledge or expertise awareness, knowledge acquisition & collaboration). The overview of study examples consists of 20 published studies of the past 16 years (i.e., publication year 1997-2013), and the two studies of the present dissertation which have been submitted for publication (Baumeister et al., subm. a,b). However, we cannot rule out that further studies may exist which also contribute to understanding the psychological effects of knowledge or expertise awareness. CSCL studies in which the participants interacted with and learned from distributed partners who had an equal level of expertise regarding the subject-matter domain of the task conducted in the studies were categorized as researching knowledge awareness (e.g. Dillenbourg & Traum, 2006, see Table 4), whereas CSCW studies which involved distributed professional cooperation or help seeking between interaction partners who showed a larger asymmetry of the level of expertise regarding the subject-matter domain of the task conducted in the studies were categorized as

researching expertise awareness (e.g. Nückles & Stürz, 2006; Reichling & Wulf, 2009, see Table 5).

The following conventions are used for describing each type of knowledge or expertise awareness according to the combined classification (see Tables 4 & 5): Double-lines indicate the boundaries *between* the dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness; that is, a computer-supported environment can feature a configuration of several dimensions of knowledge or expertise awareness simultaneously, for example, hybrid, subjective, and static knowledge or expertise awareness providing an explicit level of expertise (e.g., Baumeister et al., subm. b). In addition, due to the dynamic nature of the information about others' knowledge or expertise, changes within each dimension are possible (e.g. from an implicitly to an explicitly provided level of expertise), and the subcategories are not mutually exclusive.

#### *2.5.3.1 Perceiving Knowledge or Expertise Awareness Information*

Some studies tested the effectiveness of an environment for supporting knowledge awareness and included a manipulation check of whether knowledge awareness indeed was acquired (e.g. Engelmann et al., 2010b; Engelmann & Hesse, 2010). These studies have consistently shown that the participants perceived the awareness information regarding their group members' task-relevant knowledge accurately (e.g. Engelmann & Hesse, 2010). Further, in a study by Sangin and colleagues (2011), dyads provided with a knowledge awareness tool displaying explicit information about the partner's level of expertise were able to model their partner's knowledge after the collaboration phase more accurately than dyads

collaborating without the tool. It can be concluded that if the awareness information about the knowledge or expertise of other persons is helpful for the current task (cf. *representational guidance*; Suthers, 2006), it is probable that this awareness information will be perceived and interpreted accurately, and that it results in significantly more knowledge awareness compared to a condition in which this awareness information is not provided (Engelmann et al., 2010b).

#### *2.5.3.2 Psychological Effects of Knowledge or Expertise Awareness Information*

The selected results in Tables 4 and 5 are grouped according to different psychological areas, for example, whether an effect was cognitive, social, or behavioral, whether the study revealed that individual differences interacted with knowledge or expertise awareness (e.g. social comparison orientation; Ray et al., 2013) and whether a context factor such as 'anonymity' was combined with knowledge or expertise awareness (e.g., Hsi & Hoadley, 1997). Further, this overview of studies also highlights which subcategories of knowledge or expertise awareness were researched more intensively than others. For example, every second study implemented context-based knowledge or expertise awareness (e.g. Nückles & Stürz, 2006). In most studies (i.e. $n$ = 15 studies), static knowledge or expertise awareness was provided in combination with an explicit level of expertise (e.g. Molinari, Sangin, Nüssli, & Dillenbourg, 2008). Maybe this configuration (context-based, static, & explicit level of expertise) constitutes an especially efficient way of supporting knowledge or expertise awareness without overloading the users.

The collected CSCL studies consistently show that providing knowledge awareness information is an effective and efficient method for supporting both individual and collaborative computer-supported learning and problem solving (for an overview, see also Janssen & Bodemer, 2013). However, there are important moderating factors which need to be considered, for example, anonymity (Hsi & Hoadley, 1997), and individual differences (e.g. Ray et al., 2013). Similarly, providing expertise awareness information constitutes an important building block of knowledge management in CSCW. Still, it is difficult to find studies systematically testing the psychological effects of the presented applications. Important factors which need to be considered in this area are privacy, trust, an accurate representation of expertise, and social-motivational aspects of expertise profiling (Reichling & Wulf, 2009).

***Table 4***

*Knowledge Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based KA | Context-Based KA | Hybrid KA | Content-Based KA | Subjective KA | Objective KA | Explicit Level of Expertise | Implicit Level of Expertise | Static KA | Dynamic KA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Baumeister, Engelmann, & Hesse, (subm. a; *N* = 59) | | | × | | × | | × | | × | | – *cognitive & social:* confrontation with a higher-competent source's deviating task solution results in experiencing more cognitive conflict than confrontation with an equally low-competent source's deviating task solution<br>– *behavioral:* more adaptation of task solutions to the deviating solution of a higher-competent source than to the solution of an equally low-competent source<br>– *behavioral:* higher-competent sources promote correctness of task solutions more than equally low-competent sources<br>– *individual differences:* persons low in social comparison of competence adapt their task solution more to deviating solution of a higher-competent source than to the solution of an equally low-competent source |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 4 (Continued)***

*Knowledge Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based KA | Context-Based KA | Hybrid KA | Content-Based KA | Subjective KA | Objective KA | Explicit Level of Expertise | Implicit Level of Expertise | Static KA | Dynamic KA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Baumeister, Engelmann, & Hesse, (subm. b; *N* = 58) | | | × | | × | | × | | | × | – *context factor:* KA combined with peer talk helps to reduce cognitive conflicts & results in more knowledge convergence than KA without peer talk |
| Bodemer (2011; *N* = 40) | | | × | | × | | | × | | × | – *cognitive:* collaborative integration tool supports individual learning gain, especially regarding the integration of visual and algebraic information<br>– *behavioral:* dyads with collaborative integration tool discuss and resolve divergent & asymmetric task solutions more frequently; tool improves collaborative learning performance |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 4 (Continued)***

*Knowledge Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based KA | Context-Based KA | Hybrid KA | Content-Based KA | Subjective KA | Objective KA | Explicit Level of Expertise | Implicit Level of Expertise | Static KA | Dynamic KA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dehler, Bodemer, Buder, & Hesse (2009; *N* = 16) | | × | | | × | | × | | × | | – *behavioral:* KA tool supports task-focused statements, collaborative elaboration & integration of learning content, & collaborative activities, e.g., answering questions of learning partners |
| Dehler-Zufferey, Bodemer, Buder, & Hesse (2011; *N* = 42) | | × | | | × | | × | | × | | – *cognitive:* KA tool supports inferential knowledge, not factual knowledge<br>– *cognitive & behavioral:* KA tool supports knowledge transformation<br>– *behavioral & social:* adaptation of communication to partner's knowledge (gaps), e.g., more words / elaborations / relations; more questions (in case of partner knowledge) |
| Dillenbourg & Traum (2006; *N* = 40) | × | | × | | × | | | × | | × | – *context factor:* whiteboard (i.e. higher persistency) used for establishing KA & externalized group working memory; MOO chat (i.e. lower persistency) used for acknowledging KA information<br>– *context factor:* collaboration partner acknowledges task knowledge about facts more often by means of MOO chat (lower persistency) than by means of whiteboard (higher persistency) |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 4 (Continued)***

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Engelmann, Baumeister, Dingel, & Hesse (2010a; *N* = 81) | | | | × | | × | × | | × | | – *context factor:* dialogic discourse is not needed in order to acquire knowledge and information awareness but dialogic discourse combined with knowledge and information awareness results in fewer mistakes during problem solving, a superior performance, and problem solvers feeling less stressed compared to knowledge and information awareness without dialogic discourse |
| Engelmann & Hesse (2010; *N* = 120) | | | | × | | × | × | | × | | – *cognitive:* knowledge and information awareness tool supports acquisition of knowledge that only the other group members of a triad had initially<br>– *behavioral:* knowledge and information awareness supports collaboratively selecting solution-relevant information, & more efficient collaborative problem solving |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 4 (Continued)***

*Knowledge Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based KA | Context-Based KA | Hybrid KA | Content-Based KA | Subjective KA | Objective KA | Explicit Level of Expertise | Implicit Level of Expertise | Static KA | Dynamic KA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engelmann & Hesse (2011; *N* = 120) | | | | × | | × | × | | × | | – *cognitive & behavioral:* combination of being informed about others' meta-knowledge and about concrete elements is superior to just being informed about others' meta-knowledge regarding problem solving |
| Engelmann, Tergan, & Hesse (2010b; *N* = 90) | | | | × | × | | × | | × | | – *behavioral & social:* environment for supporting knowledge & information awareness enhances intersubjective knowledge construction, efficiency of communication, & correctness of complex problem solutions |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 4 (Continued)***

*Knowledge Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based KA | Context-Based KA | Hybrid KA | Content-Based KA | Subjective KA | Objective KA | Explicit Level of Expertise | Implicit Level of Expertise | Static KA | Dynamic KA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hsi & Hoadley (1997; *N* = 165) | | | | × | × | | | × | × | | – *context factor:* asynchronous discussions of middle school students are more gender-equitable than in-class discussions<br>– *context factor:* girls make more anonymous comments by means of discussion tool than boys |
| Molinari, Sangin, Nüssli, & Dillenbourg (2008; $n^a$ = 30) | | | | × | × | | × | | × | | – *context factor:* dyads provided with the same information showed superior learning performance compared to dyads provided with complementary information<br>– *context factor:* complementary information condition: longer fixation on own concept map & more eye-gaze transitions (own to peer map & own to collaborative map) compared to same information condition |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.
[a]Study by Molinari et al. (2008): From the initial sample (*N* = 58 persons), 14 dyads had to be excluded from further analyses due to technical problems (Molinari et al., 2008, p. 95).

***Table 4 (Continued)***

*Knowledge Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based KA | Context-Based KA | Hybrid KA | Content-Based KA | Subjective KA | Objective KA | Explicit Level of Expertise | Implicit Level of Expertise | Static KA | Dynamic KA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ogata & Yano (1998; *N* = 9) | × | × | | | | × | | × | | × | – *behavioral & social:* KA map & notification of others' activities helps finding suitable learning partners who can answer one's questions; supports collaborative learning of small groups if content is discussed & changed instead of just looked at |
| Ray et al. (2013; Study 1: *N* = 71; Study 2: *N* = 118) | | × | | | × | | × | | × | | – *behavioral & social:* KA display results in adaptation of communication to partner's knowledge gaps<br>– *individual differences:* persons high in social comparison share less information and less correct information with KA than without KA<br>– *context factors:* persons with KA reduce information sharing and tend to learn less if they receive a faked negative feedback about their own intelligence before the cooperation phase |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 4 (Continued)***

*Knowledge Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based KA | Context-Based KA | Hybrid KA | Content-Based KA | Subjective KA | Objective KA | Explicit Level of Expertise | Implicit Level of Expertise | Static KA | Dynamic KA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sangin, Molinari, Nüssli, & Dillenbourg (2011; *N* = 64) | | × | | | | × | × | | × | | – *cognitive:* KA tool results in more accurate partner knowledge model associated with larger learning gains<br>– *behavioral:* KA tool results in more elaborative epistemic talk, more knowledge verification & negotiation utterances, & in more expressions of uncertainty |
| Schreiber & Engelmann (2010; *N* = 90) | | | | × | | × | × | | × | | – *cognitive:* knowledge and information awareness tool results in ad hoc groups being more aware of others' knowledge („directory updating" according to the theory of transactive memory systems; Wegner et al., 1991)<br>– *behavioral:* supports sharing knowledge & solving a hidden profile task |

*Note.* The studies are ordered alphabetically according to the name of the first author. KA: Knowledge Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 5***

*Expertise Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based EA | Context-Based EA | Hybrid EA | Content-Based EA | Subjective EA | Objective EA | Explicit Level of Expertise | Implicit Level of Expertise | Static EA | Dynamic EA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Leinonen & Järvelä (2006; *N* = 23) | × | × | | | × | | | × | × | | – *cognitive & social:* visualization of each group member's understanding of the shared task supports perspective-taking; comparison of one's own vs. others' answers & knowledge; supports evaluation of others' professional status & expertise<br>– *behavioral:* visualization does not encourage discussions because visualization tool for supporting EA seldom used during collaboration |
| Nückles & Stürz (2006; *N* = 76) | | × | | | × | | × | | × | | – *cognitive:* (expertise) assessment tool for expert-layperson communication results in less comprehension problems; supports procedural knowledge acquisition; more simple & elaborate explanations of experts support declarative knowledge acquisition<br>– *behavioral:* more efficient communication: less queries, less words (production costs of experts) |

*Note.* The studies are ordered alphabetically according to the name of the first author. EA: Expertise Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 5 (Continued)***

*Expertise Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based EA | Context-Based EA | Hybrid EA | Content-Based EA | Subjective EA | Objective EA | Explicit Level of Expertise | Implicit Level of Expertise | Static EA | Dynamic EA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nückles, Winter, Wittwer, Herbert, & Hübner (2006; *N* = 72) | | × | | | × | | × | | × | | – *cognitive:* (expertise) assessment tool for expert-layperson communication helps experts to construct more accurate mental model of layperson's knowledge; the lower layperson's knowledge level is, the more intensively expert reflects upon answer formulation<br>– *cognitive:* less comprehension problems of laypersons; expert's awareness of layperson's knowledge supports layperson's knowledge gain after expert-layperson-communication<br>– *behavioral & social:* expert adapts answer more strongly to layperson's prior knowledge |
| Nückles, Wittwer, & Renkl (2005; *N* = 160) | | × | | | × | | × | | × | | – *behavioral & socal:* (expertise) assessment tool for expert-layperson communication results in expert's providing more definitions in case of laypersons' low prior knowledge level, & more statements about technical processes in case of laypersons' high prior knowledge level |

*Note.* The studies are ordered alphabetically according to the name of the first author. EA: Expertise Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

***Table 5 (Continued)***

*Expertise Awareness: Study Examples and Selected Study Results*

| Examples of Studies (*N* = Number of Participants) | Activity-Based EA | Context-Based EA | Hybrid EA | Content-Based EA | Subjective EA | Objective EA | Explicit Level of Expertise | Implicit Level of Expertise | Static EA | Dynamic EA | Selected Study Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Reichling & Wulf (2009; $N^b$ = 19) | × | | × | | × | | × | | | × | – *cognitive:* users fear that expertise profiling would involve disclosure of confidential information; refuse e-mail profiling due to privacy concerns<br>– *cognitive:* no adequate representation of type (i.e. administrative, operative etc.) & level of expertise, only of domain of expertise; problem 1: similar profiles but different tasks & levels of expertise; problem 2: prominent users in the media profiled as top ranking experts receive too many requests<br>– *behavioral & social:* over- & understatement in expertise profile creation (e.g. gaining a top position on the experts' ranking list)<br>– *behavioral:* users refuse to create an expertise profile because it could be misinterpreted as mandatory job description<br>– *cognitive & social:* heads of departments fear (a) reputation damage (poor expertise profiles) vs. (b) head hunting |

*Note.* The studies are ordered alphabetically according to the name of the first author. EA: Expertise Awareness. Double-lines indicate the boundaries *between* the different dimensions of knowledge or expertise awareness; dotted lines divide the subcategories *within* the dimensions of knowledge or expertise awareness.

[b]Study by Reichling and Wulf (2009): Field study for evaluating an expert recommender system in a large European industrial association (Reichling & Wulf, 2009; see Reichling et al., 2007, and Reichling & Veith, 2005, for further results of this longitudinal field study).

### 2.5.4 Psychological Implications of Knowledge or Expertise Awareness for CSCL and CSCW

Different features of knowledge or expertise awareness serve different psychological functions. However, the aim of the extended classification is not to predict the effects of the *configurations* of knowledge or expertise awareness. Rather, the specific functions should be traced back to the described *subcategories* of knowledge or expertise awareness as applied in these previous studies in order to illustrate what researchers and practitioners can plausibly expect when implementing one or the other type of knowledge or expertise awareness. Since the database consists of only 22 studies, "patterns" across studies applying the same subcategory of knowledge or expertise awareness have to be interpreted carefully and tentatively until further studies, systematically varying the subcategories, show whether the specific functions can be corroborated reliably.

***Function of content-based knowledge or expertise awareness.*** This type of awareness information is well suited for supporting intersubjective knowledge construction in small groups while solving problems that require integrating different sources of knowledge and information and that include multiple solution steps (e.g., Engelmann, Baumeister, Dingel, & Hesse, 2010a; Engelmann et al., 2010b; Engelmann & Hesse, 2011; Schreiber & Engelmann, 2010); that is, with these kinds of problems, each individual group member possesses only part of the total knowledge and information base which is necessary to find the optimal solution. In the form of digital concept maps, for example, this awareness information supported detecting a hidden profile (e.g., Schreiber & Engelmann, 2010). Further, groups provided with this type of awareness information reached

decisions based upon shared knowledge more effectively (i.e. more correct solutions) and more efficiently (i.e. more quickly) compared to groups not provided with content-based knowledge awareness information (e.g., Engelmann et al., 2010b).

***Function of context-based knowledge or expertise awareness.*** Since this type of awareness information is provided only as an enrichment accompanying the core task, it depends on the intensity of using this awareness information whether this information is helpful or not. Those studies which applied context-based knowledge or expertise awareness information and did track its usage (i.e., Leinonen & Järvelä, 2006; Ogata & Yano, 1998) showed that (1) this information is actually not always used intensively enough for supporting knowledge exchange (Leinonen & Järvelä, 2006) and that (2) a more intense usage is related to better learning outcomes (Ogata & Yano, 1998).

***Function of hybrid knowledge or expertise awareness.*** This type of awareness information supports individual conceptual learning if, for example, learners compare their own task solution with a learning partner's task solution which helps them to improve the correctness of their task solutions (Baumeister et al., subm. a, b; Bodemer, 2011). Further, hybrid knowledge or expertise awareness can be used to activate socio-cognitive conflicts (Mugny et al., 1995) by confronting learners with a partner who reaches a different task solution than they themselves reach.

***Function of activity-based knowledge or expertise awareness.***

Information about users' activities constitute the basis of knowledge management systems and are used in order to support expertise awareness (e.g. eXacT; Dörner et al., 2007). The field study by Ogata and Yano (1998) corroborates the usefulness of activity-based information for CSCL by showing that informing learners about which other learner has visited or has worked on the pieces of information they are interested in helps them to find a suitable learning partner. This principle is called *social navigation* (Dourish & Chalmers, 1994; Höök, Benyon, & Munro, 2003), and it is implemented by means of so called *recommender systems* (Konstan & Riedl, 2003). However, the studies by Schwind and colleagues (Schwind & Buder, 2012; Schwind, Buder, Cress, & Hesse, 2012) have shown that it is not enough for cognitive elaboration to be informed about information which is similar to that which one already knows: learners also need to be confronted with preference-inconsistent information.

***Function of subjective knowledge or expertise awareness.*** Actively creating for others information about one's own knowledge is a metacognitive activity which supports self-reflection and individual learning (Mayer, 1998; Schraw, 1998), for example, in the context of ePortfolio work (Hand et al., 2012). With regard to knowledge management in CSCW, subjective assessments are needed in combination with automatic expertise profiling in order to correct the profiles (e.g. delete trivial keywords) and increase user acceptance (Reichling & Wulf, 2009) over purely self-generated or automatically generated profiling. However, errors in self-profiling one's expertise can result in becoming overburdened by the incoming requests (Vivacqua, 1999).

***Function of objective knowledge or expertise awareness.*** The strength of objective knowledge or expertise awareness is that it should be "unbiased" due to the external knowledge assessment. However, in authentic situations of distributed collaboration and lifelong learning, the partners' knowledge or expertise is, for the most part, not provided in pre-formatted ways.

***Function of an explicit level of expertise.*** An explicitly provided level of expertise supports virtual teams in establishing a *transactive memory system* (Schreiber & Engelmann, 2010) because group members are informed about who is responsible for storing and retrieving certain information (Wegner, 1995).

However, explicitly informing persons about others' level of expertise also is a strong anchor of social influence. Learning from a more competent partner is only possible if this learning partner is not threatening our self-esteem (e.g., by talking to us in a condescending way; cf. Darnon, Doll, & Butera, 2007). Examples of the negative effects of a competence threat are a mere imitation of the partner's decisions without elaboration (Butera et al., 2005), reduced information sharing due to seeking self-enhancement by holding back important information (Ray et al., 2013, Study 2), and, in the end, reduced learning (Darnon et al., 2007). Therefore, explicitly disclosing the level of expertise of learners should only be applied in a well-considered way. For example, learning to solve a knowledge-rich task from an expert reduces doubts in the correctness of the expert's task solution compared to learning the same task from a peer layperson (Baumeister et al, subm. a). However, an explicit level of expertise should be avoided if this information is not necessary in order to solve the task collaboratively and if it would distract learners'

attention from the core task (Darnon et al., 2007; Quiamzade & Mugny, 2001) because learners may socially compare their competences and experience a competence threat (Ray et al., 2013, Study 2).

***Function of an implicit level of expertise.*** Not providing learners with explicit information about their learning partners' expertise does not mean that learners will not search for competence-related information themselves (Leinonen & Järvelä, 2006). If information about others that would be helpful for efficient collaboration is missing, learners have to engage more in searching for this information by means of dialogic discourse and knowledge exchange.

***Function of static knowledge or expertise awareness.*** In many situations of distributed collaboration, it will be sufficient to provide collaborators just once with information about their partners' knowledge instead of continuously displaying changes. If groups collaborate for a short period of time, it is important to avoid overloading them with information not necessarily needed for completing the task (Eppler & Mengis, 2004; Sparrow, 1999).

***Function of dynamic knowledge or expertise awareness.*** Providing up-to-date information about users' knowledge or expertise is a standard requirement of knowledge management systems for CSCW. For example, the "Expertise Awareness Monitor" notifies users about changes to others' expertise (Dörner et al., 2007). However, there are only a few CSCL studies using an external representation which informed the learners continuously about changes to others' knowledge (Baumeister et al., subm. b; Bodemer, 2011; Ogata & Yano, 1998). This

type of knowledge awareness information combined with peer talk can help to resolve socio-cognitive conflicts (Baumeister et al., subm. b; Bodemer, 2011). Further, observing in real-time how another learner is modifying his or her task solution could provide an affordance (Suthers, 2006) for considering further changes and optimization of one's own solution (Baumeister et al., subm. b). Especially long-term studies are needed which investigate the usefulness of dynamic knowledge or expertise awareness for supporting socio-cognitive processes.

### 2.5.5 Issues of Anonymity

Anonymity is a crucial moderating factor of users' behavior in CSCL and CSCW settings. It was not included in the combined classification of knowledge or expertise awareness because anonymity is conceptualized as a context factor, namely as an aspect of *social group awareness* (Janssen & Bodemer, 2013), which can be combined with all described subcategories of knowledge or expertise awareness. For example, in the application "Xpertfinder" (Sihn & Heeren, 2001), users have access to a graph visualizing company-wide anonymous experts, and can choose to which company their query will be forwarded. Thus, aspects of the area and level of expertise are provided explicitly without disclosing the experts' personal data. There is a broad consensus in the knowledge management literature that employees would reject expert finding systems if their personal information was not protected sufficiently (Kautz, Selman, & Milewski, 1996; Papacharissi, 2009; Reichling & Wulf, 2009; Sihn & Heeren, 2001).

A further positive psychological effect of anonymity was identified in CSCL research: Hsi and Hoadley (1997) have shown that girls at a coeducational middle school contributed more to discussions about scientific phenomena if their contributions remained anonymous. This finding and further effects of anonymity can be explained by means of the SIDE model (Social Identity model of DEindividuation Effects; e.g., Lea, Spears, & de Groot, 2001; Reicher, Spears, & Postmes, 1995) which differentiates whether people are visually anonymous or whether their behavior is not identifiable. The visual anonymity of virtual environments can support a salient social identity over the personal identity (Lea et al., 2001). This kind of social presence results in more cohesive groups whose members cooperate more productively compared to a non-anonymous condition (Lea et al., 2001). Cress (2005) extended these findings by showing that *member portraits* can have ambivalent effects on participation in virtual groups, depending on the members' social value orientation (Van Lange & Semin-Goossens, 1998): Being provided with portraits, persons with a *prosocial orientation* (aim: maximize group's benefit) lowered their contribution rate because the portraits made their personal identity more salient than their group identity, whereas persons with an *individualistic orientation* (aim: maximize own benefit) slightly, however non-significantly, increased their contribution rate because they became more aware of being a group member. By using homogeneous visualizations of group members (i.e., the same photo six times for all 6 group members), information sharing of *proselfs* (aim: maximize own gain) can be increased without compromising information sharing of *prosocials* (Wodzicki, Schwämmlein, Cress, & Kimmerle, 2011).

In addition, Cress and Kimmerle (2008) showed that if the contribution behavior was identifiable, people contributed more to a shared database in comparison to a condition in which they did not receive a feedback about each member's number of contributions. A further relevant personality trait in the context of information exchange via a shared database is *protective self-presentation* (aim: avoiding social rejection; Wolfe, Lennox, & Cutler, 1986): Especially people with a high need for protective self-presentation cooperated more if a group awareness tool made their individual behavior identifiable compared to a condition in which the group awareness tool only mirrored the group's average contribution, and compared to without such group awareness information (Kimmerle & Cress, 2008).

## 2.6 Conclusions

In our information and knowledge society (van Weert, 2006; Webster, 2006), it is increasingly taken for granted that people can get informed about others' knowledge and expertise no matter how spatially distributed the others are. As research on knowledge and expertise awareness proceeds, different dimensions and their psychological functions are explored. The present chapter has provided an overview of psychological theories related to these concepts, an overview of computer-based applications for supporting knowledge and expertise awareness, results of previous studies revealing the various psychological effects, and a classification combining relevant features identified in the context of CSCL and CSCW research and development. Specifically, it was suggested to differentiate (1) between an *explicit* versus *implicit level of expertise* and (2) between *static* versus

*dynamic* knowledge or expertise awareness information because (1) these are core aspects of knowledge management systems, and (2) an explicit level of expertise may be suitable for different situations than an implicit level of expertise, as well as static knowledge or expertise awareness may serve different goals than dynamic knowledge or expertise awareness.

Since the overview of applications and studies of knowledge and expertise awareness is not exhaustive, published examples easily available on the Internet dominate over unpublished or only internally reported ones (cf. “publication bias”, Renkewitz, Fuchs, & Fiedler, 2011). Although a lot of different applications for supporting knowledge or expertise awareness have been developed in the past, it seems that studies are missing which evaluate the psychological effects of the features of these applications systematically (Reichling & Wulf, 2009).

The overview of studies shows that there are some moderating factors which need to be considered such as individual differences (e.g. need for socially comparing competences), and context factors (e.g. anonymity & communication). To sum up, is seems that research and development in the context of knowledge and expertise awareness could cross-fertilize each other more if they were more strongly connected.

# Overview – Part I

After introducing the combined classification of knowledge and expertise awareness in CSCL and CSCW developed in the context of the present dissertation, the first experimental study will be presented which applied a specific configuration of knowledge awareness briefly outlined in Table 2 of Chapter 1.

In this study, it was investigated whether knowledge awareness can be acquired if the externalized task solution of another person (e.g., a peer learner) or a more abstract source (e.g., a textbook of the subject-matter domain) is presented to the learner. Thus, by viewing both the other person's or source's task solution and by being informed about the source (e.g., "peer", "textbook", etc.), a learner should be made aware of the knowledge of the other person or source. Since knowledge awareness was regarded as a prerequisite for the further assumptions of this study, the acquisition of knowledge awareness was tested more in the context of the manipulation check than in the context of a hypothesis. In addition, previous studies have already shown that knowledge awareness can be acquired by means of computer-based external representation which differ from the one used in this study (e.g. Engelmann & Hesse, 2010; Engelmann et al., 2010b). Therefore, beside testing and extending assumptions of conflict elaboration theory (Mugny et al., 1995), this study also tests the reproducibility of previous results regarding the acquisition of knowledge awareness using a different external representation and experimental task.

# 3 Study 1: Impact of Knowledge Awareness Regarding a Higher Competence Source of a Cognitive Conflict

**This chapter is based on:**

Baumeister, A. E. E., Engelmann, T., & Hesse, F. W. (subm. a). *One task, divergent solutions: Source labels and social comparison guide adaptation in a cognitive conflict task.* Manuscript submitted for publication.

## 3.1 Introduction

Socio-cognitive conflict is an effective instructional strategy for supporting learning and problem solving (e.g., Limón, 2001). The rationale of this constructivist approach, for example, of conflict elaboration theory (Pérez & Mugny, 1992; Mugny, Butera, Sanchez-Mazas, & Pérez, 1995), is to confront learners with task solutions of relevant sources which deviate from their own solution. The first study of the present dissertation aims at showing that knowledge awareness can support the experience of a cognitive conflict.

Although certain previous studies identified under which conditions peer learning in the context of a cognitive conflict is advantageous (e.g., Buchs & Butera, 2009; Quiamzade, Mugny, & Darnon, 2009), they did not identify all of the conditions under which learning from a high competent source is more effective than learning from a low competent source. This study contributes to answering this question by arguing that the studies advocating peer learning by cognitive

conflict applied rather well-defined problems (e.g., anagram tasks; Quiamzade et al., 2009) whose solution strategies could be acquired during the course of short experiments. It will be shown that social influence dynamics change for more complex, knowledge-rich tasks. Also, assumptions of conflict elaboration theory regarding the impact of cognitive conflict have not been completely empirically validated. Therefore, this first study of the dissertation conceptualizes perceived cognitive conflict as a mediator of the problem solvers' behavior. Further, this study is the first one to show that social comparison orientation as a personality trait (cf. Festinger, 1954; Gibbons & Buunk, 1999) is a moderator of the problem solvers' adaptation behavior in a cognitive conflict task.

## 3.2 Being Confronted with a Deviating Task Solution: Assumptions of Conflict Elaboration Theory

*Conflict elaboration theory* (Mugny et al., 1995) as a Neo-Piagetian constructivist approach to learning predicts that confrontation with a task solution that deviates from one's own solution can spark a cognitive conflict encouraging problem solvers to improve their own task solution (Quiamzade & Mugny, 2001). Several studies, also conducted outside the context of this theory, have shown that comparing one's own task solution to the deviating solution of a peer learner (Bodemer, 2011) or of other group members (Constantino-Gonzáles & Suthers, 2001) helps problem solvers to improve their solution. Further, this comparison process should be activated by the computer-based external representation for supporting knowledge

awareness (cf. Buder et al., 2009). Therefore, the following hypothesis is postulated:

> *Hypothesis 1:* Comparing one's own solution to the deviating solution of another source helps problem solvers to improve the correctness of their task solution compared to a baseline condition without this possibility to compare solutions.

## 3.3 Impact of High Competence Sources in Knowledge-Rich Tasks

Further, the conflict elaboration theory predicts that learners and problem solvers who are confronted with a deviating task solution and who are uncertain about the correct solution will focus especially on the *competence* of the source of the deviating solution. Thereby, both a confrontation with a *high competent source* (e.g., a textbook on the subject-matter domain) and a *low competent source* (e.g., a peer layperson) can promote seeking the best solution. In some experiments testing these assumptions, focusing on the competence of the source of a deviating solution was fostered by *labeling* the source of the deviating solution (e.g., bogus feedback of a competence score or academic labels such as "student", "professor"; Mugny, Tafani, Butera, & Pigière, 1998), and in most studies by excluding interaction between the target person and the source of the deviating solution (e.g., Quiamzade, 2007).

Further, developers of conflict elaboration theory argued that being confronted with the deviating task solution of a peer should particularly encourage

problem solvers to find the best task solution because, in this constellation of a "conflict of incompetencies" (Quiamzade & Mugny, 2001), problem solvers can neither maintain their initial solution easily nor simply imitate the peer's deviating solution.

For example, Quiamzade and colleagues (2009) showed in two studies that low competent sources can influence problem solvers' behavior more than high competent sources. The target persons first solved verbal game tasks individually. After this, they were informed about the task solutions of either a higher- or an equally low competent source and could infer the source's strategy. The problem solving tasks involved ticking as quickly as possible words containing the letter "F" and solving anagram tasks. In other experiments, a hypothesis testing task was used (e.g., Quiamzade, 2007). These tasks have in common that they can be classified as well-defined problems having a single correct solution although solution strategies can differ (cf. Schraw, Dunkle, & Bendixen, 1995). Moreover, these tasks do not require an extensive knowledge base in contrast to knowledge-rich tasks. Examples of knowledge-rich tasks are playing chess, making medical diagnoses, or solving law cases (cf. Nievelstein, van Gog, Boshuizen, & Prins, 2010; Sweller, van Merriënboer, & Paas, 1998). Strategies for solving well-defined problems can be acquired more quickly, even in the course of participating in one experiment (e.g., reading a string of letters backwards in an anagram task; Quiamzade et al., 2009) than strategies for solving knowledge-rich, complex problems which require schema construction and automation (cf. Sweller et al., 1998; VanLehn, 1999). However, there is a lack of studies testing assumptions of conflict elaboration theory for complex, less well-defined problems requiring a large knowledge base. It is known that social influence dynamics vary across different

types of tasks (cf. Mugny et al., 1995), and therefore, it is probable that they also vary across different levels of task complexity.

Especially if problem solvers are laypersons in a specific kind of knowledge-rich task, it will be difficult for them to identify strategies just from being informed about another source's task solution without having the possibility to ask the other source for further explanations. In such a situation, problem solvers most probably will imitate especially a more competent source's solution (cf. Bandura, 2006; Quiamzade & Mugny, 2001). Consequently, in the present study, it is assumed that for such knowledge-rich problems without interaction between source and target person, a peer's social influence on conflict elaboration will be much weaker than usually postulated by studies on conflict elaboration theory applying less knowledge-rich problems (e.g., anagram tasks; Quiamzade et al., 2009). According to conflict elaboration theory, a high competent source's deviating solution will generally be imitated more often than a low competent source's solution (Quiamzade et al., 2009; Quiamzade & Mugny, 2001). However, it remains to be investigated which kind of imitation of the high competent source will occur since two types of imitation are discussed by conflict elaboration theory (Quiamzade & Mugny, 2001):

a) In the positive form of imitation, the high competent source is regarded as an epistemic authority because this source provides helpful knowledge and information without questioning the target person's competence. Imitation results because learners focus on the task and want to improve their ability;
b) In the negative form of imitation, the high competent source threatens self-esteem by questioning the target person's competence (cf.

> Darnon et al., 2007). In this constellation, "Imitation is an easy and rapid solution to reestablish lost self-esteem … no further elaboration of the task is necessary", however, this also means that "There is no learning or improvement …" (Quiamzade & Mugny 2001, p. 315).

How can the positive versus negative form of imitation be differentiated empirically? In the present dissertation, it is suggested to present an only partly correct solution of the low and high competent source. This offers the possibility to differentiate whether a problem solver uncritically imitates the wrong part of the presented solution or whether he or she is able to identify it. In this first study of the present dissertation, it is argued that if the target person focuses more on the task than on the other source's competence, then the target person will ponder which aspect of the other source's solution seems to be plausible and which not. In this case, the target person will not imitate the presented solution completely uncritically, especially not if parts of the other source's solution are wrong. On the other hand, if the target person is misled by the other source's high competence, then the target person will not question the correctness of the other source's solution. Instead, the target person will adopt more parts of the presented solution also including false aspects. This leads us to the following hypotheses:

> *Hypothesis 2a:* In case of a positive form of imitation, problem solvers will selectively adopt correct parts of the deviating solution of a high competent source (i.e., a "textbook on the subject-matter domain") more often than of a low competent source (i.e., a "peer layperson").
>
> *Hypothesis 2b:* In contrast, in case of a negative form of imitation, problem solvers will adopt false parts of a high competent source's

solution more often than false parts of a low competent source's solution.

In this first study of the dissertation, a supposed textbook of the subject-matter domain was used as a high competent source. That is, this study investigated whether a textbook can also result in knowledge awareness which is a new aspect not researched by previous studies on knowledge awareness before. Therefore, the term "textbook knowledge" is defined in brief. *Textbook knowledge* is information contained in a textbook of a specific domain. The term textbook knowledge is commonly used as the following examples demonstrate: Cohen (1990), for example, stated that "(…) textbook knowledge is imperfect (…)" (p. 743), and Neale (1988) criticized the "unjustified faith in textbook knowledge and what experts say they do" (p. 135). Further, the term textbook knowledge can be found in the leading journals of interdisciplinary scientific research (e.g., in Science: Gaskell, Bauer, Durant, & Allum, 1999). In addition, since textbooks are generally written by one expert or a group of experts, it seems appropriate to speak not only of the contents of a textbook but also of the knowledge of the author(s), or put shortly, of the textbook knowledge. Thus, this study investigated among others whether being informed about textbook knowledge can be regarded as an instance of knowledge awareness.

## 3.4 Cognitive Conflict as a Mediator of Problem Solvers' Adaptation Behavior

According to Lee and colleagues (2003), "Cognitive conflict is a perceptual state in which one notices the discrepancy between one's cognitive structure and the environment (external information) …" (p. 585). In most studies on conflict elaboration theory, however, being confronted with a deviating task solution was simply equated to cognitive conflict without assessing directly whether learners had actually experienced a cognitive conflict (e.g., Quiamzade, 2007). In contrast, in our study perceived cognitive conflict is measured by means of subjective rating scales (e.g., Darnon et al., 2007; Lee et al., 2003).

Conflict elaboration theory argues that problem solvers confronted with a low competent source's deviating task solution will have greater doubts regarding the correctness of the low competent source's solution compared to problem solvers confronted with a high competent source's deviating task solution (Quiamzade et al., 2009). Therefore, problem solvers confronted with a low competent source will start to search more intensively for the correct solution. In contrast, problem solvers confronted with a high competent source will have no or fewer doubts that the high competent source's solution is correct. Therefore, problem solvers confronted with a high competent source will be much more likely to imitate the high competent source's solution. Since "having doubts about other's or one's own solution" is one aspect of the experience of a cognitive conflict (cf. Lee et al., 2003), the developers of conflict elaboration theory at least implicitly state that problem solvers confronted with a low competent source of a deviating solution would experience a more intense cognitive conflict than problem solvers

confronted with a high competent source of a deviating solution. Thus, the hypothesis according to conflict elaboration theory is:

> *Hypothesis 3a:* Problem solvers confronted with a low competent source's deviating task solution experience more cognitive conflict than problem solvers confronted with a high competent source's deviating solution.

However, to our knowledge, no study exists which has empirically validated this assumption by measuring perceived cognitive conflict and the resulting adaptation behavior to a low or high competent source's solution. Therefore, in the present study, we examined whether the opposite could also be possible: Targets confronted with a low competent source may consider their own solution to be more plausible. Consequently, they do not experience a high degree of a cognitive conflict, and they do not adopt parts of the other source's solution. Similarly, it could also be possible that targets confronted with a high competent source consider their own solution to be less plausible. Consequently, they do experience a high degree of a cognitive conflict and ultimately imitate the presented solution. Therefore, the following assumption, contrary to that of conflict elaboration theory, was also investigated in the present study:

> *Hypothesis 3b:* Problem solvers confronted with a high competent source's deviating task solution experience more cognitive conflict than problem solvers confronted with a low competent source's deviating solution.

Neo-Piagetian approaches regard cognitive conflict as the driving force of cognitive and behavioral changes in the sense of learning (cf. Mugny et al., 1995; Limón, 2001). Therefore, in the present study, it is argued that cognitive conflict

can be conceptualized as a mediator of problem solvers' adaptation behavior in the context of this knowledge-rich task:

> *Hypothesis 3c:* Cognitive conflict mediates problem solvers' adaptation behavior: The more cognitive conflict is experienced, the more adaptation to the presented deviating task solution will be shown.

In the following, we will extend assumptions of conflict elaboration theory further by considering a personality trait as a potential moderator of problem solvers' behavior, namely, a person's need for social comparison of his or her abilities.

## 3.5 Adapting to Others: Why Social Comparison Orientation Matters

Recent studies on conflict elaboration theory have started to take the impact of relevant personality traits on conflict regulation into account, for example, mastery vs. performance goals (e.g., Darnon & Butera, 2007). The present study integrates a further trait directly associated with social influence, namely, social comparison orientation (cf. Festinger, 1954), that is, the need to evaluate one's abilities (and opinions) by means of social comparison processes.

Reviewing previous studies on social comparison, Buunk and Gibbons (2007) conclude that high comparers are more uncertain about the self and are interested in reducing this self-uncertainty. For example, persons with a high need for social comparison are more interested in information about other participants'

test performance than those with a low need for social comparison (Gibbons & Buunk, 1999). Moreover, persons with a high need for social comparison search for information about others in order to validate their position no matter whether the others are more or less similar to themselves (Michinov & Michinov, 2001).

While there are a lot of studies which have investigated affective and behavioral aspects of people high in social comparison orientation (cf. Buunk & Gibbons, 2007), less is known about people who indicate that they do not often compare themselves with others. One reason for a low social comparison orientation could be that "… social comparison … [is] viewed by many as socially undesirable…" (Buunk & Gibbons, 2007, p. 13). Further, people low in social comparison orientation may lack awareness or recall of such comparisons (Wood, 1996). It is plausible, however, that people low in social comparison orientation still use others as models for their own performance – at least, no evidence exists that a low need for social comparison would be associated with performance avoidance or depressive symptoms, for example. Instead, classic studies have shown that "individuals generally prefer to compare with others who are thought to be slightly better off …" (Buunk & Gibbons, 2007, p. 4) confirming Festinger's concept of "upward drive". Especially in situations in which individuals strive to improve their performance, they are interested in the performance of others who do better on the same task and thus serve as models (Smith & Sachs, 1997). This could also be true for persons low in social comparison of abilities. Therefore, in this study, it is postulated that social comparison regarding performance or ability is a moderator of problem solvers' adaptation behavior:

> *Hypothesis 4a:* Persons high in social comparison of ability will adapt their task solution more often to the presented deviating one,

regardless of whether the source label of the deviating task solution indicates a low or a high competent source (Michinov & Michinov, 2001). They do so because they are uncertain about the self, thus, having more doubts about the correctness of their own solution than about others' solutions.

*Hypothesis 4b:* Persons low in social comparison of ability adapt their task solution more often to the presented deviating solution of a high competent source than to a low competent source because they strive to improve their performance (Smith & Sachs, 1997).

In addition, we examined whether the postulated interaction of knowledge awareness and social comparison orientation of ability is mediated in its relation to adaptation behavior by cognitive conflict. That is, a mediated moderation model was postulated (see Figure 1):

*Hypothesis 5:* If persons low in social comparison orientation of ability are confronted with a high competent source's deviating solution, they will experience more cognitive conflict than similar persons who are confronted with a low competent source's deviating solution because they have no or fewer doubts regarding the correctness of a high competent source's solution than regarding the correctness of a low competent source's solution. Consequently, persons low in social comparison orientation of ability confronted with a high competent source's solution will adapt their own task solution more extensively to the presented solution because they strive to improve their performance.

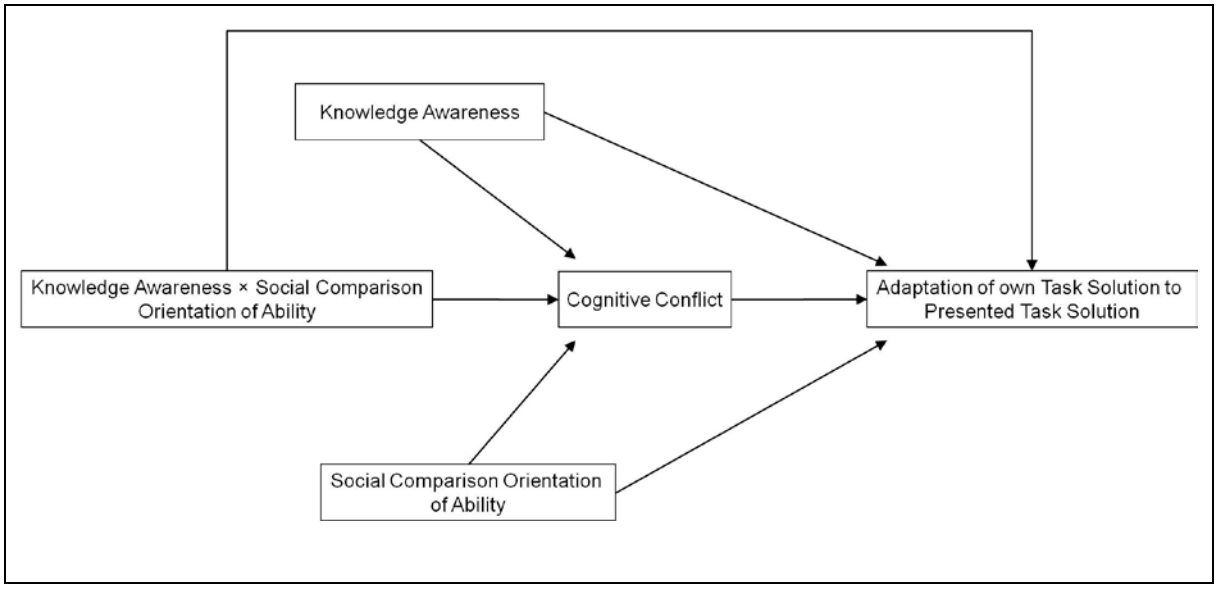


***Figure 1.*** *Hypothesized Mediated Moderation Model Whereby Knowledge Awareness, Social Comparison Orientation of Ability, and Cognitive Conflict Predict Adaptation of One's Own Task Solution to the Presented Deviating Task Solution of the Other Source.*

## 3.6 Experimental Study

In this first study of the present dissertation, the impact of knowledge awareness in the sense of source labels of varying expertise level (i.e., low vs. high competence) combined with the presentation of a task solution which deviates from the target person's solution on problem solving was investigated. Specifically, it was examined how source labels influence problem solvers with respect to experiencing cognitive conflict. It was tested whether cognitive conflict can be conceptualized as a mediator and social comparison orientation of ability as a moderator of problem solvers' adaptation behavior regarding the presented

deviating task solution. Finally, it was examined whether the interplay of these variables can be explained by a mediated moderation model.

## 3.6.1 Method

### *3.6.1.1 Participants and Design*

Fifty-nine university students (41 female, 18 male; *M* = 24.46 years, *SD* = 3.20) of different fields of study at a university in southern Germany volunteered to participate in the study for either payment or course credit. The participants were randomly assigned to one of three conditions of a between-subjects design. In the following two conditions, the participants were provided with a computer-based external representation for supporting knowledge awareness: (1) In the *"peer condition"* ($n_p$ = 20), participants compared their task solution with the deviating solution of a low competent source, namely, a former participant of the pilot study. (2) In the *"textbook condition"* ($n_t$ = 20), participants compared their task solution with the deviating task solution of a supposed high competent source, namely, a textbook on the subject-matter domain of this study (criminal law). In fact, participants in the textbook condition received the same task solution as participants in the peer condition, produced by the same former participant of the pilot study. This task solution contained one correct aspect and three false aspects. In the *baseline condition* ($n_b$ = 19), participants did not receive a deviating task solution of another source.

#### *3.6.1.2 Procedure*

The participants were tested individually. They were told that the study was about solving criminal law cases by means of a computer-supported environment and that they would get to know different problem solving strategies. Figure 2 provides an overview of the phases of the experiment.

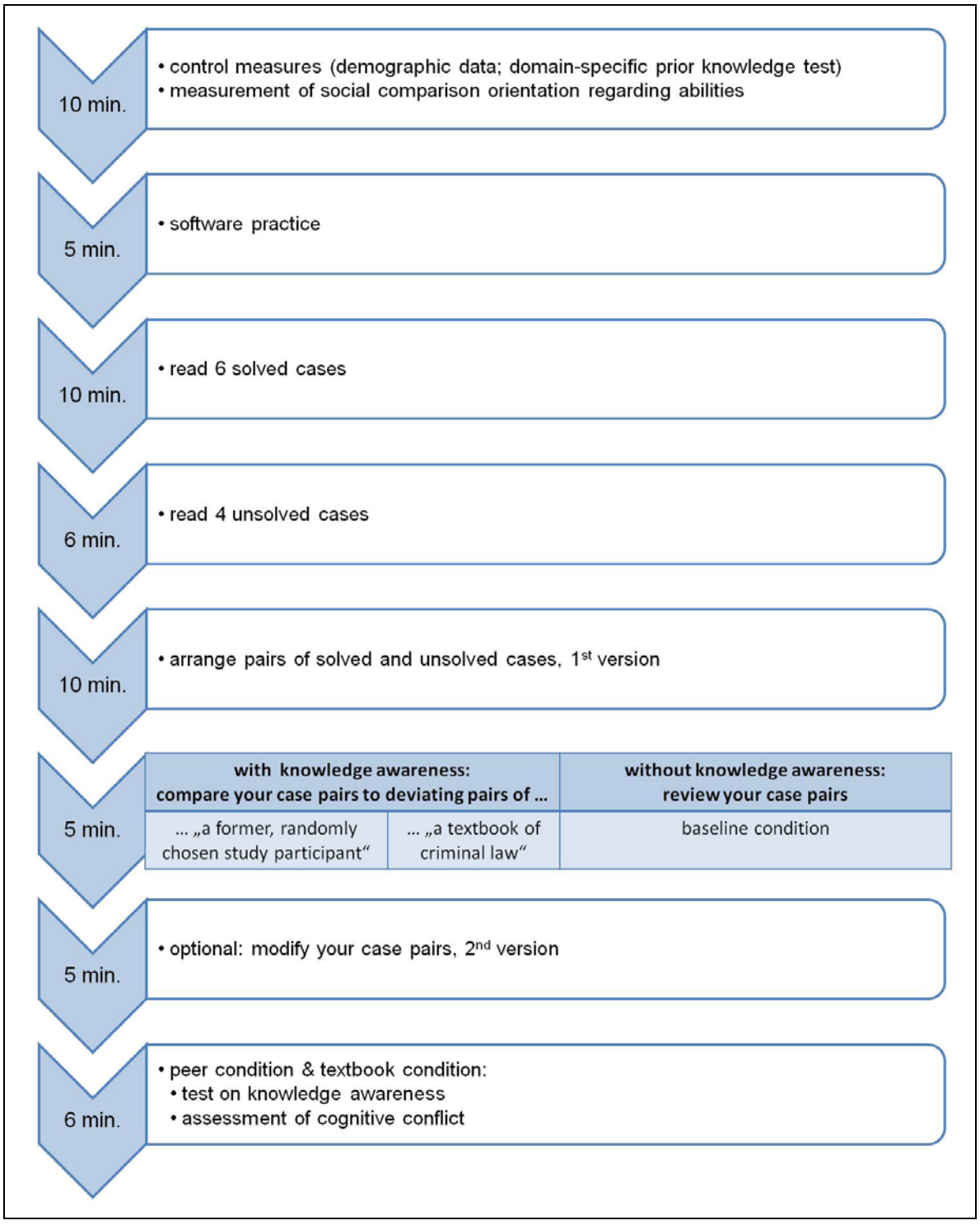


***Figure 2.*** *Overview of the Phases of Experiment 1 and Their Duration in Minutes.*

First, the participants filled in a web form assessing demographic data, domain-specific prior knowledge, and social comparison orientation regarding abilities. Then the participants practiced using the software tool of this study (CmapTools, see 3.6.1.3, “cognitive conflict task”). Following this, they were given six solved cases to read in paper from the domain of criminal law in 10 minutes (cf. Appendix A). The participants returned the solved cases to the experimenter and received four unsolved cases from the same domain. They had 6 minutes to read these cases. Subsequently, the solved cases were handed out again, and the participants were asked to build pairs of the four unsolved cases and the six solved cases by means of a computer-based external representation (CmapTools; see Figure 3, left side and in the middle). The participants were given 10 minutes to arrange each unsolved case next to the solved case whose solution could be transferred best to this unsolved case. For this purpose, they dragged colored text boxes (i.e., unsolved cases) next to grey text boxes (i.e., solved cases) on the screen. After this, the participants were randomly assigned to one of the following three conditions: In the peer condition, the task solution (case pairs) of the participants was juxtaposed to the solution that had been created by a former participant of a pilot study. The participants were informed that the solution presented had been created by “a former, randomly chosen participant of a pilot study” (Figure 3, right side). In the textbook condition, the solution of the participants was juxtaposed to the same solution as in the peer condition; however, a textbook on criminal law was indicated to be the source. In both conditions, participants had 5 minutes to compare their own with the provided task solution. In the baseline condition, the participants were not provided with an additional solution. Keeping time-on-task constant among the three conditions, participants of

the baseline condition had 5 minutes to review their self-created solution. In the next phase, the participants of all three conditions were given 5 minutes to create a second version of case pairs by modifying their first version if they wished to do so. During this phase, the solution of the other source was still present in the peer condition and in the textbook condition. The online test on knowledge awareness followed in the peer condition and in the textbook condition (see 3.6.1.3, "knowledge awareness in the textbook condition and in the peer condition"). Subsequently, participants of the peer condition and of the textbook condition answered the cognitive conflict item. An experimental session lasted 60 minutes. At the end of the experiment, the participants were thanked, rewarded, and debriefed.

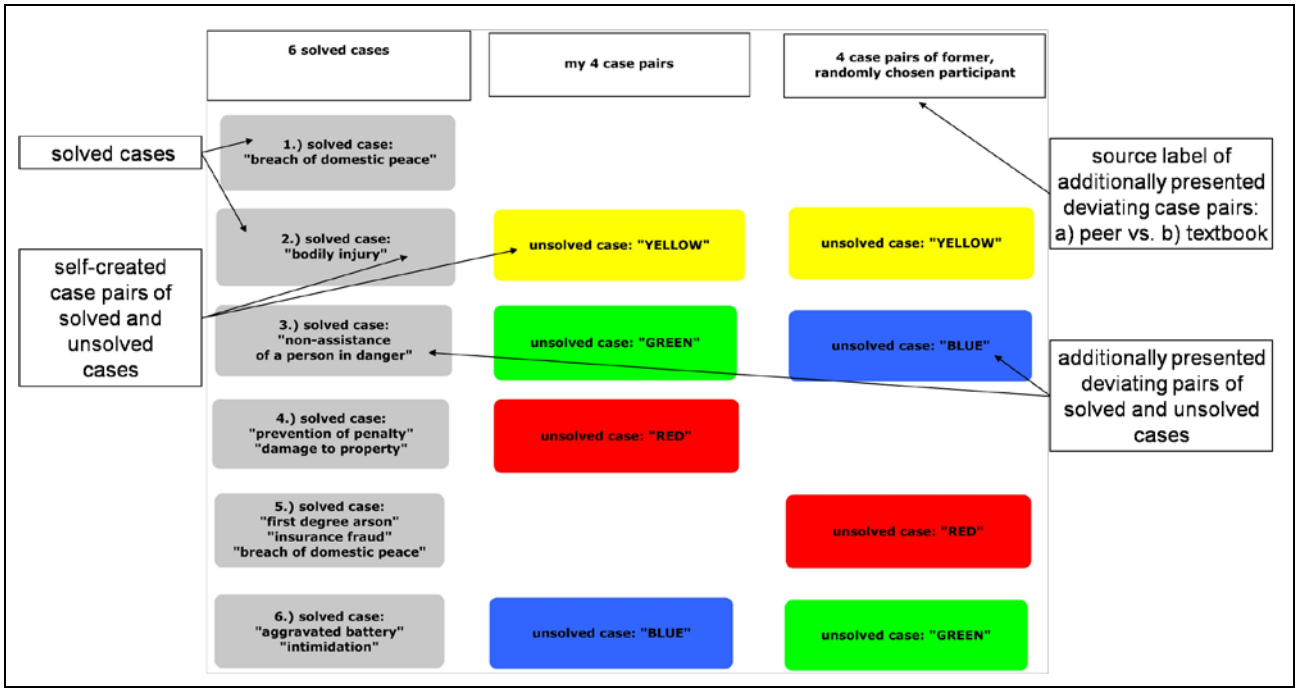


***Figure 3.*** *Computer-based external representation for supporting knowledge awareness: Self-created case pairs in the middle and in juxtaposition with presented deviating case pairs and source label on the right side.*

#### *3.6.1.3 Materials and Measures*

***Demographic data and prior knowledge.*** Demographic data (e.g., gender, age) and prior knowledge of German case law were assessed by means of a web form. The maximum attainable score on the prior knowledge test was ten points.

***Cognitive conflict task.*** An inductive reasoning task was developed so as to maximize variety of task solutions: The problem solvers had to pair each of four unsolved criminal law cases with one of six solved criminal law cases, thus leaving two solved cases unpaired (cf. Appendix A). The aim was to build pairs with a high structural similarity, that is, pairs that required a similar solution so that the solution of the solved case could be transferred to the unsolved case. Previous studies have shown that legal reasoning (among others, by analogy) is a highly complex cognitive skill requiring a large knowledge base (Nievelstein et al., 2010).

The software tool used for sorting the law cases in order to build structurally similar pairs was *CmapTools* (cf. Novak & Cañas, 2006; see, http://ftp.ihmc.us/). It allows for moving text boxes easily which represented the solved and unsolved cases. Further, the computer-based external representation of the sorting task also allowed for comparing self-arranged case pairs with case pairs presented additionally in the peer condition and in the textbook condition. This external representation initially contained six grey text boxes labeled with the titles of the six solved cases, and four colored text boxes representing the unsolved cases (Figure 3, left side and in the middle). Each unsolved case could be arranged in a pair with a solved case by dragging the colored text boxes next to the grey text boxes on the screen.

We assessed the *correctness* of the first version of self-created pairs of solved and unsolved cases. Only two pairs were counted as correct solutions because structural similarities between the solved and unsolved cases existed, while for the other two unsolved cases, no structurally similar solved case existed. Thus, two points were attainable as maximum correctness score. This correct solution was identified in a pilot study with advanced law students ($n$ = 8). The participants of the present study were not informed about the solution structure beforehand.

The *match* between the *first version* of the self-created task solution (case pairs) and the solution presented in the peer condition and in the textbook condition was assessed to test whether the self-created solution (Figure 3, in the middle) naturally deviated from the presented one (Figure 3, right side). The score could range between “0” and “4” matching case pairs.

Further, we assessed the *adaptation* to the task solution presented in the peer condition and textbook condition by counting how many case pairs had been adapted to the presented ones in the *second version* of the task solution. The maximum score was four points if the participant had adapted all four case pairs to the presented ones. In addition, it was assessed how often the participants of the peer condition and textbook condition had adopted the one correct and the three false case pairs of the presented solution. Consequently, the *correctness of the second version* of self-created case pairs was also assessed. It was measured analogously to the correctness of the first version, that is, again two points were attainable as maximum score.

***Knowledge awareness in the textbook condition and in the peer condition.*** An online test was performed in the peer condition and in the textbook condition consisting of two parts: In the first part, a multiple-choice item assessed whether the participants could remember the source of the presented deviating task solution correctly. The multiple-choice item included six alternatives: “Several former participants of a pilot study whose task solutions were averaged”, “a textbook on criminal law”, “a random generator”, “an expert in criminal law”, “a former, randomly chosen participant of a pilot study”, and “a group of experts in criminal law”. The participants received either one point for choosing the indicated source correctly according to the previous instructions or zero points for choosing a wrong alternative. In the second part, the case pairs of the other source had to be reproduced from memory. The maximum score for correctly remembering the case pairs was four points because four case pairs had been presented to them.

The assessment of knowledge awareness in this study is similar to the assessment in the context of certain previous studies (e.g., Engelmann, Baumeister, Dingel, & Hesse, 2010a; Engelmann, Dehler, Bodemer, & Buder, 2009; Engelmann & Hesse, 2010). In these previous studies on knowledge awareness, it was also assessed whether learners or problem solvers had perceived that another source of knowledge, task solutions, and information existed. Further, in some studies on knowledge awareness, it was also assessed whether learners or problem solvers had perceived content elements (e.g., the task solution) of the other source’s knowledge (Engelmann et al., 2010a; Engelmann et al., 2009; Engelmann & Hesse, 2010).

***Cognitive conflict in the peer condition and in the textbook condition.*** The following item assessed in retrospect whether a cognitive conflict was experienced after being confronted with the task solution of another source which deviated from one's own solution: "I had doubts about one or more of my case pairs when I saw the other case pairs that were provided". The participants indicated their (dis)agreement on a 5-point rating scale (from 1 for "low agreement" to 5 for "high agreement"). This item assesses one aspect of the component "recognition of contradiction" of the Cognitive Conflict Levels Test by Lee and colleagues (2003).

***Social comparison orientation regarding abilities.*** A German translation of the items of the factor "Social Comparison Orientation Regarding Abilities" (6 items, Cronbach's α = .87) of the Iowa-Netherlands Comparison Orientation Measure (INCOM, Gibbons & Buunk, 1999) was administered in the peer condition and in the textbook condition. The participants indicated on 5-point rating scales (from 1 for "I disagree strongly" to 5 for "I agree strongly") how often they compare themselves to others with respect to, for example, what they have accomplished in life.

### 3.6.2 Results

For testing the hypotheses, mainly multiple linear regression analyses were conducted using IBM SPSS Statistics 19. The alpha level was set at .05. Cohen's *d* is reported as effect size measure, adjusted for interactions. By convention, *d* effect

sizes of 0.2, 0.5, and 0.8 are interpreted as small, medium, and large, respectively (Cohen, 1988).

First, the results of the control measures and of the manipulation check will be presented. After this, the results of the hypotheses tests will be reported.

#### *3.6.2.1 Results of the Control Measures and of the Manipulation Check*

No statistically significant differences were found between the three conditions regarding the two *demographic data* "gender" (Pearson-$\chi^2$ (2, $N$ = 59) = 0.35, $p > .10$) and "age" ($F < 1$) and *domain-specific prior knowledge* ($F < 1$). Average *domain-specific prior knowledge* was medium, $M_{overall}$ = 5.17; $SD$ = 1.93 (cf. Table 6).

As expected, the three conditions did not differ regarding how many case pairs of the first self-created version matched the presented pairs in the peer condition and textbook condition, $F < 1$ (cf. Table 6). All participants created a first version of case pairs which deviated from the ones presented later. For 68% of the participants ($n$ = 40), none or only one of the self-created case pairs of the first version matched the presented ones, for 22% ($n$ = 13), two of the four case pairs matched the presented ones, and for 10% ($n$ = 6), three of the four case pairs matched the presented ones. Thus, divergence between self-created and the solution presented additionally naturally occurred in this study due to the numerous possibilities of combining solved and unsolved cases.

In addition, as expected, the three conditions did not differ regarding the *correctness of the first version* of case pairs, $F < 1$ (cf. Table 6).

***Table 6***

*Means (and Standard Deviations) of Control Measures and Correctness of the 2nd Version of Task Solutions*

| | Peer condition ($n_p$ = 20) *M* *(SD)* | Textbook condition ($n_t$ = 20) *M* *(SD)* | Baseline condition ($n_b$ = 19) *M* *(SD)* |
|---|---|---|---|
| Domain-specific prior knowledge | 5.60 (1.98) | 5.15 (2.25) | 4.74 (1.45) |
| Match between 1st version of self-created vs. presented task solutions (peer condition & textbook condition) | 1.15 (0.93) | 1.15 (0.88) | 1.21 (1.03) |
| Correctness of 1st version of task solutions | 1.10 (0.64) | 0.95 (0.83) | 1.05 (0.40) |
| Correctness of 2nd version of task solutions | 1.05 (0.60) | 1.20 (0.41) | 1.00 (0.47) |

As one part of the manipulation check, the *test on knowledge awareness* showed that the participants of the peer condition and textbook condition remembered the indicated source of the presented case pairs correctly according to the instructions (i.e., as “peer” in the peer condition and as “textbook” in the textbook condition), Pearson- $\chi^2$ (2, $N$ = 40) = 40.00, $p < .01$. Further, the participants of the peer condition ($M_p$ = 2.60; $SD$ = 1.46) and of the textbook condition ($M_t$ = 2.73; $SD$ = 1.19) did not differ significantly in reproducing the case

pairs of the other source correctly, $F < 1$. Thus, it can be concluded that both participants of the peer condition and of the textbook condition had acquired an equally high amount of knowledge awareness regarding content elements of the other source's knowledge, that is, case pairs.

#### *3.6.2.2 Impact of Comparing Task Solutions*

It was tested whether problem solvers who could compare their task solution to the deviating solution of another source produced more correct task solutions compared to problem solvers who did not have the possibility to compare task solutions (Hypothesis 1). In line with Hypothesis 1, the textbook condition achieved a more correct task solution compared to the baseline condition, β = .27, $p = .05$, $R^2_{adj} = .34$, $F(1, 37) = 10.57$, $p < .001$, $d = 0.45$ (cf. Table 6). However, contrary to Hypothesis 1, the peer condition did not achieve a more correct task solution compared to the baseline condition, β = .01, $p = .92$, $R^2_{adj} = .66$, $F(1, 37) = 37.18$, $p < .001$, $d = 0.09$. Inspection of the descriptive statistics revealed that performance did decline slightly both in the peer condition and in the baseline condition. Thus, Hypothesis 1 could only partly be confirmed, namely, for the textbook condition but not for the peer condition.

#### *3.6.2.3 Impact of Source Label: Textbook versus Peer*

In the next step, we analyzed whether the source label (i.e., peer vs. textbook) of the deviating solution that was presented has an influence on whether and how problem solvers adapt their case pairs to the presented ones and improve the correctness of their task solution (Hypotheses 2a & 2b). For this purpose, we contrasted the peer condition (coded by -1) with the textbook condition (coded by

+1) regarding the extent of adaptation to false and correct aspects of the deviating solution. While creating the second version of case pairs, participants in the textbook condition adapted significantly more case pairs to the presented ones than participants of the peer condition, β = .45, $p < .01$, $R^2_{adj} = .18$, $F(1, 38) = 9.77$, $p < .01$, $d = 0.89$ (cf. Table 7). However, participants in the textbook condition and in the peer condition did not differ in how often they adopted the false aspect of the presented task solution, β = .13, $p = .43$, $F < 1$, $d = 0.26$. Instead, participants of the textbook condition selectively adopted the correct aspect of the presented task solution more often compared to participants in the peer condition, β = .42, $p < .01$, $R^2_{adj} = .15$, $F(1, 38) = 8.10$, $p < .01$, $d = 0.83$. Consequently, the textbook condition tended to arrive at a more correct task solution than the peer condition, β = .21, $p = .11$, d = 0.29. Thus, Hypothesis 2a was confirmed which predicted a positive form of imitation of a high competent source's solution, and Hypothesis 2b was rejected which predicted a negative form of imitation.

***Table 7***

*Means (and Standard Deviations) of Cognitive Conflict, Adaptation of Task Solutions, and Social Comparison Orientation of Abilities in the Peer Condition and in the Textbook Condition*

| | Peer condition ($n_p$ = 20) *M* *(SD)* | Textbook condition ($n_t$ = 20) *M* *(SD)* |
|---|---|---|
| Cognitive conflict | 3.05 (1.23) | 4.15 (0.93) |
| Extent of adaptation to presented task solution | 0.45 (0.76) | 1.35 (1.04) |
| Extent of adaptation to presented correct aspect of task solution | 0.05 (0.22) | 0.40 (0.50) |
| Extent of adaptation to presented false aspect of task solution | 0.40 (0.68) | 0.60 (0.88) |
| Social comparison orientation regarding abilities (*z*-Scores) | 0.09 (1.11) | -0.09 (0.89) |

#### *3.6.2.4 Impact of Cognitive Conflict*

In order to test whether participants of the textbook condition experienced more (Hypothesis 3b) or less (Hypothesis 3a) cognitive conflict than participants of the peer condition and whether cognitive conflict mediates the participants' adaptation behavior (Hypothesis 3c), a mediation analysis was carried out. For this purpose, the IBM SPSS Statistics macro SOBEL (v3.6, written by Andrew F. Hayes, 2011, see http://www.afhayes.com/spss-sas-and-mplus-macros-and-code.html) and

procedures introduced by Preacher and Hayes (2004) were used providing unstandardized mediation coefficients and Sobel test statistics. The unstandardized coefficients were converted into standardized coefficients in order to make the results comparable across all analyses of this study. SOBEL estimates the size of an indirect effect of *X* on *Y* through a single mediator *M*, and computes both normal theory (Sobel's test; Sobel, 1982) and bootstrap approaches for inference. The analysis was based on 5.000 bootstrap resamples and a bias-corrected 95% confidence interval (*CI*).

In line with Hypothesis 3b and, thus, rejecting Hypothesis 3a, participants of the textbook condition experienced more cognitive conflict than participants of the peer condition, $\beta_{MX} = .46$, $p < .01$ (cf. Table 8). Moreover, experiencing more cognitive conflict in both experimental conditions with knowledge awareness resulted in adapting one's own case pairs more often to the presented ones, $\beta_{YM,X} = .57$, $p < .001$ (Table 8). Further, as already mentioned, participants of the textbook condition adapted their case pairs more often to the presented ones, $\beta_{YX} = .45$, $p < .01$. Cognitive conflict fully mediated the relationship between the experimental conditions with knowledge awareness and adaptation behavior, $\beta_{YX,M} = .23$, $p = .17$. The indirect effect of knowledge awareness on adaptation behavior mediated by cognitive conflict was significant, both as Sobel's statistic ($Z_{Sobel} = 2.49$, $SE = 0.10$, $p = .01$) and as bootstrap result ($Z_{Boot} = 0.26$, $SE = 0.08$, $CI\ \alpha = .05$ [.10; .43]). Thus, Hypothesis 3b was confirmed: The more cognitive conflict was experienced, the more adaptation to the presented deviating solution was shown.

***Table 8***

*Regression Results of the Mediation Analysis*

| Regression | β | *SE* | *t* |
|---|---|---|---|
| Adaptation on experimental condition | .45 | 0.14 | 3.13** |
| Cognitive conflict on experimental condition | .46 | 0.17 | 3.18** |
| Adaptation on cognitive conflict controlling for experimental condition | .57 | 0.11 | 4.20*** |
| Adaptation on experimental condition controlling for cognitive conflict | .23 | 0.14 | 1.41 |

*Note:* Experimental condition: Textbook = +1, Peer = -1. Coefficients are standardized β-coefficients. $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

#### *3.6.2.5 Impact of Social Comparison of Abilities on Adaptation*

In addition, we tested whether the problem solvers' social comparison orientation of abilities is a moderator of the impact of knowledge awareness regarding the presented deviating task solution on the adaptation of one's task solution to the presented one (Hypotheses 4a & 4b). That is, persons with a high need for engaging in social comparison of abilities should generally adapt more of their case pairs to the ones presented additionally compared to persons with a low need to engage in social comparison of abilities (Hypothesis 4a). The source label of the presented task solution, however, should have a larger impact on adaptation behavior in cases of a low need to engage in social comparison of abilities (Hypothesis 4b).

Participants of the peer condition did not differ significantly from participants of the textbook condition regarding social comparison orientation of abilities, $\beta = .09$, $p = .58$, $F < 1$ (cf. Table 7). For testing the hypotheses, multiple regression analyses were performed. As predictors, the z-standardized factor "Ability" of the Iowa-Netherlands Comparison Orientation Measure, the peer (coded by "-1") versus textbook (coded by "+1") condition, and the interaction term of both were inserted, and the adaptation of case pairs served as criterion variable. The three predictors explained about 23% of the participants' extent of adaptation, $R^2_{adj.} = .23$, $F(3, 35) = 4.76$, $p < .01$, $d = 0.21$. Not surprisingly, the main effect of knowledge awareness on the extent of adaptation was confirmed once again. That is, the participants of the textbook condition adapted significantly more case pairs to the presented ones than participants of the peer condition, $\beta = .42$, $p < .01$. No significant main effect of the factor "Ability" was found, $\beta = .17$, $p > .10$. A significant interaction, however, emerged between the factor "Ability" and the peer versus textbook condition, $\beta = -.31$, $p = .05$ (Figure 4).

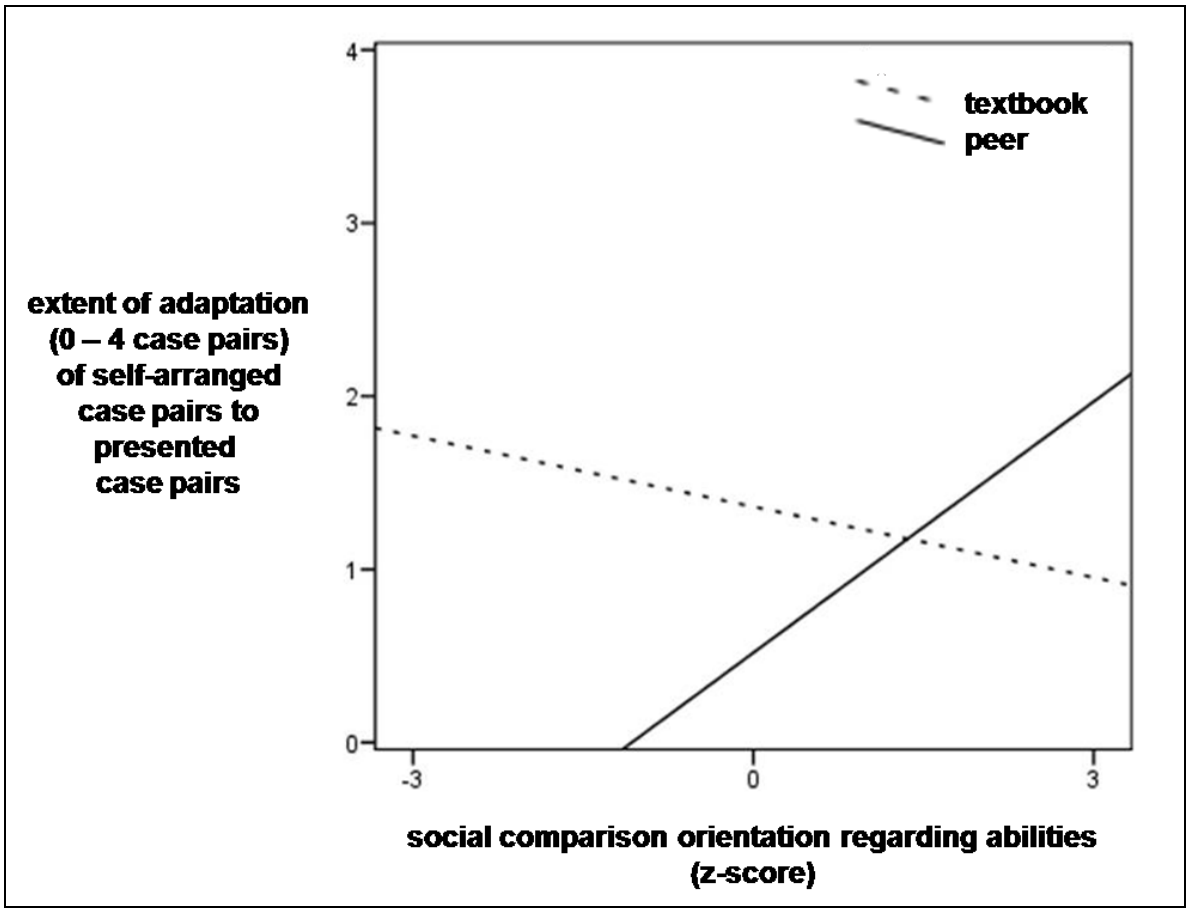


***Figure 4.*** *Interaction Between Need for Social Comparison of Abilities and Knowledge Awareness Regarding the Source of Presented Deviating Case Pairs on Extent of Adaptation to the Presented Case Pairs (N = 39).*

Simple slope analyses (cf. Aiken & West, 1991) indicated that knowledge awareness only had an impact on the adaptation of case pairs for persons with low values on the factor “Ability” but not for persons with high values on this factor. That is, in case of a high need to engage in social comparison of ability, the pattern of results points in the direction of participants generally adapting more case pairs independently of the source of the presented task solution; however, this pattern of

results was too weak to reach statistical significance, β = .11, $p$ = .60. Therefore, Hypothesis 4a was rejected. In case of a low need for engaging in social comparison of ability, the participants of the textbook condition adapted significantly more case pairs to the presented ones than the participants of the peer condition, β = .73, $p$ < .01, which confirms our Hypothesis 4b.

#### *3.6.2.6 Mediated Moderation Analysis*

Since in this study cognitive conflict was a mediator and social comparison orientation of ability a moderator of the participants' adaptation behavior, we conducted a mediated moderation analysis (Hypothesis 5). For this purpose, the IBM SPSS Statistics macro PROCESS (Beta release 040612, written by Andrew F. Hayes, 2012, see http://www.afhayes.com/introduction-to-mediation-moderation-and-conditional-process-analysis.html) was used. The experimental conditions with knowledge awareness (peer vs. textbook) served as independent variable (*X*), cognitive conflict as mediator (*M*), social comparison orientation of ability as moderator (*W*), and adaptation of one's own case pairs to presented ones as dependent variable (*Y*). The unstandardized coefficients again were converted into standardized coefficients. The analysis was based on 5.000 bootstrap resamples. The 95% confidence interval (CI) obtained for the indirect effects of knowledge awareness × social comparison of ability interaction on adaptation behavior through the mediator of cognitive conflict did contain zero, $Z_{Boot}$ = -0.10, $SE$ = 0.09, $CI$ $\alpha$ = .05 [-.30; .05] (see Figure 5 for a graphical depiction of the mediated moderation model results). Therefore, Hypothesis 5 was rejected because it could not be concluded that a more intense adaptation behavior of persons with low values regarding their social comparison orientation of ability in the textbook

condition was mediated by cognitive conflict. Instead, it seems that cognitive conflict as a mediator and social comparison of ability as a moderator exerted unique and independent effects on adaptation behavior in this study.

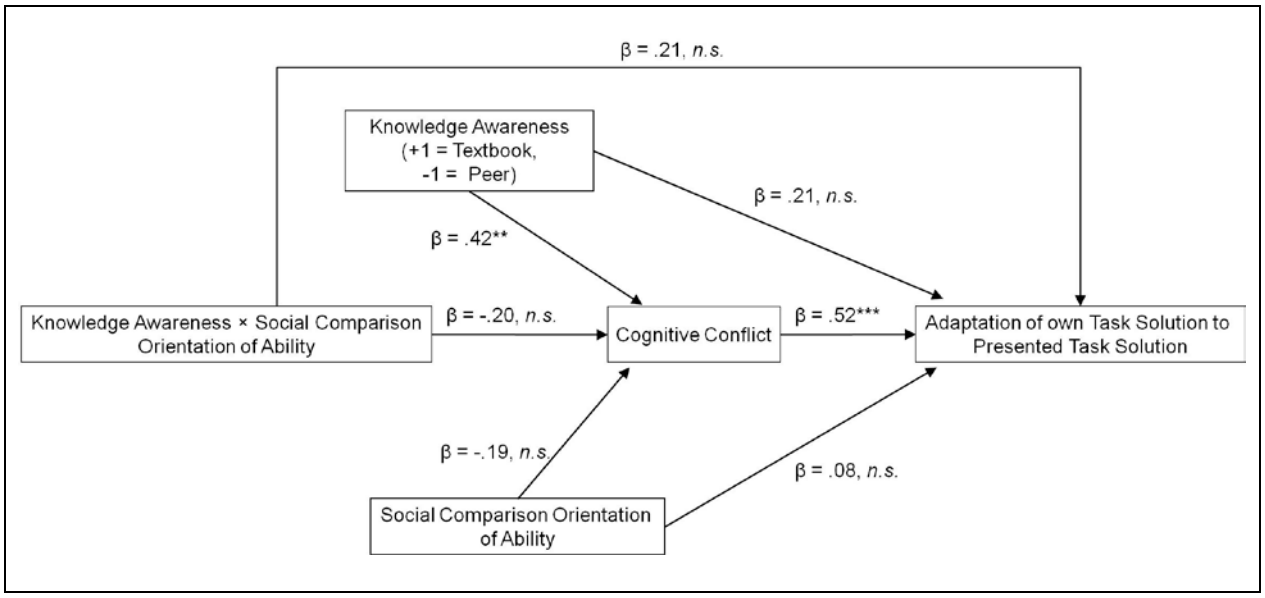


***Figure 5.*** *Results of the Mediated Moderation Model. All Path Coefficients are Standardized* β*-Coefficients. Total Adjusted* $R^2$ *for the Model:* $R^2_{adj}$ *= .49, F(4, 34) = 8.08, p < .001.* $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

## 3.7 Summary and Discussion

This first study of the present dissertation provides a synthesis of the following three research areas: (1) research on knowledge awareness, (2) research on conflict elaboration theory, and (3) research on personality differences regarding social comparison of abilities. Specifically, the study aimed at testing and extending assumptions of conflict elaboration theory (Mugny et al., 1995) by using a

knowledge-rich, complex problem solving task. In order to induce a cognitive conflict in the context of this problem solving task, problem solvers were provided with knowledge awareness regarding the source of a task solution that deviated from their own solution. By means of this cognitive conflict task, the impact of knowledge awareness regarding sources of varying levels of expertise (i.e., high vs. equally low competence) and the impact of individual differences regarding social comparison orientation on adaptation behavior was investigated. For this purpose, problem solvers compared their task solution in two experimental knowledge awareness conditions either with the deviating solution of a peer layperson or with the deviating solution of a supposed textbook on the subject-matter domain. Participants of the baseline condition only reviewed their self-created task solution. This study showed that for a knowledge-rich problem solving task without interaction between the source of the cognitive conflict and the target person, the impact of low competent sources is much weaker than postulated in the context of previous studies on conflict elaboration theory using more well-defined problems (e.g., anagram tasks; Quiamzade et al., 2009). That is, only knowledge awareness as the possibility to compare one's task solution with the deviating solution of a high competent source encouraged problem solvers to improve the correctness of their task solution but not knowledge awareness as the comparison with the deviating solution of an equally low competent source. One reason for this finding could be that knowledge-rich tasks are too complex in order to learn solution strategies quickly just from being provided with a deviating solution without receiving further explanations from the source of this deviating solution. In such a situation, problem solvers are not only especially uncertain about their own

solution, but also about a peer's solution. Therefore, they are much more likely to trust a high competent source's solution than a low competent source's solution.

Despite the present findings, peer learning can be helpful in the context of knowledge-rich cognitive conflict tasks if certain conditions are met. Previous studies have shown that for learning to solve such tasks, it is crucial that peer interaction takes place (cf. Bodemer, 2011) because explaining one's solution to a peer can help both to resolve cognitive conflicts and to improve task solutions (Baumeister, Engelmann, & Hesse, subm. b). Therefore, *peer talk* became the starting point of the second study of this dissertation because it was assumed that peer talk could strengthen the positive impact of knowledge awareness regarding an equally low competent source on problem solving in the context of this cognitive conflict task. This study will be presented in the following Chapter 4.

Moreover, the cognitive conflict task applied in the first study resulted in the positive form of a selective imitation (cf. Quiamzade & Mugny, 2001) because problem solvers selectively adopted the correct aspect of the high competent source's solution whereas they did not adopt the false aspects more often than problem solvers confronted with a low competent source's solution. This positive form of imitation resulted in slightly more correct task solutions of problem solvers confronted with a high competent source's solution compared to problem solvers confronted with a low competent source's solution. What caused this positive form of selective imitation? In this study, it was shown that cognitive conflict was the driving force of problem solver's adaptation behavior. This corroborates previous assumptions and findings on the positive impact of cognitive conflict on learning as an educational strategy (cf. Limón, 2001). However, it was also shown that in contrast to previous assumptions of conflict elaboration theory (Mugny et al., 1995;

Quiamzade et al., 2009) and of other peer learning approaches (e.g., Chan, Burtis, & Bereiter, 1997), peer learning does not necessarily result in more intense cognitive conflicts than learning from an expert. In this first study of the present dissertation, problem solvers confronted with a high competent source's deviating solution experienced substantially more cognitive conflict than problem solvers confronted with a low competent source's deviating solution. Moreover, perceived cognitive conflict fully mediated problem solver's adaptation behavior regarding the presented deviating task solution. That is, the more cognitive conflict problem solvers perceived, the more extensively they adapted their solution to the presented one, no matter whether their knowledge awareness referred to a high or a low competent source. This pattern of results can be interpreted in reference to the specific problem solving situation created in this study which differed from the learning settings investigated by previous studies on conflict elaboration theory: In contrast to previous studies using more well-defined problems whose solution strategies could be acquired in the course of the experiments (cf. Quiamzade et al., 2009), in this study, a knowledge-rich problem solving task was applied. The solution strategies of such tasks take more time to learn because they require a large knowledge base (cf. Sweller et al., 1998; VanLehn, 1999) which was not available to the participants of the study who were laypersons in the subject-matter domain of criminal law. Further studies are needed applying longitudinal designs in order to investigate whether and how such social influence dynamics change in the course of learning how to solve knowledge-rich problem solving tasks.

Further, in this study, social comparison orientation regarding ability moderated the relationship between knowledge awareness and adaptation behavior. That is, persons with a low need for social comparison of abilities

adapted their task solutions especially to those of a high competent source. Thus, this first study of the present dissertation contributes to understanding how persons low in social comparison orientation of ability react to social influence in a cognitive conflict task. The pattern of results illustrates that basic human needs such as the "upward drive" (Buunk & Gibbons, 2007; Festinger, 1954; Smith & Sachs, 1997), that is, comparing oneself with others who presumably do better on the same task in order to improve one's performance, even apply to persons who characterize themselves as not preferring to compare themselves with others. Perhaps an especially valid assessment of personality traits such as social comparison orientation requires both self-assessments and assessments by others (e.g., close friends or relatives).

For persons with a high need to compare their abilities, it was postulated that they would generally adapt their task solution more often to the presented deviating solution regardless of whether the source label indicated a low or a high competent source (Michinov & Michinov, 2001). The pattern of results, however, was too weak to confirm this assumption. Perhaps in the sample of this study, there was a lack of persons with a very high need for social comparison of abilities.

Further, a mediated moderation analysis was conducted in order to clarify the interplay and relative strength of the influence of knowledge awareness, social comparison orientation regarding ability, and cognitive conflict on the adaptation of one's task solution to the presented solution (cf. Figure 5). In this model, cognitive conflict turned out to be the only direct and a very strong predictor of problem solvers' adaptation behavior. Knowledge awareness regarding sources of different levels of expertise had an indirect impact on adaptation behavior through cognitive conflict. That is, problem solvers confronted with a high competent source's

deviating solution experienced more cognitive conflict than problem solvers confronted with a low competent source's solution, and more perceived cognitive conflict resulted in more adaptation of task solutions to the presented one. However, knowledge awareness and social comparison orientation regarding ability did not interactively affect the mediator cognitive conflict. Thus, in this study, cognitive conflict as a mediator and social comparison of ability as a moderator interacted independently with knowledge awareness with respect to their impact on adaptation behavior. More studies with larger samples are needed to back up this new finding.

The question of how learners react if they are confronted with other's competence or knowledge is highly relevant for educational research and application. Being aware of others' knowledge can change a learner's or problem solver's behavior in many ways. For example, previous studies have shown that being informed about others' knowledge and information both supports individual learning by improving peer explanations (e.g., Dehler-Zufferey, Bodemer, Buder, & Hesse, 2011) and collaborative problem solving (Engelmann et al., 2009; Engelmann, & Hesse, 2010). However, individual differences substantially interact with contextual factors of learning and problem solving. Therefore, studies are needed to identify the prevalent individual differences and needs and their effects on different kinds of learning situations, respectively. For example, Ray, Neugebauer, Sassenberg, Buder, and Hesse (2013) showed in two studies that being confronted with others' knowledge activates social comparison processes which, beside more effective explanation-giving, do not necessarily result in optimal learning behavior. Instead, persons high in social comparison orientation reduced information sharing with a peer due to seeking self-enhancement, and, in contrast,

persons low in social comparison orientation did not change the amount of shared information in this setting.

## 3.8 Conclusions

This first study of the present dissertation further contributes to understanding the effects of individual differences in social comparison orientation on learner's and problem solver's performance. This study showed that in the context of a knowledge-rich cognitive conflict task, assumptions of conflict elaboration theory regarding the impact of different source labels, that is, knowledge awareness regarding different levels of expertise, applied especially to persons with a low need for social comparison of abilities or performance since these persons selectively adopted the correct aspect of a high competent source's solution more often than the same solution aspect of an equally low competent source. Thus, being low in social comparison orientation does not mean that someone is not interested in improving one's performance by learning from presumably more competent models.

Moreover, this study illustrated that perceived cognitive conflict is a strong driving force of learners' behavior. Future studies are needed to investigate the interplay of individual differences in social comparison orientation and cognitive conflict in more naturalistic settings applying, for example, real, longer-term interaction between the source and the target of a cognitive conflict. This study provides evidence regarding factors and measures which contribute to understand individual differences and mediating processes in learners' or problem solvers' behavior.

# Overview – Part II

The first study of the present dissertation had shown that in the context of a *knowledge-rich cognitive conflict task* (i.e. identifying structural similarities between law cases; Nievelstein et al., 2010) without interaction between the source of the cognitive conflict and the target person, the impact of equally low competent sources will probably be lower than the impact of more highly competent sources which is in contrast to previous assumptions of the conflict elaboration theory (Mugny et al., 1995) applying more well-defined problems (e.g., anagram tasks; Quiamzade et al., 2009). Therefore, in the next step, it is interesting to explore how the positive impact of *peer learning* could be strengthened using the same task: one possibility being *peer talk*. Peer talk in the context of this dissertation is defined as the transmission of *audio messages* between two spatially distributed learning partners with an equivalent level of expertise, that is, *two laypersons* in the subject-matter domain. Previous studies have shown that peer talk can support learning. For example, by directing explanations to a learning partner, learners improve their own understanding (Webb, 1985, 1991), and they adapt their explanations to their learning partner's current level of understanding (Clark & Murphy, 1982; Dehler et al., 2009).

The second study of the present dissertation investigates the impact of peer talk on (1.) *cognitive* (i.e., conflict resolution, knowledge convergence) and (2.) *performance-related aspects* (i.e., adaptation to the partner's solution and correctness of task solutions) while completing the same knowledge-rich cognitive conflict task as in Study 1.

Further, *static knowledge awareness* information was provided in Study 1, whereas *dynamic knowledge awareness* information will be presented in Study 2 in order to compare across both studies whether these two subcategories of knowledge awareness may have different psychological effects (cf. *technology affordances* & *representational guidance*; Suthers, 2006), according to the combined classification proposed in Chapter 2.

# 4 Study 2: Impact of Knowledge Awareness Regarding an Equally Low Competent Source Combined With Peer Talk in a Computer-Supported Cognitive Conflict Task

**This chapter is based on:**

Baumeister, A. E. E., Engelmann, T., & Hesse, F. W. (subm. b). *Impact of peer talk in a computer-supported cognitive conflict task.* Manuscript submitted for publication.

## 4.1 Introduction

Neo-Piagetian learning theories argue that *socio-cognitive conflicts*, for example, being confronted with others' task solutions which deviate from one's own solution offer a great potential for learning (cf. Marchand, 2012; Mugny, Butera, Sanchez-Mazas, & Pérez, 1995; Limón, 2001). Studies on *conflict elaboration theory* (Pérez & Mugny, 1992; Mugny et al., 1995) investigate how confrontation with a divergent task solution affects a learner's own performance if he or she does not know for sure which solution is correct. Consequently, these studies typically involve participants with low prior knowledge in the subject-matter domain, in order to induce high uncertainty regarding the correct solution and in order to maximize the probability of a cognitive conflict. One aim of conflict elaboration theory is to clarify social influence dynamics of learning through socio-cognitive conflict. Studies on

conflict elaboration theory have shown, for example, that being confronted with *a peer's deviating solution* improves learning if the peer is not threatening one's own self-esteem (Buchs & Butera, 2009; Quiamzade & Mugny, 2001). That is, learning occurs if peers compare and try to coordinate their solution strategies which results in more elaborated solutions (Quiamzade, Mugny, & Darnon, 2009) whereas learning is impaired if learning partners compete with each other and focus more on a social comparisons of their competence instead of focusing on solving the task (Darnon, Doll, & Butera, 2007).

Further, being informed about another learner's task solution that deviates from one's own solution is an instance of *knowledge awareness* (Engelmann, Dehler, Bodemer, & Buder, 2009) which is defined as "an individual's state of being informed and having perceived information about others' knowledge", that is, especially others' externalized task-relevant knowledge (Engelmann et al., 2009, p. 950). Knowledge awareness is a strand of research on *group awareness* (Gross, Stary, & Totter, 2005; Gutwin & Greenberg, 1995; Janssen & Bodemer, 2013). Research on group awareness aims at investigating and supporting "consciousness and information of various aspects of the group and its members" (Gross et al., 2005, p. 327). For example, group members should know what the others are doing or have contributed (social group awareness), and which knowledge or expertise, opinions and information they have (cognitive group awareness; Janssen & Bodemer, 2013). Group awareness has to be established in virtual teams by means of groupware because group members who are spatially separated do not receive the social cues casually transmitted face-to-face which facilitate knowledge exchange (e.g. seeing a group member nodding his or her head) and coordination of task completion (Gutwin & Greenberg, 1995).

For example, computer-based external representations which inform learners about others' task solutions help learners to acquire knowledge awareness. That is, the *task solutions* learners produce deliberately and not just by mere guessing can be regarded as externalizations of their *knowledge* ("sediments of cognitive activity"; Rindermann, 2013, p. 190). Thus, *different solutions* regarding the *same task* indicate *different knowledge*. The following study example illustrates the close relationship between learners' different knowledge and task solutions and the role which shared external representations of knowledge and task solutions can play: Bodemer (2011) provided dyads of spatially distributed learners with a shared visualization showing their individual task solutions that could differ on the same task. Dyads provided with such a shared visualization discussed conflicting task solutions more often than dyads without the shared visualization. According to Engelmann and colleagues' (2009) classification of knowledge awareness, this form of knowledge awareness is called *hybrid knowledge awareness* because learners are provided with an external representation that both informs them about the others' task solutions (i.e., content) and allows them to draw conclusions about others' knowledge (i.e., the context of the content), whereas other forms of external representations mainly inform them about their own and the others' knowledge without providing task solutions (cf. Engelmann et al., 2009).

Several studies have shown that approaches for fostering knowledge awareness both improve individual learning and collaborative problem solving (Engelmann et al., 2009; Engelmann & Hesse, 2010; Engelmann, Tergan, & Hesse, 2010; Janssen & Bodemer, 2013). Computer-based external representations of others' knowledge and information help to acquire knowledge awareness even if no further communication takes place (Engelmann, Baumeister,

Dingel, & Hesse, 2010a). However, dialogic discourse combined with external representations for fostering knowledge awareness is helpful for solving problems because mistakes are identified mutually and discussed resulting in more correct task solutions compared to without dialogic discourse (Engelmann et al., 2010a).

Nevertheless, in this dissertation's first experimental study (Baumeister, Engelmann, & Hesse, subm. a), using the same computer-supported cognitive conflict task of the present study, knowledge awareness about the partly correct task solution of a peer learner did not help learners to improve the correctness of their own task solutions compared to a baseline without knowledge awareness. In this previous study, learners either could compare their task solution to the deviating solution of a peer by means of a static external representation of the peer's solution or they were not provided with such a comparison possibility. In contrast, the present study aimed at investigating whether the impact of peer learners as producers of solutions which deviate from one's own solution, that is, sources of socio-cognitive conflicts, can be strengthened by (1.) enabling spatially distributed peer learners to talk to each other by means of computer-based audio communication and (2.) by enabling learners to observe in real-time how the peer is changing his or her solution (cf. Bodemer, 2011).

In the following sections of this chapter, it will be explained why and how computer-based peer talk could support learners in improving their task solutions after being confronted with a solution that deviates from their own. Specifically, this study aimed at elucidating the impact of peer talk on (1.) cognitive (i.e., conflict resolution, knowledge convergence) and (2.) performance-related aspects (i.e., mutual adaptation and correctness of task solutions) while completing a computer-supported cognitive conflict task.

The next section starts with arguing that the impact of authentic peer talk has indeed not yet been investigated in studies on conflict elaboration theory (Mugny et al., 1995). After this, a short review of studies on the impact of computer-mediated communication (CMC) on learning and conflict resolution is provided. Further, it will be explained under which conditions computer-based peer talk can be helpful in order to solve cognitive conflict tasks. Specifically, it will be argued that peer talk can help to resolve cognitive conflicts and can support knowledge convergence (cf. Fischer & Mandl, 2005; Jeong & Chi, 2007). Regarding performance-related aspects, it is argued that peer talk will result in a more intensive mutual adaptation of task solutions and in more correct solutions. Finally, methods and results of the experimental study are presented and discussed comparing dyads with computer-based peer talk to dyads without peer talk regarding cognitive and performance-related aspects while solving a cognitive conflict task.

## 4.2 Impact of Peer Talk

As Mercer (1995) argues, studies on the concept of socio-cognitive conflict did not focus on “the actual talk involved in such conflicts of ideas – perhaps because language still occupies a relatively marginal role in their theory. The main aim in most of their research has also been to determine whether interaction improved later *individual* performance (rather than being interested in the joint construction of knowledge).” (Mercer, 1996, p. 360). Thus, studies in the context of conflict elaboration theory (e.g., Mugny et al., 1995; Quiamzade & Mugny, 2001) did

neither clarify the impact of peer talk in face-to-face (FTF) learning situations nor by means of computer-mediated communication (CMC). Some studies have included "peer interaction", but in these cases, a confederate of the researchers presented his or her predetermined solution to university students (e.g., Buchs & Butera, 2009; Darnon et al., 2007), and mostly no dialogic discourse with this bogus partner took place (e.g., Butera, Caverni, & Rossi, 2005; Quiamzade, 2007). One study included cooperative learning but with another focus (i.e. resource interdependence among dyads of university students; Buchs, Butera, & Mugny, 2004a). Therefore, it remains to be clarified whether computer-based peer talk among university students increases or helps to resolve cognitive conflict compared to no discourse which is the aim of the present study.

Lou, Abrami, and d'Apollonia (2001) conducted a meta-analysis (122 studies) comparing dyadic or small group (i.e. 3- to 5-persons) learning versus individual learning, both using computer technology (CT). They found a small positive effect of peer talk in dyads or groups (i.e. either face-to-face or computer-mediated communication) compared to individual learning on individual achievement in immediate or delayed post-tests (based on $n$ = 100 studies, corrected for sample size differences: $d$ = 0.16). Process measures revealed that peer talk in dyads and small groups resulted in using learning strategies more frequently and effectively ($n$ = 5 studies, $d$ = 0.50), and in being more perseverant on the tasks ($n$ = 2 studies, $d$ = 0.48) compared to individual learning.

As Hobman, Bordia, Irmer, and Chang (2002) note, only few studies have investigated the impact of computer-mediated communication in text-based (i.e. written) form on different types of conflicts pertaining to task, process, and relationships. In additon, the results are inconsistent. For example, Straus (1997)

compared task-oriented conflict in CMC versus FTF groups and found more conflicts in CMC groups due to time pressure. Further, Hobman and colleagues (2002) found a similar amount of task-oriented conflict and more relationship and process conflict among CMC groups compared to FTF groups but only at the beginning of their cooperation, not in later stages.

However, Harmon (1998) showed that a relatively rich medium, such as dialogic discourse by means of audio conferencing, is especially suited for resolving socio-cognitive conflicts. Harmon (1998) concluded that most audio conferencing research in dyadic settings "has provided some indication of positive audio effects on conflict management, as evidenced by a more constructive, issue-focused conflict process and/or greater opinion change and agreement" (p. 140). However, it remains to be clarified which impact a short computer-mediated peer talk phase will have on completing a cognitive conflict task compared to no discourse.

## 4.3 Hypotheses

According to Harmon (1998), computer-mediated dyadic (audio) communication as a relatively rich medium should be helpful to solve a cognitive conflict compared to no communication:

*Hypothesis 1:* Peer talk helps to resolve cognitive conflicts.

Moreover, if communication partners exchange their knowledge and explain their positions, this should result not only in conflict resolution but also in a shared understanding called "knowledge convergence" (Dehler, Bodemer, & Buder, 2008;

Fischer & Mandl, 2005; Jeong & Chi, 2007) or "convergence of meaning" (Roschelle, 1992).

With regard to the concept of socio-cognitive conflict, it is important to explain how and why conflict resolution was achieved. Knowledge convergence as co-construction of knowledge and ideas and as perspective-taking could be a good reason for resolving an initially experienced socio-cognitive conflict. Knowledge convergence, however, does not mean that no divergence between learners exists any more but knowledge convergence could explain why initial socio-cognitive conflicts are reduced. To put it differently, if no knowledge convergence occurs this could mean that learners could not learn from each other and, thus, the educational cognitive conflict strategy has missed the target.

In previous studies with university students, knowledge convergence was mainly assessed by measuring shared knowledge (Dehler et al., 2008; Fischer & Mandl, 2005; Jeong & Chi, 2007), but also by measuring the similarity in resource use within groups of learners (Fischer & Mandl, 2005), and by measuring shared mental models (Jeong & Chi, 2007). Thus, objective measures were used. It remains to be investigated whether knowledge convergence can also be captured by means of *subjective measures*. Therefore, the present study aimed at examining: (1.) whether, in contrast to objective measures, knowledge convergence can also be measured by *self-ratings* of the learners, asking them to judge both their own task-relevant competence as well as their peer learner's task-relevant competence, and (2.) whether peer talk, while completing a cognitive conflict task, results in more knowledge convergence (subjectively rated by the learners).

*Hypothesis 2:* Communicating peers judge their own task-relevant competence and their peer learner's task-relevant competence to be more similar as a result of mutually explaining their task solutions to each other compared to non-communicating peers.

Regarding performance-related aspects, the present study aimed at examining whether peer talk has an impact on *mutually adapting task solutions* and on the *correctness* of task solutions. Since socio-cognitive conflict tasks usually involve much uncertainty regarding the correct solution on the learners' part, the question needs to be answered whether peer talk will result in more mutual adaptation of initially diverging task solutions. If the previously mentioned assumption (Hypothesis 2) holds true that peer talk results in knowledge convergence in the sense of perceiving a similar competence level of partner and self, then it can be concluded that peer talk will also more often result in adopting the peer's task solution compared to no peer talk. Thus, the following hypothesis was tested:

*Hypothesis 3:* After peer talk, learners will mutually adapt their task solutions more often compared to learners who did not talk to each other.

However, adapting task solutions can either have a positive or a negative effect on the correctness of task solutions depending on whether correct or false aspects of the learning partner's solution are adopted (cf. Chapter 3; Baumeister, Engelmann, & Hesse, subm. a). According to conflict elaboration theory, it can be expected that learners will elaborate on a peer's deviating solution if the peer is not threatening their self-esteem (Butera et al., 2005; Mugny et al., 1995; Quiamzade & Mugny, 2001). This should result in deliberate mutual adaptation which improves

the correctness of task solutions because, in this case, learners mainly adopt the correct aspects of their partner's task solution.

Which impact does peer talk have on the correctness of task solutions in a cognitive conflict task? This study aims at clarifying this question. Several studies found that the quality of the content of dialogic discourse was a crucial factor for learners' improved comprehension of the subject-matter and improved performance (Teasley, 1997; Webb, Troper, & Fall, 1995). High quality dialogic discourse can be called *exploratory talk* which Mercer (1995) defines as follows: "partners engage critically but constructively with each other's ideas. (…) Statements and suggestions are offered for joint consideration. These may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered." That is, "knowledge is made more publicly accountable and reasoning is more visible in the talk." (Mercer, 1995, p. 104). In a study, for example, teachers taught primary age children the ground rules of exploratory talk which improved their reasoning (e.g. Fernández, Wegerif, Mercer, & Rojas-Drummond, 2002; Mercer, Dawes, Wegerif, & Sams, 2004).

This dissertation's second study aimed at clarifying the question whether peer talk per se helps to improve task solutions by improving task-relevant cognitive processes (cf. Teasley, 1995) or whether the *quality* of dialogic discourse *content* matters (Mercer, 1995; Teasley, 1995):

> *Hypothesis 4 a):* The correctness of the task solution improves as a result of peer talk compared to no communication (cf. Teasley, 1995).
>
> *Hypothesis 4 b):* Only high-quality dialogic discourse will result in a more correct task solution compared to no communication. High quality means that learners talk about their interpretation of core

elements of the task and that learners use exploratory talk (Mercer, 1995, 1996, 2000; Teasley, 1995).

In order to identify high-quality discourse, that is, exploratory talk, Mercer (2000) suggests to focus discourse analysis, for example, on key words (e.g., 'reasoning words': 'I think', 'because', 'if', 'how', 'why' etc., Wegerif & Mercer, 1997; Wegerif, Mercer, & Dawes, 1999; Soter et al., 2008).

## 4.4 Experimental Study

In the second study of the present dissertation, the following two sets of research questions were investigated in the context of completing a complex, knowledge-rich cognitive conflict task: First, the impact of peer talk on cognitive aspects was examined. Second, the impact of peer talk on performance-related aspects was focused on.

Regarding cognitive aspects, it was examined whether peer talk helps to resolve cognitive conflicts. Further, it was investigated whether peers judge their own task-relevant competence and their peer learner's task-relevant competence to be more similar as a result of mutually explaining their task solutions to one another.

Regarding performance-related aspects, it was investigated whether peer learners who communicate with each other mutually adapt their task solutions more often compared to learners who did not communicate with each other. In addition, it was examined whether the correctness of the task solution improves as a result of peer talk (cf. Engelmann, Baumeister, Dingel, & Hesse, 2010a) or

whether the quality of discourse content matters. The peer talk was analyzed in more detail in order to reveal associations between discourse content, cognitive conflict, competence judgments, and improved or declined correctness of task solutions.

## 4.4.1 Method

### *4.4.1.1 Participants and Design*

The 58 university students who participated in this study (43 female, 15 male; *M* = 23.95 years, *SD* = 2.70) were drawn from a larger sample of 80 students of different fields of study who volunteered to participate for either payment or course credit. Eleven dyads were excluded from the final sample because their first version of the task solutions matched each other to a great extent. Thus, for them, this was not a cognitive conflict task. Except for the control measure “match of the first version of task solutions”, the excluded participants did not differ from the final sample regarding any of the further control measures applied.

Law students were not invited to participate in order to keep prior knowledge low in the later domain of problem solving which was criminal law. In a between-subjects design, the participants were randomly assigned to either the peer talk (pt) or the no peer talk (npt) condition. The final sample consisted of 13 dyads in the *peer talk condition* and 16 dyads in the *no peer talk condition*. In the peer talk condition, the participants compared their task solution with the solution of a peer learner that largely deviated from their own solution, and after this, both learners mutually explained their task solutions to each other. In the no peer talk condition,

the participants also compared their task solution with the largely deviating solution of a peer learner, but both learners had no possibility to communicate with each other.

#### *4.4.1.2 Materials and Measures*

***Control measures.*** All control measures, demographic data (e.g., gender, age) and domain-specific prior knowledge were assessed online by means of web forms. Domain-specific prior knowledge was assessed by a multiple-choice questionnaire of basic concepts of German case law (5 items; e.g., what are the basic fields of law?). The maximum attainable score was ten points.

As a control measure, a test on *knowledge awareness* was performed in both conditions (cf. Baumeister et al., subm. a). That is, it was tested whether the participants were informed about the peer learner's task solution and could reproduce it from memory. The maximum score for correctly remembering the peer's solution was five points.

As a further control measure, the *match* between the first version of the task solutions within each dyad was assessed to test whether the task solutions deviated sufficiently, which is a prerequisite for a cognitive conflict task. The criterion for being included in the final sample was to have between zero and a maximum of two matches within each dyad. Since the task involved arranging five pairs of solved and unsolved criminal law cases, the score ranged from "0" to "5" matching case pairs within each dyad of peer learners.

***Computer-supported cognitive conflict task.*** An inductive reasoning task was applied which in this dissertation's first experimental study had proven to maximize the variety of task solutions and, thus, the experience of a cognitive conflict (cf. Chapter 3; Baumeister et al., subm. a): The learners had to pair each of five unsolved criminal law cases with one of five solved criminal law cases (cf. Appendix B). The aim was to build pairs with a high structural similarity, that is, pairs that required a similar solution so that the solution of the solved case could be transferred to the unsolved case. Five solved criminal law cases each consisting of three to four sentences along with their solution were printed on single sheets of paper, respectively. Further, five unsolved criminal law cases were presented on five cards. The software tool used for sorting the law cases in order to build structurally similar pairs was *CmapTools* (cf. Novak & Cañas, 2006; see, http://ftp.ihmc.us/) which allows for moving the text boxes easily that represented the solved and unsolved cases. Moreover, using CmapTools, the computer-based external representation of the sorting task also allowed for comparing self-arranged case pairs with the peer learner's case pairs presented additionally both in the peer talk condition and in the no peer talk condition (see Figure 6). This external representation initially contained five grey text boxes labeled with the titles of the five solved cases and five colored text boxes representing the unsolved cases. Each unsolved case could be arranged in a pair with a solved case by dragging the colored text boxes next to the grey text boxes on the screen.

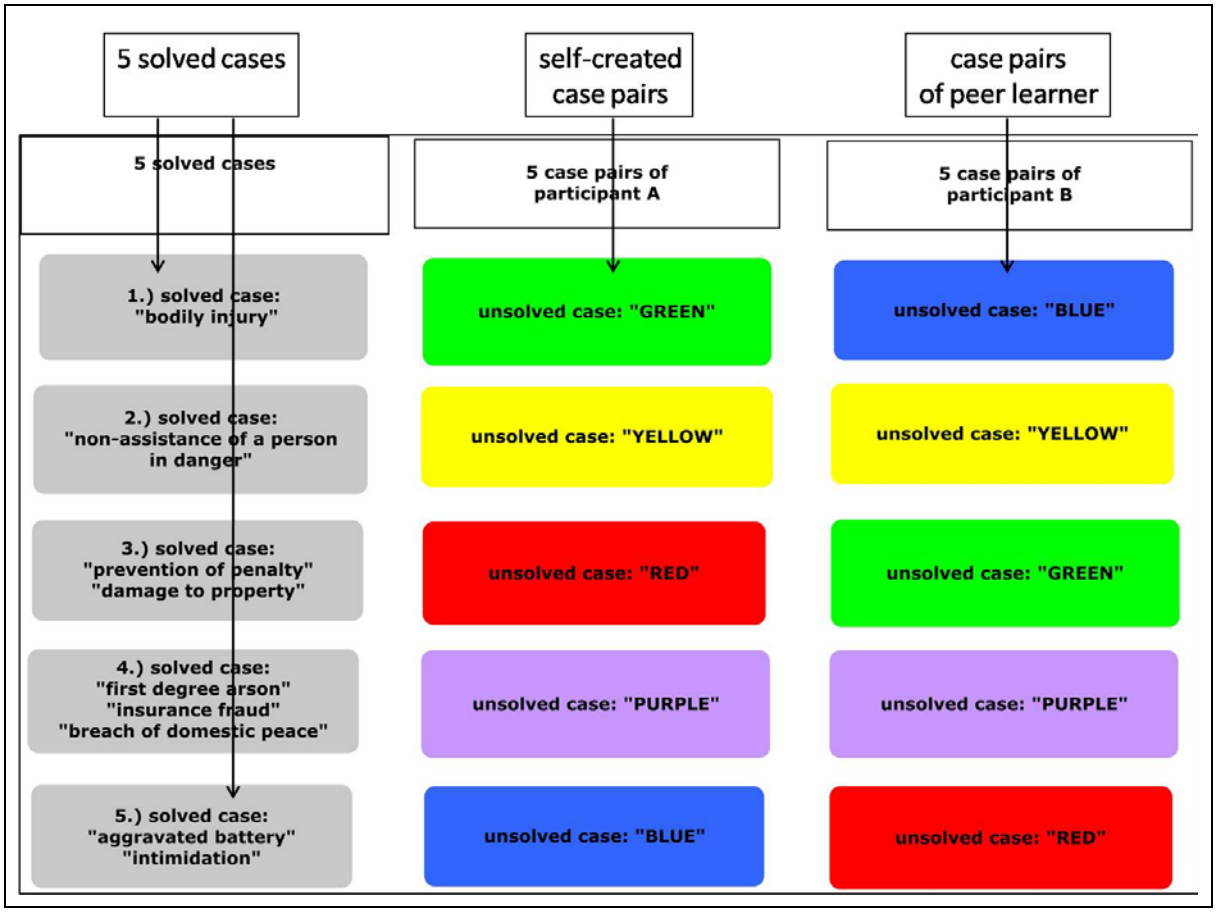


***Figure 6.*** *Computer-Based External Representation for Supporting Knowledge Awareness: Self-Created Case Pairs in the Middle and Additionally Presented Deviating Case Pairs of a Peer Learner on the Right Side.*

***Cognitive conflict.*** It was assessed whether the participants experienced a *cognitive conflict* while they were confronted with the case pairs of a peer learner which deviated from their self-created pairs. The participants indicated on three 5-point rating scales (from 1 for “low agreement” to 5 for “high agreement”; Cronbach’s α = 0.82) whether they “had doubts regarding the correctness of the presented deviating task solution” of a peer and regarding the “peer’s task-related competence”, and whether the deviating task solution “did not convince” them. This

test was administered before and after the experimental variation (i.e., presence / absence of a peer talk phase).

***Competence rating: Self vs. peer.*** In order to assess knowledge convergence, the participants were asked to rate both their *own competence* and their *peer learner's competence* regarding building correct case pairs. The competence ratings were given on two separate 11-point rating scales, one scale for the participant's competence and one scale for the peer's competence (from 0% for "not competent at all" to 100% for "highly competent"). In order to assess whether the participants rated their own competence lower or higher than the peer's competence, a competence difference variable was calculated by subtracting the values of the rating of peer competence from the values of the rating of one's own competence. Positive values on this competence difference variable indicated that the participant had rated his or her own competence higher than the peer's competence, whereas negative values indicated that the participant had rated the peer's competence higher than his or her own competence. The nearer the difference value was to zero, the more similar the rating of own and the peer's competence was. Both competence rating scales were administered before and after the experimental variation (i.e., presence / absence of a peer talk phase).

***Adaptation of task solution.*** It was assessed how many case pairs in the *second version* of the own task solution had been adapted to the presented solution of the peer learner. The maximum score was five points if the participant had adapted all five case pairs to the case pairs of the peer learner. Note that adaptation can only be assessed if divergence between task solutions existed

initially. This is a further reason (beside the aim to create a cognitive conflict situation) why dyads had to be excluded from the final sample if their initial task solutions were highly matched. Further, it was assessed whether learners adopted correct (i.e. structurally similar) or false case pairs of their peer.

***Correctness of task solution.*** The participants' *correctness* of the first and second version of the task solution was assessed regarding pairing solved and unsolved cases. Only two pairs were counted as the correct solution because structural similarities between the solved and unsolved case existed. For the other three unsolved cases, no structurally similar solved case existed. Thus, they served as distractors. Two points were attainable as the maximum score for the correctness of building structurally similar case pairs. The correct solution had been previously identified in a pilot study with advanced law students ($n$ = 8).

***Content analysis of discourse.*** In the peer talk condition, the verbal activity was recorded via Camtasia Studio screen recorder software (see, http://www.techsmith.com/camtasia/). Transcripts of the audio files were generated. One dyad had to be excluded from the analysis because the audio data were too noisy. For the remaining 12 communicating dyads, both learning partners were identified and labeled in the transcripts. Verbal statements were segmented into utterances based on content and pauses. In a first step, all utterances were coded into categories. For this purpose, no apriori coding system was used, but categories emergent from the data were used. One utterance could be coded into several categories. In a second step, the frequencies of the categories were calculated, and the most representative categories were identified. This procedure

yielded seven categories and a total of 203 verbal statements which were representative for the special discourse situation of this experimental setting. These 203 verbal statements were completely and independently coded by two coders who resolved disagreements through discussion. 173 statements (85.2%) were coded into one category, 29 statements were coded into two categories (14.3%), and one statement was coded into three categories (0.5%). As a measure of inter-rater agreement, Spearman's rho was calculated because the categories were rank-ordered. The inter-rater agreement was high, Spearman's $\rho(232) = .79$, $p < .001$. After this, the transcripts were reanalyzed in order to investigate whether aspects of exploratory talk (cf. Mercer, 1995, 1996, 2000) were identifiable. Based on the description of concordance analysis offered by Mercer (2000), a computer-based search for indicator words of explanatory talk was conducted. That is, the occurrence of the words 'I think', 'because', 'why' and 'if' as well as of synonyms (e.g. 'I believe / I guess / I consider', 'whether', 'in case') for each word was tracked (cf. Mercer, 2000, p. 154). Two indicators of exploratory talk occurred especially frequently, namely 'I think' and 'because', whereas other indicators were almost non-existent (e.g. 'why', 'if'). Therefore, only the two indicators 'I think' and 'because' were used for analyzing associations between these aspects of exploratory talk and cognitive and performance-related aspects. The analyzed categories, their frequencies, as well as sample statements, can be seen in Table 9.

***Table 9***

*Coding Categories of Verbal Activity in the Peer Talk Condition ($n_{pt}$ = 12), Frequencies and Example Statements*

| Coding category, description and example statement | *M* (*SD*) | *Sum* (*Range*) |
|---|---|---|
| *Identification of similar cases:* Learner states that a specific solved case fits better or especially well with a specific unsolved case, e.g., "Blue is better with four." | 2.75 (2.14) | 33 (0-6) |
| *Expression of understanding:* Learner states that he or she did understand: (a) task, (b) cases or case features, (c) one's own case pairs, (d) case pairs of peer, (e) explanation or argumentation of peer, e.g., "Sounds good, I think." | 5.00 (2.89) | 60 (1-10) |
| *Request for peer-explanation:* Learner asks peer to explain and give reasons why he or she formed specific case pairs, e.g., "How did you hit on the blue one?" | 2.42 (2.02) | 29 (0-6) |
| *Expression of lack of understanding:* Learner states that he or she did not understand: (a) task, (b) cases or case features, (c) one's own case pairs, (d) case pairs of peer, (e) explanation or argumentation of peer, e.g., "I did not figure out at all which criminal action happened in this unsolved case." | 1.58 (1.51) | 19 (0-5) |
| *Task coordination:* Learner asks or suggests how to proceed, e.g., "Where do we start? With the first one?" | 4.58 (2.75) | 55 (0-11) |
| *Identification of dissimilar cases:* Learner states that a specific solved case does not fit well with a specific unsolved case, e.g., "Lilac does not fit at all with three, I think." | 2.00 (1.28) | 24 (1-5) |
| *Competence self-rating and peer-rating:* Learner expresses how he or she judges his or her own task-relevant competence vs. the peer's competence, e.g., "How incompetent have we been?" | 1.17 (2.08) | 14 (0-6) |
| *Exploratory talk I ('I think', cf. Mercer, 2000):* Reasoning is visible in the talk; knowledge is made publicly accountable, e.g., "I think that maybe I was misled too fast by these two aspects – I don't know why, but I lumped them together immediately." | 20.08 (7.49) | 241 (9-37) |
| *Exploratory talk II ('because', cf. Mercer, 1995, 1996, 2000):* Learners account for their opinions; statements and suggestions are offered for joint consideration, e.g., "Basically, it was deliberate intention because, in this case, the woman deliberately did not tell him that the injured person was still alive." | 11.67 (6.30) | 140 (4-26) |

#### *4.4.1.3 Procedure*

The participants were welcomed in dyads so that both participants of a dyad were informed about the presence of a “real” peer learner, but they did not know each other beforehand. They were told that the study was about solving criminal law cases by means of a computer-supported environment, and that they would get to know different problem solving strategies. After this, the participants of the dyads were guided to separate rooms. At the beginning of the study, all participants worked individually. Figure 7 provides an overview of the phases of the experiment.

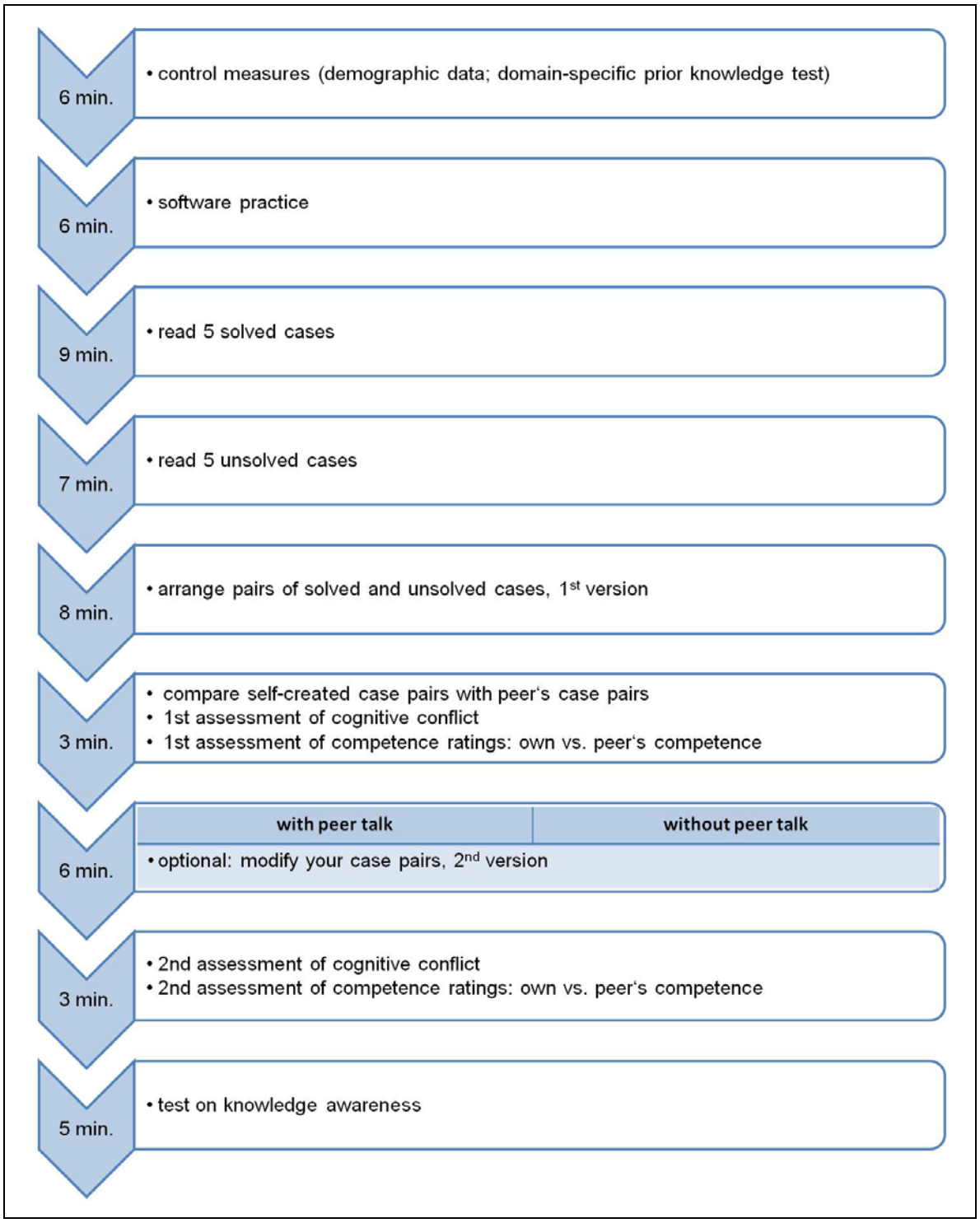


***Figure 7.*** *Overview of the Phases of Experiment 2 and Their Duration in Minutes.*

First, the participants filled in a web form (6 minutes) assessing control measures, such as demographic data and domain-specific prior knowledge (German case law). Then the participants practiced using CmapTools (6 minutes). Following this, they were asked to read through five solved cases from the domain of criminal law (9 minutes). The participants returned the solved cases to the experimenter, received five unsolved cases from the same domain, and again were asked to read them through (7 minutes). Subsequently, the five solved cases were handed out again, and the participants were asked to build pairs of the unsolved cases and the solved cases (8 minutes) by means of a computer-based external representation of all cases (CmapTools). For each unsolved case, the solved case that was supposed to be identified was the one whose solution could be transferred best to this unsolved case. To this end, the participants dragged the colored text boxes (i.e., unsolved cases) next to the grey text boxes (i.e., solved cases) on the screen. After this, the computer-based external representation was extended on the right side to display the case pairs of the peer (see Figure 6). The participants were informed that the presented case pairs had been created by the peer learner whom they had met at the beginning of the experiment. The participants were asked to compare their self-created case pairs with those of the peer learner. Additionally, all participants received the three cognitive conflict items and the two competence rating scales. They had three minutes for comparing the case pairs and for giving cognitive conflict and competence ratings. Subsequently, the participants were randomly assigned to one of two conditions: In the peer talk condition, they were asked to explain mutually to each other why they had arranged the case pairs in this way. They communicated by using “SkypeTM”, a free internet phone software (see, http://www.skype.com). The participants were

informed that their talk would be recorded. Moreover, they had the possibility to modify their self-created case pairs, if they wished to. They were told that the aim of this phase was to identify the correct task solution and that this did not require coming to an agreement with the peer. The participants of the peer talk condition had six minutes for communicating and for modifying their case pairs. To keep time-on-task constant between both conditions, the participants of the no peer talk condition also had six minutes for modifying their case pairs. They were also told that the aim was to identify the correct solution which did not require bringing one's own case pairs into agreement with the peer's case pairs. In both the peer talk and no peer talk condition, the participants could view which changes the peer learner made to his or her case pairs in real-time (i.e., the colored text boxes on the right side of the external representation started moving when the peer dragged them to a new position). Subsequently, all participants again received the three cognitive conflict items and the two competence rating scales for providing their second ratings (3 minutes). During this phase, the computer-based external representation with the self-created and the additionally presented case pairs of the peer was still present. The online test on knowledge awareness followed in both conditions (5 minutes). Overall, the experimental session lasted about 60 minutes. At the end of the experiment, the participants were thanked, rewarded, and debriefed.

### 4.4.2 Results

All analyses were performed on the dyadic mean values of the individuals because peer talk and its effects can only be interpreted meaningfully on the dyadic level. For testing the hypotheses, mainly multiple linear regression analyses were

conducted using IBM SPSS Statistics 20. The alpha level was set at .05. Cohen's *d* is reported as effect size measure, adjusted for multiple predictors and interactions. By convention, *d* effect sizes of 0.2, 0.5, and 0.8 are interpreted as small, medium, and large, respectively (Cohen, 1988). First, we will present the results of the control measures, then the results regarding the impact of peer talk on cognitive and performance-related aspects, followed by the results of the content analysis of discourse.

#### *4.4.2.1 Results of the Control Measures*

With regard to the *demographic data* "gender distribution across dyads" (Pearson-$\chi^2$ (2, $N$ = 29) = 2.05, $p$ > .10) and "age" ($F$ < 1), no statistically significant differences were found between the peer talk (coded by 1) and no peer talk condition (coded by 2). Further, the two conditions did not differ in their average *domain-specific prior knowledge* which was low ($M_{pt}$ = 0.08; $SD$ = 2.47; $M_{npt}$ = 0.44; $SD$ = 2.28), $F$ < 1.

It was also tested whether both conditions had acquired knowledge awareness, that is, whether the learners were informed about their peer's task solution. An ANOVA showed no differences between both conditions on the *test on knowledge awareness*, $F$ < 1. That is, participants of both conditions reproduced the case pairs of the peer learner equally well ($M_{pt}$ = 3.38; $SD$ = 1.16; $M_{npt}$ = 3.28; $SD$ = 1.11). Thus, the dyads of both conditions had acquired an equally high amount of knowledge awareness regarding the peer's case pairs.

In addition, match of the first version of case pairs as the selection criterion of the final sample was checked statistically. As intended, both conditions did not differ regarding how many case pairs of the first self-created version matched

within the dyads of peer learners ($M_{pt}$ = 1.69; *SD* = 0.63; $M_{npt}$ = 1.38; *SD* = 0.62), $F(1,27) = 1.85$; $MSE = 0.39$; $p > .10$. All selected participants created a first version of case pairs which deviated from their peer learner's case pairs. In 41% of all selected dyads (*n* = 12), none or only one of the case pairs of the first version matched, whereas in the remaining 59% of all selected dyads (*n* = 17), two of the five case pairs matched. Thus, divergence between self-created task solution and additionally presented peer solution was sufficiently high as a prerequisite for the experience of a cognitive conflict and for investigating adaptation behavior. Since match vs. divergence of task solutions was regarded as the crucial source of experiencing a cognitive conflict and of guiding behavior (e.g., adaptation) and peer talk, the variable "match" was included as a further predictor in the following analyses.

#### *4.4.2.2 Results on the Impact of Peer Talk on Cognitive Aspects*

It was tested whether peer talk helps to resolve cognitive conflicts and whether peer talk results in more similar ratings for both one's own task competence and for the peer learner's task competence.

As expected, the two conditions did not differ regarding the experience of a *cognitive conflict* at the first assessment, β = -.12, $p = .54$, $R^2_{adj} = .00$, $F(2, 28) = 1.03$, $p = .37$, $d = 0.07$ (match of the first case pair version: β = .21, $p = .28$; see Table 10). However, as expected (Hypothesis 1), after communicating with each other, participants experienced less *cognitive conflict* at the second assessment compared to participants who did not communicate with each other, β = .42, $p = .01$, $R^2_{adj} = .35$, $F(3, 25) = 6.03$, $p < .01$ , $d = -0.28$ (match of the first case pair version: β = .35, $p = .04$; cognitive conflict at the first assessment,

β = .43, *p* = .01; see Table 10). Thus, the first hypothesis was confirmed that peer talk helps to reduce cognitive conflicts in this setting.

***Table 10***

*Means (and Standard Deviations) of Cognitive and Performance-Related Aspects at the First and Second Assessment*

| Variable category | Variable and measurement time | Condition with peer talk ($n_{pt}$ = 13) *M* *(SD)* | Condition without peer talk ($n_{npt}$ = 16) *M* *(SD)* |
|---|---|---|---|
| Cognitive aspects | Cognitive conflict (z-score), 1st assessment | 0.34 (0.93) | 0.09 (0.54) |
| | Cognitive conflict (z-score), 2nd assessment | -0.54 (1.32) | 0.07 (1.02) |
| | Difference of competence ratings, 1st assessment | -15.00 (26.30) | -6.25 (16.07) |
| | Difference of competence ratings, 2nd assessment | -9.23 (14.56) | 5.63 (11.81) |
| Performance-related aspects | Adaptation (overall) of own case pairs to peer's case pairs | 1.27 (0.97) | 1.03 (0.92) |
| | Adaptation of own case pairs to peer's correct case pairs | 0.19 (0.25) | 0.31 (0.36) |
| | Adaptation of own case pairs to peer's false case pairs | 0.12 (0.30) | 0.00 (0.00) |
| | Correctness of 1st version of case pairs | 1.38 (0.46) | 1.34 (0.35) |
| | Correctness of 2nd version of case pairs | 1.50 (0.61) | 1.59 (0.38) |

Further, already before communicating with each other, participants of the peer talk condition rated the peer's competence higher than their own competence, compared to participants of the no peer talk condition, β = .35, $p$ = .05, $R^2_{adj}$ = .27, $F(2, 26) = 6.12$, $p < .01$, $d$ = -0.01 (match of the first case pair version: β = .54, $p < .01$; see Table 10). This was in contrast to our expectations. Therefore, this first assessment was used as a second covariate (beside match of the first version of case pairs), when analyzing the competence difference at the second assessment point of time. In line with Hypothesis 2, at the second assessment, participants of the peer talk condition still rated the peer's competence higher but more similar to their own competence, whereas participants of the no peer talk condition rated their own competence higher than the peer's competence, β = .33, $p < 01$ ., $R^2_{adj}$ = .78, $F(3, 25) = 33.06$, $p < .001$ , $d$ = -0.02 (match of the first case pair version: β = -.04, $p < .72$; competence difference rating at the first assessment: β = .78, $p < .001$). This finding supports the second hypothesis.

To sum up, the reported results confirm the set of hypotheses concerning the impact of peer talk on cognitive aspects. In line with the hypothesis, peer talk helped to resolve cognitive conflict since learners were more convinced about the peer's solution and had less doubts about his or her task-relevant competence and the correctness of his or her solution compared to learners who did not communicate with each other. Moreover, the hypothesis was confirmed that learners judge their task-relevant competence more similarly to their peer's competence after communicating with him or her.

#### 4.4.2.3 Results on the Impact of Peer Talk on Performance-Related Aspects

The present study also examined whether peer learners mutually adapt their task solutions more often after communicating with each other. In addition, it was tested whether the correctness of the task solution improves as a result of peer talk.

Contrary to the assumptions (Hypothesis 3), participants of both conditions did not differ in their overall *adaptation behavior*, β = -.27, $p$ = .12, $R^2_{adj}$ = .25, $F(2, 26) = 5.70$, $p < .01$ , $d$ = 0.05 (match of the first case pair version: β = -.56, $p < .01$). Thus, participants of both conditions did neither differ in adopting *correct case pairs* of their learning partner (β = .07, $p$ = .71, $R^2_{adj}$ = .21, $F(2, 26) = 4.72$, $p$ = .02 , $d$ = -0.01; match of the first case pair version: β = -.50, $p < .01$), nor in adopting *false case pairs* (β = -.25, $p$ = .20, $R^2_{adj}$ = .03, $F(2, 26) = 1.42$, $p$ = .26 , $d$ = 0.49; match of the first case pair version: β = .14, $p$ = .49). Consequently, the third hypothesis regarding the impact of peer talk on adaptation of task solutions must be rejected in this setting.

Further, the two conditions did not differ in the *correctness of task solutions* at the first assessment, β = .06, $p$ = .74, $R^2_{adj}$ = .13, $F(2, 26) =$ , $p$ = .06 , $d$ = -0.21 (match of the first case pair version: β = .45, $p$ = .02). At the second assessment, participants of both conditions achieved a significantly higher correctness compared to the first assessment, β = .76, $p < .001$, $R^2_{adj}$ = .42, $F(3, 25) = 7.79$, $p$ = .001 , $d$ = -0.47 (match of the first case pair version: β = -.29, $p$ = .09). In contrast to the expectations (Hypothesis 4a), however, no differences were found between both conditions (β = .06, $p$ = .67, $d$ = -0.27). Further, a time-by-condition interaction emerged, β = -.31, $p < .04$, $R^2_{adj}$ = .50, $F(4, 24) = 8.01$, $p < .001$ , $d$ = -0.47 (match of the first case pair version: β = -.32, $p$ = .05; see Table 10). Thus, rejecting Hypothesis 4a), peer talk did not result in larger improvements of

the correctness of task solutions compared to no peer talk (β = -.15, *p* = .48). Instead, the learners without peer talk tended to improve the correctness of their solutions more than the learners with peer talk (β = .41, *p* = .06).

In summary, the set of hypotheses regarding the impact of peer talk on performance-related aspects could not be confirmed because peer talk resulted neither in learners mutually adapting their task solutions more often nor in a higher correctness of task solutions compared to no peer talk.

#### *4.4.2.4 Content Analysis of Discourse*

In order to find out why peer talk had a positive effect on cognitive conflict and competence ratings, but not on performance-related aspects, the associations between discourse content and cognitive aspects as well as correctness of the second version of case pairs as a performance-related aspect were analyzed. The focus was on the second assessment of the repeated measures, that is, after peer talk took place. Due to the small sample size of twelve communicating dyads, Kendall's Tau-c coefficient as a non-parametric test of the association between variables was used.

First, associations of the discourse content with the two cognitive measures "cognitive conflict" and "difference of competence ratings" (self-rating of one's own vs. peer's competence) are reported, controlling for match of the first version of case pairs (cf. Table 11).

Dyads tended to rate the peer's solution to be more convincing, and they tended to have less doubts about the correctness of the peer's solution and the peer's competence, the more often they talked about similarities between cases (*Kendall's Tau-c* (9) = -.40, *p* = .07), and the less they understood the task, the

cases, or case features (*Kendall's Tau-c* (9) = -.62, $p < .01$). It seems that, in the first case, the dyads talked about good task solutions, while in the second case, the dyads developed explanations which were helpful to understand the task. Thus, both kinds of discourse content were associated with a decrease in perceived cognitive conflict.

***Table 11***

*Associations (Kendall's Tau-c, n = 9) Between Discourse Content and Cognitive Measures After Discourse*

| | Cognitive conflict, 2nd assessment | Difference of competence ratings, 2nd assessment |
|---|---|---|
| Identification of similar cases | -.40$^{t}$ | -.17 |
| Expression of understanding | .35$^{t}$ | .20 |
| Request for peer-explanation | .59$^{*}$ | -.53$^{**}$ |
| Expression of lack of understanding | -.62$^{**}$ | -.63$^{***}$ |
| Task coordination | .18 | -.07 |
| Identification of dissimilar cases | .10 | .07 |
| Competence self-rating and peer-rating | -.10 | -.20 |
| Exploratory talk I ('I think') | .03 | .10 |
| Exploratory talk II ('because') | .03 | -.13 |

*Note:* $^{***}p \leq .001$, $^{**}p \leq .01$, $^{*}p \leq .05$, $^{t}p \leq .10$.

On the other hand, the more often dyads had to ask for explanations of why the partner had built specific case pairs, the less convincing they rated the peer's

solution to be and the more doubts they had about the correctness of the peer's solution and about the peer's competence after the peer talk phase, *Kendall's Tau-c* (9) = .59, $p$ = .02. Similarly, the more often a partner expressed that he or she did understand aspects of the task, the less convincing they tended to rate the peer's deviating solution to be and the more doubts they tended to have about the correctness of the peer's deviating solution and about the peer's competence after the peer talk phase, *Kendall's Tau-c* (9) = .35, $p$ = .08. Thus, both requesting peer explanations and expressing that one had understood the task was associated with an increase in perceived cognitive conflict.

Further, the more often dyads had to ask for explanations of why the partner had built specific case pairs, the lower they rated their own competence in relation to the peer's competence after the peer talk phase, *Kendall's Tau-c* (9) = -.53, $p$ = .01.

Similarly, the more often dyads expressed that they did not understand the task, the cases, or case features, the lower they rated their own competence and the higher they rated the peer's competence after the peer talk phase, *Kendall's Tau-c* (9) = -.63, $p$ < .001.

Second, associations between discourse content and the performance-related measure "correctness of the second version of case pairs" are reported, again controlling for match of the first version of case pairs (cf. Table 12).

The more often dyads talked about similarities between cases, the more correct was the second version of their case pairs, *Kendall's Tau-c* (9) = .61, $p$ < .001. This association corresponds with Hypothesis 4b) stating that high-quality peer talk about the core elements of the task should improve the correctness of

task solutions. Thus, identifying similarities was both associated with a trend towards conflict resolution and with more correct task solutions.

***Table 12***

*Associations (Kendall's Tau-c, n = 9) Between Discourse Content and Performance-Related Aspects After Discourse*

| | Correctness of 2nd version of case pairs | Improvement (+1) vs. deterioration (-1) of correctness of 2nd version of case pairs |
|---|---|---|
| Identification of similar cases | .61*** | .15 |
| Expression of understanding | -.09 | .54** |
| Request for peer-explanation | -.42t | -.19 |
| Expression of lack of understanding | .15 | .04 |
| Task coordination | -.56* | -.15 |
| Identification of dissimilar cases | .33 | .70*** |
| Competence self-rating and peer-rating | -.17 | -.48* |
| Exploratory talk I ('I think') | .46t | .67* |
| Exploratory talk II ('because') | -.51t | -.33 |

*Note:* $^{***}p \leq .001$, $^{**}p \leq .01$, $^{*}p \leq .05$, $^{t}p \leq .10$.

On the other hand, the more often dyads tended to ask for explanations of why the partner had built specific case pairs (*Kendall's Tau-c* (9) = -.42, $p = .08$) and the more often dyads talked about how to proceed with the task (i.e., task coordination), the less correct was the second version of case pairs, *Kendall's*

*Tau-c* (9) = -.56, $p$ = .03. Thus, coordination problems were associated with decreased correctness of task solutions.

The more often dyads used the reasoning word ‘I think’ (exploratory talk, cf. Mercer, 1995, 2000), the more correct tended the second version of case pairs to be, *Kendall’s Tau-c* (9) = .46, $p$ = .08. However, the occurrence of the word ‘because’ as a further indicator of exploratory talk tended to be associated with a less correct second version of case pairs, *Kendall’s Tau-c* (9) = -.51, $p$ = .08. This pattern of findings corresponds only partly with Hypothesis 4b) because, in this study, only some of the typical indicators of exploratory talk (i.e., the reasoning word ‘I think’) and not all indicators analyzed (e.g., the reasoning word ‘because’) were associated with an improved correctness of task solutions.

Moreover, based on the initial level of correctness of task solutions, it was analyzed which discourse content was associated with improved or decreased correctness of task solutions.

The more often dyads expressed that they had understood either the case features or the explanations exchanged for building specific case pairs, the more often did the correctness of case pairs improve, *Kendall’s Tau-c* (9) = .54, $p$ = .01. In addition, the more often dyads talked about dissimilar cases, the more they enhanced the correctness of their solutions, *Kendall’s Tau-c* (9) = .70, $p < .001$. On the other hand, the more often dyads expressed doubts about either their own task-relevant competence or the peer’s competence, the more they impaired correctness of task solutions, *Kendall’s Tau-c* (9) = -.48, $p$ = .03. Thus, it can be concluded that exchanging good explanations as well as talking about the core of the task was associated with improved performance (Hypothesis 4b), whereas

talking about competences was associated with decreased correctness of task solutions.

Moreover, the reasoning word ‘I think’ as an indicator of exploratory talk (cf. Mercer, 1995, 2000) was associated with improved correctness of task solutions, *Kendall’s Tau-c* (9) = .67, *p* = .01.

This confirms Hypothesis 4b) stating that only high-quality dialogic discourse helps to improve the correctness of task solutions.

## 4.5 Summary and Discussion

This second study of the present dissertation investigated the impact of peer talk on cognitive and performance-related aspects while completing a computer-supported cognitive conflict task. In the *peer talk condition* (13 dyads), participants compared their task solution with a peer learner’s solution that deviated from their own solution; subsequently, both learners explained their task solutions to each other. In the *no peer talk condition* (16 dyads), the participants also compared their task solution with the deviating solution of a peer learner, but both learners had no possibility to communicate with each other.

This study shows as expected that computer-mediated peer talk helps to resolve cognitive conflicts (cf. Harmon, 1998) because dyads after peer talk were more convinced about the peer’s solution and had less doubts about the peer’s task-relevant competence and the correctness of his or her solution compared to dyads without peer talk. Thus, even a very short computer-mediated discourse phase can be sufficient for conflict reduction which is a new finding. However, a

longer discourse phase could have different effects: For example, it could result in more co-construction of knowledge, that is, in learners discussing task solutions in more detail and in mutually identifying the optimal task solution. In addition, personality traits could unfold during a longer discourse phase. For example, more dominant learners could persuade their partners to adopt aspects of their own solution. However, only deliberate adaptation of solutions should result in higher correctness (cf. Chapter 3; Baumeister et al., subm. a).

A further positive aspect of peer talk was that the learners rated the peer's competence to be more similar to their own competence than the learners of the no peer talk condition who rated their own competence higher than the peer's competence. Since participants of both conditions were laypersons in the subject-matter domain, it seems that peer talk resulted not only in more similar, but also in more accurate competence ratings. The finding of converging competence ratings due to peer talk is consistent with results of previous studies (e.g., Jeong & Chi, 2007), although, in the present study, a more subjective measure of knowledge convergence was used. It can be assumed that subjective measures of knowledge convergence are appropriate if learning partners work through completely identical information such as in the presented study.

In spite of decreased doubts about the peer's competence and the correctness of his or her task solution, peer talk did not result in more often adopting the peer's task solution. However, mutual adaptation of task solutions is not necessarily the best decision for solving problems because it could also be harmful for one's performance if the learner adopts false aspects of the peer's task solution. In this regard, the present finding of a lack of adaptation is in line with assumptions of conflict elaboration theory stating that peer solutions, compared to

expert solutions that deviate from one's own solution, are evaluated more critically and encourage learners more to find the correct solution (Mugny et al., 1995); in contrast, expert solutions are more often imitated uncritically (Quiamzade & Mugny, 2001).

Further, this dissertation's second study tested whether the correctness of the task solution improves as a result of peer talk. This was not the case. Instead, the correctness of task solutions improved both in the peer talk condition and in the no peer talk condition when the learners created their second version of task solutions. It can be concluded that, in this type of task, learners who are confronted with a peer's solution that deviates from their own solution gradually improve in identifying structurally similar cases even if they do not receive peer explanations concerning the peer's deviating solution. Thus, the possibility to compare solutions may be helpful to improve one's performance even without the possibility to receive a peer's explanations (cf. Chapter 3; Baumeister et al., subm. a). However, in this dissertation's first study (Baumeister et al., subm. a), using the same computer-supported cognitive conflict task, no improvement of task solutions was found in the peer condition in which there was no talk. Beside this different pattern of findings, a further difference between the previous study and the present study was that in the first study, the computer-supported external representation (Study 1: Figure 3; Study 2: Figure 6) displaying the solution of the peer learner did not change whereas in the present study, the peers could observe in real-time how the learning partner changed his or her task solution. One explanation for this different pattern of findings across both studies could be that observing by means of a computer-based external representation how another learner is modifying his or her task solution provides an affordance for considering further changes of one's

own task solution (Suthers, 2006) even if the learning partner does not try to convince the learner to modify the own task solution. However, the time dimension, that is, whether the computer-based external representation displays the partner's task solution statically versus dynamically, should be varied within one study in order to substantiate this assumption.

In addition, previous studies have shown that discourse is especially helpful for solving complex or information-rich tasks which often involve multiple steps, sometimes with increasing difficulty (Engelmann et al., 2010a; Hirokawa, 1999). Such tasks often result in cognitive overload of individual problem solvers, and therefore, discourse as 'interthinking' (Mercer, 2000) can help to distribute solution procedures among learners. Further, awareness tools have been proven to be helpful in order to support both collaborative problem solving and reasoning during dialogic discourse (e.g., Engelmann et al., 2009; Buder & Bodemer, 2008; De Groot et al., 2007; Janssen & Bodemer, 2013; Wegerif et al., 2010).

The content analysis of discourse revealed that learners reacted quite differently to the deviating task solution of their peer. Some learners used the discourse phase to express that they were not at all confident about having understood the task; it seems that this increased or improved peer explanations because, afterwards, those learners were convinced about the peer's solution. Some learners needed to ask the peer quite often to explain his or her solution; perhaps this was due to poor explanations (cf. Webb, 1989; Webb et al., 1995) or to strange task solutions of the peer because those learners were less convinced about the peer's solution afterwards. Thus, it seems that peer talk resulted in two types of learners: those who had more doubts about the peer's task-relevant competence and the correctness of the peer's solution, and those who had less

doubts and were more convinced about the peer's solution than about their own solution. This mixed finding shows that effects of peer talk on socio-cognitive conflicts are not clear-cut per se. Peer talk can increase or decrease cognitive conflicts (or sometimes can have no effect). Further studies with larger samples and more process measures are needed for investigating, for example, under which conditions computer-mediated peer talk supports the resolution of socio-cognitive conflicts reliably.

In line with the assumptions of conflict elaboration theory (Quiamzade & Mugny, 2001), as well as with the results of a study by Darnon and colleagues (2007), in this second study of the present dissertation, talking about one's own or the partner's competence was associated with less correct solutions, perhaps because it distracted learners from the core task. Thus, by talking about competences, the learners were more engaged in a relational conflict (i.e., "who is more competent?") than in an epistemic conflict using exploratory talk (i.e., "how can we find the correct solution?"; Mercer, 1995, 1996, 2000).

Moreover, it was shown that aspects of exploratory talk had a differential impact on learners' performance: On the one hand, the reasoning words 'I think' were associated with improved correctness of task solutions. On the other hand, the reasoning word 'because' tended to be associated with less correct task solutions. Although research has shown that such reasoning words (and their synonyms) are associated with high-quality discourse (Mercer, Wegerif, & Dawes, 1999; Soter et al., 2008; Teasley, 1997), only 'I think' was associated with an improved performance in this study. Inspection of the transcripts revealed that the reasoning word 'because' indeed was not always used in a deliberate and appropriate way by adult learners. Instead, it was sometimes used as a filler word

in order to gain time for further consideration (e.g., “Well, because, hm, because, in the end, hm, yes, that is wrong.”), and sometimes only fragments of arguments were brought up (e.g., “Yes, because the doctor – no, that makes no sense.”; “This is very simple because it is bodily harm with fatal consequences, but -.”). Since learners did not interrupt each other frequently, it can be excluded that interruptions were the reason for fragmentary arguments. Instead, it could be possible that media effects on sentence length could be a reason for the heterogeneous findings regarding exploratory talk in this study. That is, ‘I think’ often was used in very short sentences, whereas ‘because’ usually requires a main clause and a subordinate clause. This longer sentence structure could have caused a higher working memory load of learners using synchronous audio communication resulting in incomplete statements if learners lost the thread (Baddeley, 2003). Perhaps text-based communication (e.g., chat) or asynchronous media (e.g. discussion forums) would have resulted in a more effective spontaneous use (i.e., without training) of exploratory talk, especially in more complete and more elaborated claims using ‘because’.

Moreover, the content analysis of discourse revealed associations between discourse content and learners’ performance. Learners who focused on understanding the core of the task, namely, identifying structurally similar cases in order to arrange them in pairs were more successful. In contrast, learners who centred their peer talk on task coordination (e.g., which case pair to talk about next) were less successful. Similar results have been shown by several studies investigating text-based computer-mediated communication (chat, discussion forums, e-mail) of synchronous and asynchronous online learning groups (e.g., Paulus, 2009; Strømsø et al., 2007). These studies found that students using

computer-mediated communication often communicated “off-topic”, that is, not about the concepts to be learned but instead about procedures for completing the task, for example, technical issues. Paulus (2009) argues that off-topic communication seems to be an integral part of students’ grounding processes in distance learning environments (cf. Clark & Schaefer, 1989) and that distance learning groups need enough time both for on- and off-topic communication (cf. Orvis, Wisher, Bonk, & Olson, 2002).

## 4.6 Conclusions

To sum up, in this dissertation’s second experimental study, there is a mixed balance of findings regarding the impact of computer-mediated peer talk on completing a cognitive conflict task: Peer talk had a positive impact on some cognitive aspects; that is, peer talk helped to reduce cognitive conflict by increasing confidence in the peer learner’s competence and the correctness of his or her task solution. Moreover, peer talk resulted in more similar and thus more accurate ratings of one’s own and the partner’s competence compared to no peer talk. No effect of peer talk, however, was found regarding the performance-related measures “mutual adaptation of task solutions” and “correctness of solution”. However, the content analysis of discourse revealed that particular aspects of high-quality reasoning and discourse were associated with improved performance (cf. Mercer, Dawes, Wegerif, & Sams, 2004; Teasley, 1997; Webb, Troper, & Fall, 1995). In line with previous field studies (e.g. Paulus, 2009; Strømsø, Grøttum, & Lycke, 2007), the present laboratory study also suggests that it is important for

learners to focus on core elements of the task instead of talking about how to proceed or about competences. However, future studies with larger samples and a longer duration of the peer talk phase than in the present study are needed in order to substantiate the present findings and conclusions. Further, the impact of knowledge awareness as observing how other learners change their task solutions on improving one's own solution should be clarified by future studies.

# Overview – Part III

The aim of this second experimental study was to strengthen *peer influence*, compared to the first study, in the context of this knowledge-rich cognitive conflict task. The results of Study 2 showed that especially *high-quality peer talk* was associated with more correct task solutions. Thus, it can be concluded that peer talk had a positive impact on task solutions if peers talked about their understanding of the task instead of talking about their task-relevant competence.

Across both studies, time on task was virtually identical. However, a direct, statistical comparison of the correctness of task solutions in the peer condition of Study 1 and the peer talk condition of Study 2 is not possible due to other differences between these conditions. For example, in Study 1, *static knowledge awareness* was applied, whereas in Study 2, *dynamic knowledge awareness* was implemented. Therefore, comparing both studies only descriptively, the correctness of task solutions generally improved in Study 2 across both conditions, whereas it did not improve in the peer condition of Study 1. Further studies will have to prove whether this pattern of results was caused by static (Study 1) versus dynamic (Study 2) knowledge awareness. It could be possible that observing in real-time how another learner is modifying his or her task solution (i.e., dynamic knowledge awareness) additionally encourages learners to improve their own task solution (cf. *technology affordances* & *representational guidance*; Suthers, 2006) beyond being informed only once about another solution (cf. Study 1: static knowledge awareness). In the following chapter, the aims and results of this dissertation project will be summarized and discussed, and implications for future studies will be derived.

# 5 General Discussion

One aim of the present dissertation was to contribute to research on *knowledge awareness* (Engelmann, Dehler, Bodemer, & Buder, 2009) by suggesting a classification which combines the previous ones of Engelmann and colleagues (2009: *context-based*, *content-based*, & *hybrid knowledge awareness*), Sangin, Molinari, Nüssli, and Dillenbourg (2011: *subjective* vs. *objective knowledge awareness*), and of Ogata and Yano (1998: *activity-based knowledge awareness*) with the awareness features described by Maybury, D'Amore, and House (2002: *explicit* vs. *implicit awareness information*, & *static* vs. *dynamic awareness information*) in the context of CSCW and *expertise awareness*. *Knowledge awareness* (Engelmann et al., 2009) is a type of *cognitive group awareness* (Janssen & Bodemer, 2013) defined as "an individual's state of being informed and having perceived information about others' knowledge", that is, especially others' *externalized task-relevant knowledge* (Engelmann et al., 2009, p. 950). Similarly, *expertise awareness* can be defined as being informed about various aspects of others' expertise, for example, their "type and level of expertise" (Maybury et al., 2002, p. 204), their activities in their area of expertise, and changes to their area of expertise (Dörner, Pipek & Won, 2007; Reichling & Wulf, 2009; Vivacqua, 1999). In this dissertation, CSCL studies in which the distributed participants interacted with and learned from partners who had an equal level of expertise regarding the subject-matter domain of the task conducted in the studies were categorized as researching knowledge awareness (e.g. Bodemer, 2011), including this dissertation's both experimental studies. In contrast, CSCW studies which involved distributed professional cooperation with or help seeking between interaction

partners who showed a larger asymmetry of the level of expertise regarding the subject-matter domain of the task conducted in the studies were categorized as researching expertise awareness (e.g. Nückles & Stürz, 2006; Reichling & Wulf, 2009). By means of a literature review of 30 computer-based applications for supporting knowledge or expertise awareness and a review of 20 published studies which contributed to clarifying the psychological effects of knowledge or expertise awareness and which were conducted in the past 16 years, and including this dissertation's two studies submitted for publication, it was shown that it is important to further differentiate the subcategories of knowledge awareness and expertise awareness. The combined classification (Baumeister, Engelmann, Cress, & Hesse, in prep.) helps to predict the psychological effects of knowledge awareness and expertise awareness more thoroughly and to derive implications concerning the question of when to use which subcategory of knowledge awareness and expertise awareness in order to optimize CSCL and CSCW settings.

A further aim of this dissertation was to integrate research on knowledge awareness (Engelmann et al., 2009) and research on the *conflict elaboration theory* (Mugny, Butera, Sanchez-Mazas, & Pérez,1995; Quiamzade & Mugny, 2001). This theory aims at predicting under which conditions social influence in the context of *cognitive conflict tasks* can support or hinder learning. "Cognitive conflict is a perceptual state in which one notices the discrepancy between one's cognitive structure and the environment (external information) …" (Lee et al., 2003, p. 585).

It was shown that providing learners with knowledge awareness information about a task solution that deviates from their own in combination with explicit information about the expertise of the producer of the deviating task solution (e.g.,

a peer vs. a textbook of the subject-matter domain) by means of a computer-supported external representation indeed results in knowledge awareness, and it is well suited for sparking a *cognitive conflict* (Lee et al., 2003) and for testing and extending assumptions of the conflict elaboration theory (Mugny et al., 1995; Quiamzade & Mugny, 2001).

For this purpose, two experimental studies were conducted investigating the impact of knowledge awareness regarding a higher competence source (Study 1) and regarding an equally low competent source combined with *peer talk* (Study 2) in the context of completing a *knowledge-rich cognitive conflict task* (i.e. identifying structural similarities between law cases; Nievelstein, van Gog, Boshuizen, & Prins, 2010). Thus, the first study focused on the relative impact of a high competent source of a cognitive conflict compared to a low competent source in a context without interaction between source and target person (cf. Butera, Caverni, & Rossi, 2005). The second study aimed at fostering the low competent source's influence by means of *peer talk* (Mercer, 1995; Teasley, 1995).

## 5.1 Discussion of Main Findings

The combined classification of knowledge awareness in CSCL and expertise awareness in CSCW introduced in Chapter 2 showed that it is important to differentiate whether the awareness information regarding the users' *level of expertise* is *explicitly* provided, for example, by using labels such as "layperson", "novice" or "expert" (e.g., Bromme, Jucks, & Rambow, 2004; Bromme, Rambow, & Nückles, 2001; Mugny, Tafani, Butera, & Pigière, 1998), or *implicitly* provided, for

example, by enabling audio or text communication in the computer-based interaction space. Further, it is important to differentiate whether the awareness information is provided only once which was called *static knowledge awareness information* or whether users can observe changes to others' knowledge or expertise in real-time which was called *dynamic knowledge awareness information* (cf. Engelmann et al., 2009).

Categorizing studies implementing knowledge or expertise awareness information in the past 16 years highlighted that these studies applied various configurations of the dimensions of knowledge awareness and expertise awareness. The configuration of knowledge awareness information implemented in the two studies of this dissertation is outlined in Table 2 (Chapter 1). Three of the four newly suggested subcategories of knowledge awareness information were implemented in the studies, namely, an explicit level of expertise (Study 1 & 2), static knowledge awareness information (Study 1), and dynamic knowledge awareness information (Study 2). Further studies are needed to investigate systematically the impact of each of the subcategories of knowledge awareness, for example, by keeping constant as many of the other subcategories as possible.

In addition, the specific function of each subcategory of knowledge awareness in CSCL and expertise awareness in CSCW was described. For future CSCL studies, it could be interesting, for example, to identify which instructional method goes especially well with a subcategory of knowledge awareness. As tentative first suggestions that need to be examined, one could imagine combining, for example, *reciprocal teaching* (Palincsar & Brown, 1984) with subjective knowledge awareness information because both approaches foster *peer explanations* (Teasley, 1995, 1997; Webb, 1985, 1991). Further, content-based

knowledge awareness could be used in the context of *anchored instruction* (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990) because both approaches support the integration of multiple sources of information in order to solve problems including multiple solution steps (e.g. Engelmann et al., 2009; Engelmann & Hesse, 2010; Engelmann, Baumeister, Dingel, & Hesse, 2010a; Engelmann, Tergan, & Hesse, 2010b).

In the following sections, the results of the two experimental studies will be discussed. In the first study, students in two conditions ($N$ = 59) compared their self-created task solution with a partly correct solution presented additionally, deviating from their solution. The source label of the presented solution indicated either an equally low competent (“peer”) or a high competent source (“textbook”) whereas the presented solution was identical. A baseline condition lacked this possibility for comparison.

After comparing task solutions, students of the textbook condition achieved a more correct second task solution than students of the baseline condition who did not compare task solutions. This effect was small to medium ($d$ = 0.45). Since previous studies have already shown that comparing one’s task solution to a deviating solution helps problem solvers to improve their solution (Bodemer, 2011; Constantino-Gonzáles & Suthers, 2001), it can be concluded that this is a stable effect, across different types of problems (for the positive effect of such comparison processes on learning, see meta-analytic review by Alfieri, Nokes-Malach, & Schunn, 2013). However, in contrast to assumptions of the conflict elaboration theory (e.g. Quiamzade, Mugny, & Darnon, 2009), students of the peer condition were not superior to students of the baseline condition regarding correctness of the

second version of task solutions. This result corroborates the first study's argument that task complexity matters (cf. Alfieri et al., 2013): That is, in the context of knowledge-rich problems, a mere comparison of task solutions may not be enough in order to improve one's own solution if problem solvers have larger doubts regarding the presented deviating solution than about their own solution, which was the case in the peer condition. From previous studies conducted in the context of conflict elaboration theory (e.g. Butera et al., 2005; Quiamzade et al., 2009) as well as from this dissertation's studies, it can be concluded that well-defined problems (e.g. hypothesis testing, anagram tasks) are more suited for peer learning if peers can combine their individual solution strategies in order to co-construct the best solution (Quiamzade et al., 2009). In contrast, it seems that learning to solve knowledge-rich, complex problems requires more modeling, learning by imitation, interaction and feedback (cf. Bandura, 2006) than co-construction. Thus, learning to solve knowledge-rich problems is more suited for learning from a higher competence source. Further studies are needed in order to examine the generalizability of this conclusion and the impact of different forms of interaction between the source of the cognitive conflict and the target person.

Also in contrast to assumptions of the conflict elaboration theory (e.g. Quiamzade et al., 2009), students of the textbook condition experienced more cognitive conflict than students of the peer condition, whereas this theory would predict that low competent sources elicit stronger cognitive conflicts than high competent sources (Quiamzade et al., 2009). Cognitive conflict was a mediator of problem solver's adaptation behavior: That is, the more cognitive conflict was experienced, the more the problem solvers adapted their task solution to the presented one. This result is traced back to the knowledge-rich task applied. Since

such tasks require more time in order to identify solution strategies than the participants had, learners may have considered their own solution to be more plausible than the peer's solution. Therefore, they did not experience a high degree of a cognitive conflict in the peer condition. In contrast, learners confronted with the solution of a supposed textbook indeed had larger doubts about their own solution which resulted in adopting the presented solution more often in the textbook condition than in the peer condition. To date, there are only few studies that have measured perceived cognitive conflict (e.g., Darnon, Doll, & Butera, 2007; Heiß & Sander, 2010; Lee et al., 2003). These studies applied very different tasks and measured subjective cognitive conflict differently. Therefore, studies are needed that systematically compare cognitive conflict and its effects across different kinds of tasks, applying the same conflict measure.

Moreover, the presented source labels had a differential impact on adaptation behavior: Students of the textbook condition adopted more case pairs of the presented solution than students of the peer condition. This is in line with previous findings of conflict elaboration theory showing that the solutions of high competent sources generally are more often imitated than the solutions of low competent sources (Quiamzade et al., 2009; Quiamzade & Mugny, 2001). However, participants of the textbook condition and of the peer condition did not differ in how often they adopted the false aspect of the presented task solution. Instead, participants of the textbook condition selectively adapted their solution more often to the correct aspect of the presented solution than participants of the peer condition. Thus, a positive form of imitation (cf. Quiamzade & Mugny, 2001) occurred in the textbook condition. It can be assumed that learners focused on improving their own solution and did not just imitate the presented solution

uncritically. Since no interaction between the learners and the low or high competent source of the cognitive conflict occurred, the learners in the textbook condition were free to decide for or against adopting aspects of the presented solution. Therefore, they probably did not experience a competence threat (Buchs & Butera, 2009; Quiamzade & Mugny, 2001) which, in this situation, would have caused them to imitate both the correct and the false aspects of the presented solution uncritically.

Further, this first study of the dissertation showed that social comparison orientation (cf. Festinger, 1954) as an individual difference variable (e.g. Buunk & Gibbons, 2007; Gibbons & Buunk, 1999) is a relevant moderator of a problem solver's adaptation behavior in the context of this cognitive conflict task: Especially students with a low need for social comparison of ability adapted their solution more extensively in the textbook condition than in the peer condition. However, a mediated moderation analysis (Hayes, 2013) failed to show that the impact of the interaction between source labels and social comparison orientation on adaptation behavior is mediated by cognitive conflict. Instead, it seems that cognitive conflict as a mediator and social comparison of ability as a moderator exerted unique and independent effects on adaptation behavior in this first study. However, larger samples are needed in order to test whether this is a stable result.

The second experimental study of this dissertation investigated the impact of *peer talk* (cf. Mercer, 1995, 1996, 2000; Teasley, 1995, 1997; Webb, 1985, 1991) while learners completed a cognitive conflict task, being confronted with a peer's solution that deviated from their own solution. Fifty-eight participants were randomly assigned to either 13 dyads with peer talk or 16 dyads without peer talk.

All dyads compared their own task solution to their partner's deviating task solution by means of a computer-supported representation. Peer talk resulted in reduced perceived cognitive conflict. Larger samples are needed in order to corroborate the reliability of this finding. Moreover, this result probably depends on the type of task and the *quality of peer talk* (Mercer, 1995, 1996, 2000; Teasley, 1995).

After peer talk, peers *rated* their own *task-relevant competence* to be more similar to the task-relevant competence of their partner compared to those participants without peer talk. Thus, it is concluded that *knowledge convergence* (cf. Fischer & Mandl, 2005; Jeong & Chi, 2007) can be measured by means of subjective competence ratings of own versus peer's competence and that knowledge convergence occurred in this setting. To put it more simply: Peer learners felt that they had learned together or from each other. Since competence ratings generally increased from the first to the second measurement time, learners became more confident regarding their task-relevant competence. This dissertation recommends that studies applying cognitive conflict tasks in the context of peer learning generally should check both whether peers *objectively* and *subjectively* were able to learn from each other as it was done in Study 2. If this is not the case, for example, if learners are more uncertain about the correct solution and about their task-relevant competence after talking with the peer than before peer talk, the educational method of cognitive conflict has missed its target.

Peer talk did not result more often in *adapting* one's task solution to that of the peer. Moreover, peer talk overall did not result in improving the *correctness* of one's own solution. These findings further corroborate the pattern of results of the first study: In the context of a knowledge-rich, cognitive conflict task, peer learning might not be as effective as learning from a higher competence source – a finding

which is in contrast to previous assumptions of the conflict elaboration theory applying more well-defined problems (e.g. hypothesis testing, anagram tasks; Butera et al., 2005; Quiamzade et al., 2009). The reason for this may be because in such a complex task, peers doubt each other more and are less willing to adopt all parts of the peer's deviating solution in contrast to more well-defined problems. These problems allow for quick learning solution strategies from the peer, even in the course of a short experiment (cf. Quiamzade et al., 2009).

Further, the correctness of task solutions generally improved in Study 2 across both conditions. As already mentioned, this could be an effect of *dynamic knowledge awareness* because observing in real-time how another learner was modifying his or her task solution could have encouraged learners both of the peer talk condition and of the condition without peer talk to improve their own task solution (cf. *technology affordances* & *representational guidance*; Suthers, 2006). More studies with larger samples, a longer duration of the dialogic discourse phase and systematically varying static versus dynamic knowledge awareness within one and the same study are needed in order to examine the relative impact of peer talk versus talk with a more competent partner than oneself is and dynamic knowledge awareness in the context of a knowledge-rich task.

Further, the quality of the discourse content did matter in improving the correctness of task solutions: *Exploratory talk* (cf. Mercer, 2000) about one's understanding of the task was associated with a more correct solution, whereas talking about coordinating task completion was associated with a less correct solution. These findings are in line with those of several previous studies on online or distance learning showing that *epistemic talk* results in superior learning

outcomes than *off-topic talk* (e.g., Paulus, 2009; Strømsø, Grøttum, & Lycke, 2007).

In addition, talking about one's own or the partner's competence was harmful for task performance. This is in line with previous studies done in the context of conflict elaboration theory (cf. Darnon et al., 2007; Quiamzade & Mugny, 2001). This pattern of results highlights the special challenge for collaborative learning through cognitive conflict which is to foster *epistemic talk* (i.e., "how can we find the correct solution?") but not *relational conflict* (i.e., "who is more competent?").

### 5.1.1 Computer-Supported Cognitive Conflict Task

In the context of this dissertation, a *knowledge-rich*, *computer-supported cognitive conflict task* was developed: The learners who were laypersons in the domain of law were asked to build pairs of structurally similar solved and unsolved criminal law cases (cf. Nievelstein et al., 2010). Numerous combinations of case pairs were possible. This increased the probability of achieving divergence between the participant's task solution and the one presented and, thus, of sparking a cognitive conflict (Lee et al., 2003).

Particularly noteworthy is that the cognitive conflict task applied differed in *complexity* from the tasks applied in the context of the *conflict elaboration theory* (Mugny et al., 1995; Quiamzade & Mugny, 2001) because the previous studies tested assumptions of this theory by means of well-defined problems, for example, anagram tasks or hypothesis testing (cf. Butera et al., 2005; Quiamzade et al., 2009). Therefore, by means of this more knowledge-rich cognitive conflict task, the

aim was to extend assumptions of the conflict elaboration theory by proposing that previously proven *social influence dynamics* may change for more complex cognitive conflict tasks. In the next step, studies are needed varying task complexity within one and the same study thereby directly comparing conflict elaboration and social influence for well-defined versus more knowledge-rich, complex problems.

With regard to computer-support, it can be concluded that *dynamic knowledge awareness information* (Study 2), that is, the possibility to observe changes to others' knowledge and task solutions in real-time, is especially suited for investigating conflict elaboration processes because dynamic external representations both make divergence between learning partners visually salient which increases the probability of discussing such socio-cognitive conflicts (cf. Bodemer, 2011), and they mirror the resolution of these conflicts, for example, if the learning partners mutually adapt their task solutions.

Future studies could examine whether there are *gender differences* in conflict elaboration, perhaps depending on *context factors* such as the subject-matter domain of the cognitive conflict task and *anonymity* (cf. Chapter 2) of the conflicting contributions to a shared interaction space (cf. Hsi & Hoadley, 1997).

### 5.1.2 Perceived Cognitive Conflict

In the first study of the present dissertation, *perceived cognitive conflict* was measured *in retrospect* after the participants had been given the possibility to modify their case pairs. The item used for this assessment was: "I had doubts about one or more of my case pairs when I saw the other case pairs that were

provided" (to be answered on a 5-point rating scale). This item assesses one aspect of the component "recognition of contradiction" of the *Cognitive Conflict Levels Test* by Lee and colleagues (2003).

In the second study, perceived cognitive conflict was measured *"online"*, that is, simultaneously when being confronted with the peer's task solution which deviated from the participant's own solution. Since in this study among other questions, the impact of *peer talk* on cognitive conflict was examined, perceived cognitive conflict was measured once again after the peer talk phase in both conditions with versus without peer talk. The participants indicated whether they "had doubts regarding the correctness of the presented deviating task solution" of a peer and regarding the "peer's task-related competence", and whether the deviating task solution "did not convince" them (to be answered on 5-point rating scales).

In further studies on cognitive conflict, the use of such *subjective rating scales* can be recommended. In addition, it is possible to assess more aspects of a cognitive conflict, for example, *emotional* (e.g., "When I saw the result, I was surprised by it", cf. Lee et al., 2003, Figure 2, p. 59) and *motivational* aspects (e.g., "I would like to ascertain further whether my idea is incorrect or not", Lee et al., 2003, Figure 2, p. 59). For example, Heiß and Sander (2010) used selected items of the "Differentielle Affekt Skala" (DAS; Merten & Krause, 1993) in order to assess emotional aspects of perceived cognitive conflict, conflict resolution, and learning success. Using more than one item for measuring cognitive conflict offers a more reliable assessment, but the sample has to be large enough in order to conduct a factor analysis. In addition, research in this area should try to separate cognitive conflict as a *situational variable* from related *personality traits* that could also be

activated in this situation (e.g., neuroticism, Costa & McCrae, 1992; need for cognition, Cacioppo & Petty, 1982).

To conclude, both experimental studies revealed different aspects of the psychological course of a cognitive conflict: Study 1 showed that different sources of socio-cognitive conflict have a different impact on learners' behavior (cf. Mugny et al., 1995), whereby a higher competent source encouraged them more to improve the correctness of their task solutions by working on them and making changes than an equally low competent source. Study 2 suggested that peer talk can help to resolve cognitive conflicts. However, conflict resolution per se does not mean that the correctness of task solutions improves (cf. Light & Glachan, 1985). As both studies have shown, it depends on the *quality of the conflict resolution* (cf., Study 1: two kinds of imitating high competent sources; Quiamzade & Mugny, 2001) and on the *quality of the content of peer talk* (cf. Study 2: exploratory talk; Mercer, 1995, 1996, 2000).

## 5.2 Implications of Knowledge Awareness for Computer-Supported Collaborative Learning

This dissertation provided an overview and analysis of the strengths of the concept of knowledge awareness for supporting individual and collaborative computer-supported learning and its potential problems if unfavorable social influence dynamics are activated (cf. Chapter 2).

One implication of the suggested extended classification of knowledge awareness is that instructors should consider which subcategories of knowledge

awareness could be helpful for specific learning goals and tasks of computer-supported collaborative learning. For example, if a group of learners with *heterogeneous levels of expertise* (i.e., novices & intermediates; Bromme et al., 2001, 2004) are supposed to collaborate, providing *explicit information* about the *levels of expertise* should be avoided because this could result in an unfavorable social comparison for the less competent learners and, thus, in a *competence threat* (Buchs & Butera, 2009; Quiamzade & Mugny, 2001). Instead, heterogeneous groups could be provided with *subjective knowledge awareness information* in a more task-focused sense such as, for example, “I did not understand this point” rather than in a competence-focused sense such as “I am a layperson”, since subjective knowledge awareness, in combination with further subcategories such as context-based knowledge awareness, has supported *adaptation of communication* to the learning partner’s understanding (Dehler-Zufferey, Bodemer, Buder, & Hesse, 2011). However, the studies by Ray, Neugebauer, Sassenberg, Buder, and Hesse (2013) applying the same configuration of knowledge awareness as Dehler-Zufferey and colleagues (2011) have shown that (1) *personality factors* such as a high *need for social comparison* and (2) *context factors* such as a faked negative feedback about one’s own intelligence can counteract the positive impact of this configuration of knowledge awareness.

The present dissertation’s first experimental study suggests that the configuration of *hybrid* and *subjective knowledge awareness information* in combination with providing *explicit information* about the higher competence of the source (i.e., a textbook of the subject-matter domain) of the presented task solution, which deviated from the learner’s solution, supported solving a

knowledge-rich task correctly. Further, comparing the peer condition of Study 1 with the no peer talk condition of Study 2 indicates that *dynamic knowledge awareness information* (Study 2), that is, observing how the learning partner changes his or her task solution in real-time, more strongly encouraged learners to improve their own task solution (cf. *technology affordances* & *representational guidance*; Suthers, 2006) than *static knowledge awareness information* (Study 1). However, the time dimension of knowledge awareness (static / dynamic) should be varied within one and the same study in order to substantiate this assumption.

Finally, since most studies on knowledge awareness have been conducted in the laboratory, future studies should more strongly focus on implementing and evaluating the impact of, for example, dynamic knowledge awareness information in longitudinal field studies.

# Summary

The present dissertation examined how learners react if they are confronted with a task solution that deviates from their own solution provided by a source of either equally low or high competence. This dissertation combined and extended two research areas in order to predict learners' cognition and behavior in the context of a knowledge-rich, cognitive conflict task (Chapter 1): (1) research on the concept of *knowledge awareness* (Engelmann, Dehler, Bodemer, & Buder, 2009) and (2) research on the *conflict elaboration theory* (Mugny, Butera, Sanchez-Mazas, & Pérez, 1995). Knowledge awareness (Engelmann et al., 2009) is an approach developed in the field of computer-supported collaborative learning (CSCL), and it is defined as "an individual's state of being informed and having perceived information about others' knowledge", that is, especially others' externalized task-relevant knowledge (Engelmann et al., 2009, p. 950). According to the conflict elaboration theory (Mugny et al., 1995) that is based on educational (e.g., Mugny & Doise, 1978) and social psychological theories and findings (e.g. majority vs. minority influence; Deutsch & Gerard, 1955; Moscovici & Personnaz, 1986), confronting learners with a task solution that deviates from their own solution offers a great potential for learning if the producer of the deviating solution is an equally low competent learning partner ("peer") because these learning partners may activate a stronger cognitive conflict (Quiamzade, Mugny & Darnon, 2009) that results in a more intensive search for the correct solution compared to high competent learning partners whose solution may be imitated more often uncritically (Quiamzade & Mugny, 2001).

In order to provide a distinction between the related concepts of knowledge awareness in CSCL and *expertise awareness* in computer-supported cooperative work (CSCW), in order to predict their psychological effects more comprehensively and in order to describe more precisely the configuration of knowledge awareness implemented in the context of this dissertation's two experimental studies, *a combined classification of knowledge awareness* and *expertise awareness* in CSCL and CSCW was suggested in the conceptual part of the dissertation (Chapter 2). It was proposed to use the concept of "knowledge awareness" for CSCL settings which involve distributed persons with an equal level of expertise in a subject-matter domain (cf. Engelmann et al., 2009), whereas the concept of "expertise awareness" should be used for CSCW settings which involve a stronger asymmetry regarding the level of domain-specific expertise, in case of distributed professional cooperation with or help seeking from an expert, for example (cf. Maybury, D'Amore, & House, 2002; Nückles & Stürz, 2006; Reichling & Wulf, 2009). The combined classification was based on a literature review of 30 computer-based applications for supporting knowledge or expertise awareness and a review of 22 studies which contributed to clarifying the psychological effects of knowledge or expertise awareness and which were conducted in the past 16 years. Engelmann and colleagues (2009) introduced three categories of knowledge awareness in CSCL: *context-based*, *content-based*, and *hybrid knowledge awareness*. Sangin, Molinari, Nüssli, and Dillenbourg (2011) distinguished further between *subjective*, *objective*, and *activity-based knowledge awareness* (cf. Ogata & Yano, 1998), the last category being conceptually identical to the concept of *action awareness* (Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). This dissertation argues for the incorporation of two further dimensions which are

relevant both for knowledge awareness in CSCL and expertise awareness in CSCW (cf. Maybury et al., 2002), namely, (1) whether the information on the *level of expertise* is *implicit* versus *explicit* and (2) whether the information about others' knowledge or expertise is provided only once (*static knowledge awareness information*) or whether dynamic changes to the knowledge or expertise are observable (*dynamic knowledge awareness information*). Based on the proposed combined classification of knowledge awareness, the studies of the present dissertation can be described as implementing *hybrid*, *subjective*, *static* (Study 1) and *dynamic* (Study 2) *knowledge awareness information* providing an *explicit level of expertise* of the learning partner. Further, possible functions of the subcategories of knowledge awareness and expertise awareness can be derived from the results of the studies that were categorized according to the combined classification.

The first experimental study (Chapter 3) aimed at investigating the impact of knowledge awareness regarding a higher competence source of a cognitive conflict. In two conditions, students ($N$ = 59) compared their self-created task solution with a partly correct solution presented additionally, deviating considerably from their solution. However, the students were not informed that the presented solution was only partly correct. The source label of the presented solution indicated either an equally low competent (*"peer"*) or a high competent source (*"textbook"*) whereas the presented solution was identical. In the *baseline condition*, this comparison possibility was missing. Students in the textbook condition experienced more cognitive conflict and adapted their solution more often to the correct aspect of the presented solution than students in the peer condition. That is, perceived cognitive conflict fully mediated the relationship between the experimental conditions with knowledge awareness and adaptation behavior.

Moreover, students' need for *social comparison of abilities* (Gibbons & Buunk, 1999) moderated their adaptation behavior in the two experimental conditions with knowledge awareness: Especially students with a low need for social comparison of ability adapted their solution more extensively in the textbook condition than in the peer condition. However, a mediated moderation model of these factors failed to reach significance. Therefore, it was concluded that the cognitive conflict as a mediator and social comparison of one's own ability as a moderator exerted unique and independent effects on adaptation behavior in Study 1.

This first study indicates that social influence dynamics postulated by the conflict elaboration theory in the context of well-defined problems (e.g., anagram tasks; Quiamzade et al., 2009), that is, a stronger cognitive conflict after being confronted with the deviating solution of an equally low competent producer (a peer) compared to a more competent producer (e.g., an expert), may not hold true for more *knowledge-rich problems* (e.g., identifying structural similarities between law cases; Nievelstein, van Gog, Boshuizen, & Prins, 2010) without interaction between the source of the cognitive conflict and the target person. Moreover, this study extended the empirical base of the conflict elaboration theory regarding relevant individual differences (i.e., need for social comparison; Gibbons & Buunk, 1999).

Since Study 1 showed that a more competent source of a cognitive conflict had more impact on target persons than an equally low competent source (peer), the second experimental study (Chapter 4) aimed at strengthening the impact of the equally low competent source by enabling *peer talk* (Mercer, 2000) in the form of computer-supported audio communication. Fifty-eight participants were randomly assigned to either 13 dyads with peer talk or 16 dyads without peer talk.

All dyads compared their own task solution to their partner's deviating task solution by means of a computer-supported external representation. Peer talk resulted in reduced perceived cognitive conflict (cf. Harmon, 1998). The correctness of task solutions was associated with the *quality* of the discourse content: *Exploratory talk* about one's understanding of the task (cf. Mercer, 2000) was associated with a more correct solution whereas talking about coordinating task completion was associated with a less correct solution. This pattern of results is consistent with previous findings regarding computer-mediated communication of distance learning groups (e.g., Paulus, 2009).

The descriptive comparison of the peer condition of Study 1 with the no peer talk condition of Study 2 showed that learners improved the correctness of their own task solution only in Study 2. In Study 1, the computer-based external representation supported static knowledge awareness, that is, information about the learning partner's solution was provided only once, whereas in Study 2, dynamic knowledge awareness was enabled, that is, observing in real-time how the learning partner is changing his or her own solution. It is possible that dynamic knowledge awareness has encouraged the learners more to change their own solution thereby improving its correctness compared to static knowledge awareness (cf. *technology affordances* & *representational guidance*; Suthers, 2006). Future studies could test this assumption by varying static versus knowledge awareness within one and the same study.

# Zusammenfassung

Die vorliegende Dissertation widmete sich der Frage, wie Lernende reagieren, wenn sie mit einer Aufgabenlösung konfrontiert werden, die von ihrer eigenen Lösung abweicht, wobei die zusätzlich dargebotene Aufgabenlösung entweder von einem, im Vergleich zum Lernenden, gleich gering kompetenten oder von einem hochkompetenten Ersteller stammt. Diese Dissertation kombinierte und erweiterte zwei Forschungsbereiche, um Kognition und Verhalten von Lernenden bei einer voraussetzungsreichen kognitiven Konfliktaufgabe vorherzusagen (Kapitel 1): (1) den Forschungsbereich zum Konzept der *Knowledge Awareness* (Engelmann, Dehler, Bodemer & Buder, 2009) und (2) den Forschungsbereich zur *Konflikt-elaborationstheorie* (Mugny, Butera, Sanchez-Mazas, & Pérez, 1995). Knowledge Awareness (Engelmann et al., 2009) ist ein Ansatz aus dem Bereich des computerunterstützten kollaborativen Lernens (CSCL) und wird definiert als „die Informiertheit einer Person über das Wissen anderer Personen“, wobei sich die Informierung insbesondere auf das externalisierte, aufgabenrelevante Wissen anderer Personen bezieht (Engelmann et al., 2009, S. 950). Gemäß der Konfliktelaborationstheorie (Mugny et al., 1995), die auf pädagogisch-psychologischen (z.B. Mugny & Doise, 1978) und sozialpsychologischen Theorien und Befunden (z.B. zum Mehrheiten- vs. Minderheiteneinfluss; Deutsch & Gerard, 1955; Moscovici & Personnaz, 1986) beruht, sei es besonders lernförderlich, wenn Lernende mit einer Aufgabenlösung konfrontiert würden, die von der eigenen Aufgabenlösung abweicht und von einem gleich gering kompetenten Lernpartner („Peer“) erstellt wurde, weil diese Lernpartner einen stärkeren kognitiven Konflikt auslösen würden (Quiamzade, Mugny & Darnon, 2009), der zudem eher zu einer

Suche nach der richtigen Lösung führen würde als hochkompetente Lernpartner, deren Lösung häufiger unreflektiert imitiert würde (Quiamzade & Mugny, 2001).

Um eine Unterscheidung zwischen den verwandten Konzepten der Knowledge Awareness im CSCL-Kontext sowie der *Expertise Awareness* im Kontext des computerunterstützten kooperativen Arbeitens (CSCW) zu treffen, um deren psychologischen Effekte umfassender vorhersagen zu können, und um die Form der Knowledge Awareness Information, die in den beiden experimentellen Studien dieser Dissertation eingesetzt wurde, genauer zu beschreiben, wurde im konzeptuellen Teil der Dissertation (Kapitel 2) *eine kombinierte Klassifikation von Knowledge Awareness* und *Expertise Awareness* für den CSCL- und den CSCW-Bereich vorgeschlagen. Zudem wurde vorgeschlagen, den Begriff Knowledge Awareness im CSCL-Kontext bei räumlich verteilten Personen zu verwenden, die einen gleich hohen Kenntnisstand in einem Bereich aufweisen (cf. Engelmann et al., 2009), während der Begriff Expertise Awareness im CSCW-Kontext verwendet werden sollte, wenn eine stärkere Asymmetrie hinsichtlich des domänenspezifischen Kenntnisstandes vorliegt, zum Beispiel im Rahmen einer räumlich verteilten, professionellen Zusammenarbeit oder bei einem Hilfegesuch an einen Experten (vgl. Maybury, D'Amore, & House, 2002; Nückles & Stürz, 2006; Reichling & Wulf, 2009). Diese kombinierte Klassifikation basierte zudem auf einem Literaturüberblick über 30 computerunterstützte Anwendungen zur Förderung von Knowledge oder Expertise Awareness sowie auf einem Literaturüberblick über 22 Studien der vergangenen 16 Jahren, welche einen Beitrag zur Klärung der psychologischen Effekte von Knowledge oder Expertise Awareness geleistet hatten. Engelmann und Kollegen (2009) stellten die drei Kategorien *Context-Based*, *Content-Based* und *Hybrid Knowledge Awareness* vor.

Sangin, Molinari, Nüssli und Dillenbourg (2011) schlugen zudem vor, zwischen *Subjective*, *Objective* und *Activity-Based Knowledge Awareness* (vgl. Ogata & Yano, 1998) zu unterscheiden. Dabei ist die letzte Kategorie konzeptuell identisch mit dem Konzept der *Action Awareness* (Carroll, Neale, Isenhour, Rosson & McCrickard, 2003). Im Rahmen der vorliegenden Dissertation wurde vorgeschlagen, zwei weitere Dimensionen in die Klassifikation einzubeziehen, welche sowohl für das Konzept der Knowledge Awareness im CSCL-Kontext als auch für das Konzept der Expertise Awareness im CSCW-Kontext relevant sind (cf. Maybury et al., 2002), und zwar (1) ob die *Information über den Kenntnisstand implizit* versus *explizit* dargeboten wird und (2) ob die Informierung über das Wissen oder den Kenntnisstand anderer Personen lediglich einmal erfolgt (*Static Knowledge Awareness Information*) oder ob dynamische Veränderungen im Wissen oder Kenntnisstand beobachtbar sind (*Dynamic Knowledge Awareness Information*). Ausgehend von dieser kombinierten Klassifikation kann die Form der Knowledge Awareness Information, die in den Studien der vorliegenden Dissertation implementiert wurde, als *Hybrid*, *Subjective*, *Static* (Studie 1) bzw. *Dynamic* (Studie 2) *Knowledge Awareness Information* mit einer *expliziten Informierung* über den *Kenntnisstand* (*Explicit Level of Expertise)* des Lernpartners beschrieben werden. Zudem können aus den Ergebnissen der Studien, die nach der kombinierten Klassifikation kategorisiert wurden, mögliche Funktionen der Subkategorien von Knowledge Awareness und Expertise Awareness abgeleitet werden.

Die erste experimentelle Studie (Kapitel 3) hatte das Ziel, den Einfluss von Knowledge Awareness bezüglich eines, im Vergleich zur Zielperson des Lernenden, höher kompetenten Auslösers eines kognitiven Konfliktes zu

untersuchen. Studierende (*N* = 59) verglichen in zwei experimentellen Bedingungen ihre selbst erstellte Aufgabenlösung mit einer zusätzlich dargebotenen, teilweise korrekten Aufgabenlösung, die von ihrer deutlich abwich. Die Teilnehmer wurden jedoch nicht darüber informiert, dass die dargebotene Lösung nur teilweise korrekt war. Als Ersteller bzw. Quelle der zusätzlich dargebotenen Aufgabenlösung wurde entweder ein gleich gering kompetenter Ersteller (ein *„Peer“*) oder eine hoch kompetente Quelle (ein *„Lehrbuch“*) angegeben, wobei die dargebotene Lösung jedoch immer identisch war. In der *Baseline-Bedingung* fehlte diese Vergleichsmöglichkeit in Form einer zusätzlich dargebotenen Aufgabenlösung. Die Teilnehmer der Lehrbuchbedingung erlebten einen stärker ausgeprägten kognitiven Konflikt und passten ihre Aufgabenlösung häufiger an den korrekten Teil der dargebotenen Lösung an als die Teilnehmer der Peer-Bedingung. Das heißt, der wahrgenommene kognitive Konflikt mediierte den Zusammenhang zwischen den experimentellen Bedingungen mit Knowledge Awareness und dem Anpassungsverhalten der Teilnehmer vollständig. Darüber hinaus moderierte die *soziale Vergleichsorientierung* der Teilnehmer *hinsichtlich ihrer Fähigkeiten* (Gibbons & Buunk, 1999) ihr Anpassungsverhalten in den beiden experimentellen Bedingungen mit Knowledge Awareness: Insbesondere Studierende mit einer gering ausgeprägten sozialen Vergleichsorientierung hinsichtlich ihrer Fähigkeiten passten ihre Aufgabenlösung in der Lehrbuch-bedingung stärker an die dargebotene Lösung an als in der Peer-Bedingung. Jedoch wurde das mediierte Moderationsmodell dieser Faktoren nicht signifikant. Deshalb wird geschlussfolgert, dass der Mediator kognitiver Konflikt und der Moderator soziale Vergleichsorientierung hinsichtlich der eigenen Fähigkeiten

jeweils einen unabhängigen Einfluss auf das Anpassungsverhalten in Studie 1 ausübten.

Diese erste Studie deutet darauf hin, dass soziale Einflussdynamiken, die von der Konfliktelaborationstheorie bei gut strukturierten Aufgaben (z.B. Anagramm-Aufgaben; Quiamzade et al., 2009) vorhergesagt wurden, d.h. ein stärkerer kognitiver Konflikt bei der Konfrontation mit der abweichenden Lösung eines gleich gering kompetenten Erstellers (Peer) im Gegensatz zu einem höher kompetenten Ersteller (z.B. Experte), möglicherweise nicht zutreffen bei stärker *voraussetzungsreichen Aufgaben* (z.B. strukturelle Gemeinsamkeiten von juristische Fällen erkennen; Nievelstein, van Gog, Boshuizen & Prins, 2010), bei denen keine Interaktion stattfindet zwischen dem Auslöser des kognitiven Konflikts und der Zielperson. Darüber hinaus erweiterte die Studie die empirische Wissensbasis zur Konfliktelaborationstheorie im Hinblick auf relevante interpersonale Unterschiede (d.h. die soziale Vergleichsorientierung).

Da die erste Studie zeigte, dass ein kompetenterer Auslöser eines kognitiven Konflikts einen größeren Einfluss auf die Zielpersonen ausübt als ein gleich gering kompetenter Konfliktauslöser (*Peer*), zielte die zweite experimentelle Studie (Kapitel 4) darauf ab, den sozialen Einfluss des gleich gering kompetenten Auslösers zu stärken, indem *Peer Talk* (Mercer, 2000) in Form von computergestützter Audio-Kommunikation zwischen dem Konfliktauslöser und der Zielperson ermöglicht wurde. Eine Stichprobe von 58 Teilnehmern wurde zufällig entweder zu 13 Dyaden mit Peer Talk oder zu 16 Dyaden ohne Peer Talk zugeteilt. Alle Dyaden verglichen ihre eigene Aufgabenlösung mit der abweichenden Lösung des Lernpartners mit Hilfe einer computergestützten externen Repräsentation der Lösungen. Peer Talk bewirkte eine Abnahme des wahrgenommenen kognitiven

Konflikts (vgl. Harmon, 1998). Die Korrektheit der eigenen Aufgabenlösung stand in Zusammenhang mit der *Qualität* der Gesprächsinhalte: Das Erklären des eigenen Aufgabenverständnisses *(Exploratory Talk*; vgl. Mercer, 2000) korrelierte mit einer korrekteren Aufgaben-lösung, während Gespräche über die Koordinierung der Aufgabenerledigung mit einer weniger korrekten Lösung korrelierten. Dieses Befundmuster stimmt mit früheren Studienergebnissen zur computergestützten Kommunikation virtueller Lerngruppen überein (z.B. Paulus, 2009).

Der deskriptive Vergleich der Peer-Bedingung aus Studie 1 mit der Bedingung ohne Peer Talk aus Studie 2 zeigt, dass sich die Korrektheit der eigenen Aufgabenlösung nur in der 2. Studie verbesserte. In Studie 1 förderte die computergestützte externe Repräsentation Static Knowledge Awareness, d.h. die einmalige Informierung über die Lösung des Lernpartners, während sie in Studie 2 Dynamic Knowledge Awareness ermöglichte, d.h. das Beobachten in Echtzeit, wie der Lernpartner seine eigene Aufgabenlösung verändert. Möglicherweise hat Dynamic Knowledge Awareness die Lernenden stärker dazu ermuntert, ihre eigene Lösung zu verändern und sie dadurch zu verbessern (vgl. *technology affordances* & *representational guidance*; Suthers, 2006). Zukünftige Studien könnten diese Annahme überprüfen, indem Static versus Dynamic Knowledge Awareness innerhalb ein und derselben Studie variiert wird.

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# Appendices

Appendix A: Study 1: Solved and Unsolved Criminal Law Cases

Appendix B: Study 2: Solved and Unsolved Criminal Law Cases

## *Appendix A*

*Study 1: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 1.) <u>"Breach of domestic peace":</u> | <u>"Green":</u> |
| Gelöster Fall Nummer 1: **<u>Hausfriedensbruch</u>** | Ungelöster Fall: „GRÜN" |
| L ist stark angetrunken und schläft an der Bartheke ein. Der Wirt hat L bereits mehrfach dazu aufgefordert, die Kneipe zu verlassen und sieht sich nun gezwungen, die Polizei zu verständigen.<br><u>Falllösung:</u><br>- Täter: L<br>- Verbrechensart: Unterlassungsstraftat<br>- Straftatbestand: Hausfriedensbruch<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Schuldfähigkeit vermindert aufgrund Alkoholisiertheit | R (24 Jahre alt) steht am Ufer und sieht, dass sein Vater (65 Jahre alt) im See am Ertrinken ist. R und sein Vater sind allein. R wirft seinem Vater ein Seil zu, welches der Vater mit letzter Kraft erfasst. Plötzlich kommt R der Gedanke, dass dies doch eine gute Möglichkeit sei, um an das Erbe seines Vaters zu gelangen. R zieht das Seil ruckartig zurück. Durch den Ruck entgleitet dem Vater das Seil. Der Vater ertrinkt. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix A (Continued)*

*Study 1: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 2.) <u>"Bodily injury":</u> | <u>"Yellow":</u> |
| Gelöster Fall Nummer 2: **<u>Körperverletzung</u>**<br>Frau P. lebt alleine in einer Reihenhaushälfte und hat im Winter die Streupflicht für den Gehweg vor ihrem Haus. Aufgrund einer akuten schweren Grippe mit hohem Fieber kann sie jedoch ihrer Streupflicht nicht nachkommen. Durch die Medikamente ist sie zudem sehr schläfrig und vergisst, bei den Nachbarn bezüglich einer Vertretung für ihren Streudienst anzufragen. Da geschieht es, dass eine ältere Dame auf dem vereisten Gehweg vor dem Haus von Frau P. ausrutscht und sich einen Beckenbruch zuzieht. Die ältere Dame verklagt Frau P. auf Schmerzensgeld.<br><u>Falllösung:</u><br>- Täter: Frau P.<br>- Verbrechensart: Unterlassungsstraftat<br>- Straftatbestand: Körperverletzung<br>- Straftatbestand vollendet<br>- Fahrlässigkeit<br>- Rechtfertigungsgrund: Konnte aufgrund eigener akuter Erkrankung ihrer Streupflicht nicht nachkommen<br>- Schuldfähigkeit vermindert aufgrund Medikamenteneinnahme | Ungelöster Fall: „GELB"<br>Die Badeaufsicht eines öffentlichen Schwimmbades geht in die Mittagspause ohne einem Kollegen Bescheid zu geben, weil sie davon ausgeht, dass sie gleich wieder da ist und in dieser Zeit schon nichts passieren wird. Doch genau in diesem Zeitraum ertrinkt ein Junge beinahe im Schwimmbecken, als er einen Krampf im Fuß bekommt. Ein Badegast zieht den Jungen aus dem Wasser. Später verklagen die Eltern des Jungen die Betreiber des Schwimmbades. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix A (Continued)*

*Study 1: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 3.) "Non-assistance of a person in danger":<br><br>Gelöster Fall Nummer 3: **<u>Unterlassene Hilfeleistung</u>**<br><br>Die Wohnung der Familie F im 3. Stock eines Hochhauses steht in Flammen. Eine Flucht durch die Tür ist nicht möglich. Die Mutter scheut sich, ihr dreijähriges Kind aus dem Fenster zu werfen, obwohl hilfsbereite Passanten vor dem Fenster stehen, um das Kind aufzufangen. Da entreißt der Vater der Mutter das Kind und wirft es den Passanten in die Arme. Das Kind bleibt unversehrt, und auch die Eltern werden kurz darauf von der Feuerwehr gerettet. Trotzdem erwägen die Großeltern des Kindes, die Mutter wegen unterlassener Hilfeleistung anzuzeigen.<br><br><u>Falllösung:</u><br>- Täter: Mutter der Familie F:<br>- Verbrechensart: Unterlassungsstraftat<br>- Straftatbestand: Unterlassene Hilfeleistung<br>- Straftatbestand nicht vollendet<br>- Fahrlässigkeit<br>- Rechtfertigungsgrund: Angst um das Leben des Kindes & Schreck<br>- Schuldfähigkeit entfällt aufgrund des Schocks in der Situation | --- |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix A (Continued)*

*Study 1: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 4.) "Prevention of penalty & damage to property":<br><br>Gelöster Fall Nummer 4: **<u>Strafverhinderung Sachbeschädigung</u>**<br><br>Ein äußerst nervöser Mann mit einer stark blutenden Schussverletzung kommt in die Arztpraxis von Dr. X, der eigentlich schon Feierabend hat und deshalb alleine in der Praxis ist. Der Doktor vermutet richtig, dass es sich bei dem Mann um einen Verbrecher auf der Flucht handelt. Er beschließt, zuerst die Wunde zu versorgen, danach aber sofort die Polizei zu verständigen. Nachdem der Doktor dem Mann einen Verband angelegt hat, lenkt der Mann den Arzt ab und schafft es, aus der Praxis zu fliehen. Als der Arzt die Polizei anrufen will, bemerkt er, dass sein Telefonkabel durchtrennt wurde. Als er es schließlich schafft, die Beamten zu verständigen, ist der Verbrecher auf der Flucht bereits erfolgreich untergetaucht.<br><br><u>Falllösung:</u><br>- Täter: Arzt Dr. X<br>- Verbrechensart: Unterlassungsstraftat<br>- Straftatbestand: Strafverhinderung<br>- Straftatbestand vollendet<br>- Rechtfertigungsgrund vorhanden: Musste zuerst seiner ärztlichen Hilfspflicht nachkommen; somit entfallen Vorsatz- / Fahrlässigkeits- & Schuldfähigkeitsfrage<br><br>- Täter: Mann auf der Flucht<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Sachbeschädigung (Telefonkabel)<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Angeklagter voll schuldfähig | --- |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix A (Continued)*

*Study 1: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 5.) "First degree arson, insurance fraud, & breach of domestic peace": | "Blue": |
| Gelöster Fall Nummer 5: **<u>Schwere Brandstiftung</u>**<br>**<u>Versicherungsbetrug</u>**<br>**<u>Hausfriedensbruch</u>**<br><br>V (46 Jahre alt) zündet nachts seine Scheune an, um in den Genuss der Versicherungssumme zu gelangen. V weiß, dass der alkoholkranke Landstreicher L häufig in der Scheune übernachtet, was V stört. Auch an diesem Tag hat V den Landstreicher L auf der Wiese vor der Scheune sitzen sehen. V schaut trotzdem nicht vorher in der Scheune nach, sondern läuft sofort vom Tatort weg. So bemerkt er nicht, dass sich L tatsächlich in der brennenden Scheune befindet, weil er dort seinen Rausch ausschlafen will. L geht davon aus, dass der Besitzer der Scheune nichts dagegen hat, wenn er ab und zu in der Scheune übernachtet. Nun kann er sich nicht mehr befreien und verbrennt. Ein Zeuge hat V heimlich beobachtet und zeigt ihn bei der Polizei an.<br><br><u>Falllösung:</u><br>- Täter: V<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Schwere Brandstiftung<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit<br><br>- Täter: V<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Versicherungsbetrug<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit<br><br>- Täter: L<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Hausfriedensbruch<br>- Straftatbestand vollendet<br>- Fahrlässigkeit<br>- Rechtfertigungsgrund: aus Not in Scheune übernachtet<br>- Schuldfähigkeit vermindert aufgrund Alkoholisiertheit<br>- Anklage entfällt, da L verstorben ist | Ungelöster Fall: „BLAU"<br><br>Der Politiker X will nach 36-stündiger Recherchearbeit mit dem Auto nach Hause fahren. Beraterin B ist seine Beifahrerin. Aufgrund von Übermüdungserscheinungen übersieht X eine Frau, die auf einem Fußgängerweg die Straße überquert. Diese bleibt schwer verletzt auf der Fahrbahn liegen. Nachdem X angehalten hat, schaut B nach dem Zustand der Frau und erklärt dem im Wagen gebliebenen X wahrheitswidrig, dass die Frau tot sei, und dass es am besten wäre, den Unfallort zu verlassen, um der Strafverfolgung zu entgehen. So geschieht es. Als endlich jemand die schwerverletzte Frau entdeckt und den Notarzt ruft, kommt jede Hilfe für die Frau zu spät. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix A (Continued)*

*Study 1: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 6.) "Aggravated battery & intimidation": | "Red": |
| Gelöster Fall Nummer 6: **Gefährliche Körperverletzung**<br>**Bedrohung**<br><br>M hat B an diesem Abend in der Disco kennengelernt. Als M sich auf einem Feldweg nach Hause von B verabschieden möchte, wird M plötzlich von B mit einem Messer bedroht. M wehrt sich in Todesangst, verletzt B dabei ohne es zu merken mit dessen Messer und läuft davon. B bleibt aufgrund der Verletzung auf dem Feldweg liegen. Beim aufkommenden Gewitter wird B vom Blitz erschlagen.<br><br>Falllösung:<br>- Täter: M<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Gefährliche Körperverletzung<br>- Straftatbestand vollendet<br>- Rechtfertigungsgrund: Notwehr, d.h. Vorsatz-/ Fahrlässigkeitsfrage & Schuldfähigkeitsfrage entfallen<br><br>- Täter: B<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Bedrohung<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit<br>- Anklage entfällt, da B verstorben ist<br><br>- Täter: B<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Gefährliche Körperverletzung<br>- Straftatbestand versucht<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit<br>- Anklage entfällt, da B verstorben ist | Ungelöster Fall: „ROT"<br><br>D filmt seine Arbeitskollegen unbemerkt dabei, wie diese planen, eine Bank auszurauben. D beschließt, den geplanten Bankraub nicht der Polizei zu melden, weil er seine Kollegen im Nachhinein erpressen möchte. Zwei Wochen später werden die Kollegen während des versuchten Bankraubs verhaftet. Als D in Verdacht gerät, vom Bankraub gewusst zu haben, durchsucht die Polizei seine Wohnung und entdeckt dort das Video mit dem geplanten Bankraub. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix B*

*Study 2: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 1.) <u>"Bodily injury":</u> | <u>"Green":</u> |
| Gelöster Fall Nummer 1: **<u>Körperverletzung</u>**<br><br>Frau P. lebt alleine in einer Reihenhaushälfte und hat im Winter die Streupflicht für den Gehweg vor ihrem Haus. Aufgrund einer akuten schweren Grippe mit hohem Fieber kann sie jedoch ihrer Streupflicht nicht nachkommen. Durch die Medikamente ist sie zudem sehr schläfrig und vergisst, bei den Nachbarn bezüglich einer Vertretung für ihren Streudienst anzufragen. Da geschieht es, dass eine ältere Dame auf dem vereisten Gehweg vor dem Haus von Frau P. ausrutscht und sich einen Beckenbruch zuzieht. Die ältere Dame verklagt Frau P. auf Schmerzensgeld.<br><br><u>Falllösung:</u><br>- Täter: Frau P.<br>- Verbrechensart: Unterlassungsstraftat<br>- Straftatbestand: Körperverletzung<br>- Straftatbestand vollendet<br>- Fahrlässigkeit<br>- Rechtfertigungsgrund: Konnte aufgrund eigener akuter Erkrankung ihrer Streupflicht nicht nachkommen<br>- Schuldfähigkeit vermindert aufgrund Medikamenteneinnahme | Ungelöster Fall: „GRÜN"<br><br>Die Badeaufsicht eines öffentlichen Schwimmbades geht in die Mittagspause ohne einem Kollegen Bescheid zu geben, weil sie davon ausgeht, dass sie gleich wieder da ist und in dieser Zeit schon nichts passieren wird. Doch genau in diesem Zeitraum ertrinkt ein Junge beinahe im Schwimmbecken, als er einen Krampf im Fuß bekommt. Ein Badegast zieht den Jungen aus dem Wasser. Später verklagen die Eltern des Jungen die Betreiber des Schwimmbades. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

***Appendix B (Continued)***

*Study 2: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 2.) <u>"Prevention of penalty, First degree arson & intimidation":</u> | <u>"Yellow":</u> |
| Gelöster Fall Nummer 2: **<u>Strafverhinderung Schwere Brandstiftung Bedrohung</u>**<br><br>H erfährt von seinem Kumpel N, dass N vor wenigen Monaten mit seiner Bande ein Feuer in einem Asylbewerberheim gelegt hat. Die Polizei konnte den Fall bisher nicht aufklären, weil die Spuren nur auf einen elektrischen Kurzschluss hindeuten. N macht H deutlich, dass er von H Stillschweigen bezüglich des Feuers im Asylbewerberheim erwartet. Da H die Brutalität seines Kumpels N kennt, hält sich H an die Abmachung.<br><br><u>Falllösung:</u><br>- Täter: H<br>- Verbrechensart: Unterlassungsstraftat<br>- Straftatbestand: Strafverhinderung<br>- Straftatbestand vollendet<br>- Rechtfertigungsgrund vorhanden: von N bedroht<br>- Vorsatz- / Fahrlässigkeitsfrage entfällt<br>- Volle Schuldfähigkeit<br><br>- Täter: N<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestände: Schwere Brandstiftung; Bedrohung<br>- Straftatbestände vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit | Ungelöster Fall: „GELB"<br><br>D filmt seine Arbeitskollegen unbemerkt dabei, wie diese planen, eine Bank auszurauben. D beschließt, den geplanten Bankraub nicht der Polizei zu melden, weil er seine Kollegen im Nachhinein erpressen möchte. Zwei Wochen später werden die Kollegen während des versuchten Bankraubs verhaftet. Als D in Verdacht gerät, vom Bankraub gewusst zu haben, durchsucht die Polizei seine Wohnung und entdeckt dort das Video mit dem geplanten Bankraub. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix B (Continued)*

*Study 2: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 3.) "Prevention of penalty & damage to property": | "Blue": |
| Gelöster Fall Nummer 3: **<u>Strafverhinderung Sachbeschädigung</u>**<br>Ein äußerst nervöser Mann mit einer stark blutenden Schussverletzung kommt in die Arztpraxis von Dr. X, der eigentlich schon Feierabend hat und deshalb alleine in der Praxis ist. Der Doktor vermutet richtig, dass es sich bei dem Mann um einen Verbrecher auf der Flucht handelt. Er beschließt, zuerst die Wunde zu versorgen, danach aber sofort die Polizei zu verständigen. Nachdem der Doktor dem Mann einen Verband angelegt hat, lenkt der Mann den Arzt ab und schafft es, aus der Praxis zu fliehen. Als der Arzt die Polizei anrufen will, bemerkt er, dass sein Telefonkabel durchtrennt wurde. Als er es schließlich schafft, die Beamten zu verständigen, ist der Verbrecher auf der Flucht bereits erfolgreich untergetaucht.<br><u>Falllösung:</u><br>- Täter: Arzt Dr. X<br>- Verbrechensart: Unterlassungsstraftat<br>- Straftatbestand: Strafverhinderung<br>- Straftatbestand vollendet<br>- Rechtfertigungsgrund vorhanden: Musste zuerst seiner ärztlichen Hilfspflicht nachkommen; somit entfallen Vorsatz- / Fahrlässigkeits- & Schuldfähigkeitsfrage<br>- Täter: Mann auf der Flucht<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Sachbeschädigung (Telefonkabel)<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit | Ungelöster Fall: „BLAU"<br>L ist stark angetrunken und schläft an der Bartheke ein. Der Wirt hat L bereits mehrfach dazu aufgefordert, die Kneipe zu verlassen und sieht sich nun gezwungen, die Polizei zu verständigen. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix B (Continued)*

*Study 2: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 4.) "First degree arson, insurance fraud & breach of domestic peace": | "Lilac": |
| Gelöster Fall Nummer 4: **<u>Schwere Brandstiftung</u>**<br>**<u>Versicherungsbetrug</u>**<br>**<u>Hausfriedensbruch</u>**<br><br>V (46 Jahre alt) zündet nachts seine Scheune an, um in den Genuss der Versicherungssumme zu gelangen. V weiß, dass der alkoholkranke Landstreicher L häufig in der Scheune übernachtet, was V stört. Auch an diesem Tag hat V den Landstreicher L auf der Wiese vor der Scheune sitzen sehen. V schaut trotzdem nicht vorher in der Scheune nach, sondern läuft sofort vom Tatort weg. So bemerkt er nicht, dass sich L tatsächlich in der brennenden Scheune befindet, weil er dort seinen Rausch ausschlafen will. L geht davon aus, dass der Besitzer der Scheune nichts dagegen hat, wenn er ab und zu in der Scheune übernachtet. Nun kann er sich nicht mehr befreien und verbrennt. Ein Zeuge hat V heimlich beobachtet und zeigt ihn bei der Polizei an.<br><br><u>Falllösung:</u><br>- Täter: V<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestände: Schwere Brandstiftung; Versicherungsbetrug<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit<br><br>- Täter: L<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Hausfriedensbruch<br>- Straftatbestand vollendet<br>- Fahrlässigkeit<br>- Rechtfertigungsgrund: aus Not in Scheune übernachtet<br>- Schuldfähigkeit vermindert aufgrund Alkoholisiertheit<br>- Anklage entfällt, da L verstorben ist | Ungelöster Fall: „LILA"<br><br>R (24 Jahre alt) steht am Ufer und sieht, dass sein Vater (65 Jahre alt) im See am Ertrinken ist. R und sein Vater sind allein. R wirft seinem Vater ein Seil zu, welches der Vater mit letzter Kraft erfasst. Plötzlich kommt R der Gedanke, dass dies doch eine gute Möglichkeit sei, um an das Erbe seines Vaters zu gelangen. R zieht das Seil ruckartig zurück. Durch den Ruck entgleitet dem Vater das Seil. Der Vater ertrinkt. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.

## *Appendix B (Continued)*

*Study 2: Solved and Unsolved Criminal Law Cases*

| *Solved Case* | *Unsolved Case* |
|---|---|
| 5.) "Aggravated battery & intimidation": | "Red": |
| Gelöster Fall Nummer 5: **Gefährliche Körperverletzung**<br>**Bedrohung**<br><br>M hat B an diesem Abend in der Disco kennengelernt. Als M sich auf einem Feldweg nach Hause von B verabschieden möchte, wird M plötzlich von B mit einem Messer bedroht. M wehrt sich in Todesangst, verletzt B dabei ohne es zu merken mit dessen Messer und läuft davon. B bleibt aufgrund der Verletzung auf dem Feldweg liegen. Beim aufkommenden Gewitter wird B vom Blitz erschlagen.<br><br>Falllösung:<br>- Täter: M<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Gefährliche Körperverletzung<br>- Straftatbestand vollendet<br>- Rechtfertigungsgrund: Notwehr, d.h. Vorsatz-/ Fahrlässigkeitsfrage & Schuldfähigkeitsfrage entfallen<br><br>- Täter: B<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Bedrohung<br>- Straftatbestand vollendet<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit<br>- Anklage entfällt, da B verstorben ist<br><br>- Täter: B<br>- Verbrechensart: Begehungsstraftat<br>- Straftatbestand: Gefährliche Körperverletzung<br>- Straftatbestand versucht<br>- Vorsatz<br>- Kein Rechtfertigungsgrund vorhanden<br>- Volle Schuldfähigkeit<br>- Anklage entfällt, da B verstorben ist | Ungelöster Fall: „ROT"<br><br>Der Politiker X will nach 36-stündiger Recherchearbeit mit dem Auto nach Hause fahren. Beraterin B ist seine Beifahrerin. Aufgrund von Übermüdungserscheinungen übersieht X eine Frau, die auf einem Fußgängerweg die Straße überquert. Diese bleibt schwer verletzt auf der Fahrbahn liegen. Nachdem X angehalten hat, schaut B nach dem Zustand der Frau und erklärt dem im Wagen gebliebenen X wahrheitswidrig, dass die Frau tot sei, und dass es am besten wäre, den Unfallort zu verlassen, um der Strafverfolgung zu entgehen. So geschieht es. Als endlich jemand die schwerverletzte Frau entdeckt und den Notarzt ruft, kommt jede Hilfe für die Frau zu spät. |

*Note.* Correct case pairs are underlined. The cases are similar, yet not identical to example cases of educational materials applied in German law studies (e.g., Hemmer & Wüst, 2001, 2002; Schmidt & Seidel, 2000). The participants of both experimental studies were informed that the cases are based on German criminal law but with the restriction that the experimental studies did not claim to provide a complete representation of current German criminal law. Rather, the information about the cases was strongly simplified for the purposes of this dissertation's both experimental studies.