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Abstract

Computer-supported collaborative learning (CSCL) is often based on written argumentative discourse of learners, who discuss their perspectives on a problem with the goal to acquire knowledge. Lately, CSCL research focuses on the facilitation of specific processes of argumentative knowledge construction, e.g., with computer-supported collaboration scripts. In order to refine process-oriented instructional support, such as scripts, we need to measure the influence of scripts on specific processes of argumentative knowledge construction. In this article, we propose a multi-dimensional approach to analyze argumentative knowledge construction in CSCL from sampling and segmentation of the discourse corpora to the analysis of four process dimensions (participation, epistemic, argumentative, social mode).

Key words

Computer-supported collaborative learning, CSCL, interaction analysis, asynchronous communication, discussion boards, argumentative knowledge construction, computer-supported collaboration scripts

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Computer-supported collaborative learning (CSCL) often implies that learners communicate with each other via text-based, asynchronous discussion boards. Learners are supposed to engage in an argumentative discourse with the goal to acquire knowledge. For instance, learners are assigned to jointly analyze a written problem case with the help of theoretical concepts in order to learn to apply and argue with these concepts. Individual learners may, for instance, compose elaborated problem analyses and post them to a discussion board where the learning partners may read the message and reply to the contribution with critique, questions, refinements, etc. During this type of discourse, learners collaboratively produce a text. The rationale for analyzing the discourse is that in this kind of data, cognitive processes of learning are being represented to a certain degree (Chi, 1997).

Approaches to analyze discourse have developed simultaneously in different fields, such as linguistics, analytical philosophy, anthropology etc. and have also inspired educational research, e.g., the concept of "grounding" in different media (Clark & Brennan, 1991) has been transferred to CSCL (Baker & Lund, 1997; Dillenbourg, Baker, Blaye, & O'Malley, 1995). These approaches need to be well connected to questions and theories of educational research (see De Wever, Valcke, Schellens, & Van Keer, this issue). The fit between theoretical and methodological approach is vital with regard to decisions on how to sample, segment, and categorize the discourse corpora. Counting the frequency of specific speech acts, for instance, may be more valuable to linguistic than educational research, because speech acts may not well represent relevant cognitive processes of learning. Furthermore, there are a number of different theoretical approaches to collaborative learning, which stress different process dimensions as indicators of knowledge building. Coding the discourse corpora with regard to one process dimension of collaborative learning may have blind spots regarding effects and side effects of other process dimensions on knowledge building. By analyzing whole samples of discourse corpora on multiple process dimensions we aim to better understand how specific processes of (computer-supported) collaborative learning contribute to and improve individual acquisition of knowledge. So far, the analysis of multiple processes is cumbersome, but as a result of this analysis, we can instructionally support those process dimensions of collaborative learning that are known to facilitate knowledge acquisition. First, we have analyzed discourse on two dimensions based on speech acts (Fischer, Bruhn, Gräsel, & Mandl, 2002). We have then revised and added categories, and segmented the discourse corpora with different grain sizes (Stegmann, Weinberger, Fischer, & Mandl, 2004; Weinberger, 2003; Weinberger, Ertl, Fischer, & Mandl, in press).

In this article, we present a framework to analyze multiple process dimensions of knowledge construction in CSCL, namely (1) the participation dimension, (2) the epistemic dimension, (3) the argument dimension, and (4) the dimension of social modes of co-construction. The analysis of discourse of collaborative learners is guided by an explicit or implicit theoretical framework on what processes and outcomes are seen as relevant for collaborative learning to be beneficial for the group and the individual. Therefore, we will first shortly summarize the theoretical background which guided our analysis toward specific process dimensions of CSCL. Second, we will introduce the CSCL environment that we have used in several studies. With this background, we present our approach on how to organize discourse data and how to categorize contributions on multiple process dimensions.

1. Argumentative Knowledge Construction in Computer-Supported Collaborative Learning – Theoretical Background

Argumentative knowledge construction is based on the assumption that learners engage in specific discourse activities and that the frequency of these discourse activities is related to knowledge acquisition. Learners construct arguments in interaction with their learning partners in order to acquire knowledge on argumentation as well as with respect to the content under consideration. This definition of argumentative knowledge construction includes that discourse activities on multiple process dimensions may facilitate knowledge acquisition. Analyzing and facilitating argumentative knowledge construction on multiple process dimensions may extend and refine our understanding of what kind of student discourse contributes to individual knowledge acquisition (van Boxtel & Roelofs, 2001).

1.1 Participation Dimension

The participation dimension provides us with two important kinds of information: Do learners participate at all and do they participate on an equal basis? To get this kind of information, we include the quantity of participation and the heterogeneity of participation in our methodology (see table 1).

(1) The *quantity of participation*, i.e. to what extent learners contribute to discourse, has been regarded as an important indicator of knowledge construction (Barab & Duffy, 2000; Cohen & Lotan, 1995). The quantity of participation indicates if learners login and enter a CSCL environment at all. The quantity of participation can thus indicate if learners had theoretically been in the position of being able to acquire knowledge within the environment. In text-based CSCL environments, the quantity of participation may be generally higher than in traditional classrooms. The fact that text-based, asynchronous CSCL may proceed in parallel discussion threads may support participation, because production blocking effects are being reduced. Learners can elaborate their contributions without interruptions from co-present peers, which may suggest to write longer and more elaborated messages (Kern, 1995; Quinn, Mehan, Levin, & Black, 1983).

(2) *Heterogeneity of participation*. Classroom discourse has been investigated with regard to *heterogeneity of participation* among participants. Collaborative learning may reduce heterogeneity of participation because all learners are supposed to contribute to small group discussions, whereas only some students have the opportunity to contribute to a classroom discussion (Cohen & Lotan, 1995). Highly heterogeneous participation has also been described as a consequence of social loafing (Latané, Williams, & Harkins, 1979) or free riding (Kerr & Bruun, 1983). At best, only some learners may benefit from knowledge co-construction scenarios while others are left behind. CSCL may contribute to a more homogeneous participation, e.g., by representing the discourse history on a discussion board. The discourse history may facilitate the learners' awareness of their participation quantity and converge towards a group norm (cf. Kreijns, Kirschner, & Jochems, 2002).

1.2 Epistemic Dimension

In contrast to participation, on an epistemic dimension not only the quantity, but also the content of learners' contributions is being analyzed. An epistemic dimension refers to how learners work on the knowledge construction task they are confronted with (Fischer et al., 2002). First, we need to analyze whether learners are engaging in activities to solve the task (on-task discourse) or whether they are rather concerned with off-task aspects. Second, we can differentiate specific epistemic activities to solve a task. The adequacy of these epistemic activities of learners can be considered in order to detect misconceptions of learners (see table 2).

Discourse is on-task when learners attempt to contribute to solve the task. On an epistemic dimension, the *amount of on-task discourse*, in contrast to off-task discourse, can be determined. The amount of on-task discourse has been found to be positively related to individual knowledge acquisition (Cohen, 1994). Many studies report that text-based CSCL supports learners to concentrate on on-task activities, in contrast to off-task activities (Kiesler, Siegel, & McGuire, 1984; Kiesler & Sproull, 1992; Rice, 1984; Woodruff, 1995).

On an epistemic dimension, on-task discourse can be further differentiated regarding the specific *epistemic activities* that describe in a more detailed and systematic way within a specific domain how learners solve the task. Learners may apply different strategies to solve the task, which may be more or less efficient with respect to the individual acquisition of knowledge (Hakkarainen & Palonen, 2003; Pontecorvo & Girardet, 1993). Different tasks require different epistemic activities. Depending on the task, specific epistemic activities may foster knowledge acquisition. Tasks for argumentative knowledge construction, which require learners to analyze learning cases using theoretical concepts, include at least three different kinds of epistemic activities (Fischer et al., 2002). Learners need to construct the problem space, the conceptual space, and relations between conceptual and problem space (see table 2). The *construction of problem space* is required for the understanding of a problem. Learners select, evaluate, and relate single components of problem case information. It has been found, however, that successful learners often go beyond the concrete level of case information and rather relate to theoretical concepts (Fischer et al., 2002; Salomon & Perkins, 1998; Weinberger, 2003). Learners focusing on the construction of problem space at the cost of neglecting other epistemic activities may retell rather than interpret a problem. Accordingly, it has been shown that discourse beyond a concrete level of the problem space may foster the individual acquisition of knowledge in learning scenarios based on complex problems (Fischer et al., 2002; Hogan, Nastasi, & Pressley, 2000). The *construction of conceptual space* comprises summarizing, rephrasing, and discussing theoretical concepts and principles. Learners construct relations between single theoretical concepts or distinguish concepts from each other. Learners define and categorize concepts. This has been argued to be essential for successfully understanding the theoretical concepts that are supposed to be learned (De Grave, Boshuizen, & Schmidt, 1996; Pontecorvo & Girardet, 1993). The *construction of relations between conceptual and problem space* can be regarded as the main task in problem-oriented learning environments (De Grave et al., 1996). The individual relations between concepts and problem information that learners construct can indicate how learners approach a problem in detail, as well as to what extent learners are able to apply knowledge adequately. Therefore, relations between conceptual space and problem space can indicate knowledge application on the basis of the concepts that learners resort to in order to analyze the problem. With respect to complex problems with multiple facets, learners need not only to construct one specific relation between conceptual and problem space, but to apply multiple concepts to multiple facets of the problem. The collaborative application of theoretical concepts to problem space may indicate the internalization of these relations between conceptual and problem space (Palincsar, Anderson, & David, 1993). In other words, learners who apply theoretical concepts to problems collaboratively may be able to transfer this knowledge to future problem cases and apply theoretical concepts individually (Vygotsky, 1978). The frequency of the construction of relations between conceptual and problem space may thus indicate knowledge acquisition. A further question is if learners apply new conceptual space that is to be learned or apply concepts from prior knowledge. Another question is whether learners construct relations between conceptual and problem space *adequately* and acquire adequate application-oriented knowledge or if collaborative learners do not apply knowledge adequately and may acquire misconceptions (e.g., Palincsar et al., 1993; Schwarz, Neumann, & Biezuner, 2000; Weinberger, Stegmann, & Fischer, 2004).

1.3 Argument Dimension

In argumentative knowledge construction learners need to inquire complex problems. Learners need to construct and balance arguments and counterarguments in order to prove possible resolutions to these problems (Walton & Krabbe, 1995). Learners thus continuously warrant, qualify or argue against solutions to the problems until they converge towards a joint solution. On the argument level, discourse corpora can be analyzed with respect to (1) the construction of arguments (see table 3) and (2) the construction of sequences of arguments (see table 4). Apart from argumentative moves, non-argumentative moves can be differentiated. Non-argumentative moves do not contain a claim and comprise questions, coordinating moves, and meta-statements on argumentation.

(1) The *construction of single arguments* is based on Toulmin's model of arguments with the elements *claim*, *ground with warrant*, and *qualifier* (Toulmin, 1958; van Eemeren, 2003; Voss, Tyler, & Yengo, 1983; Voss & Van Dyke, 2001). Claims are statements that advance the position learners take. Grounds with warrants present the reason why a claim is valid. Grounds are evidences, e.g., observations or experiences, and warrants are logical connections between the grounds and claims that indicate how a claim is supported by the grounds. Qualifiers, on the contrary, are statements that limit the validity of a claim to specific circumstances.

Constructing arguments with these elements facilitates self-explanation of the learning material (Baker, 2003). Self-explanation is supposed to facilitate the integration of new knowledge into existing cognitive structures. Self-explanations were spontaneously generated by good students and learners prompted to give self-explanations acquired higher forms of knowledge than unsupported learners (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Chi, DeLeeuw, Chin, & LaVander, 1994).

There are indications that even adult learners rarely construct warranted and qualified claims on their own (Kuhn, 1991). In asynchronous CSCL, however, learners have more time to formulate their arguments, which may facilitate argumentative knowledge construction

(Marttunen & Laurinen, 2001). In CSCL, argumentation can also be visualized, e.g., by graphical connections that indicate arguments and the corresponding counterarguments on the screen, and support learners to refine their argumentation (Kirschner, Buckingham Shum, & Carr, 2003).

(2) In discourse, single arguments need to be arranged in a line of argumentation. Typically, participants collect arguments that support one specific perspective rather than building sequences of arguments that represent different perspectives (Kuhn, 1991). Specific *sequences of argumentation* representing different perspectives, however, facilitate knowledge acquisition (Leitão, 2000). These specific sequences of argumentation consist of arguments, counterarguments, and replies. Leitão states that the individual steps of this argumentation sequence represent a knowledge building cycle. First, knowledge building in discourse requires that learners construct arguments to justify their position. This construction of arguments facilitates self-explanation of the learning material (see Baker, 2003). Second, learning partners construct counterarguments to challenge and reconsider these positions. Counterarguments facilitate meta-cognitive activities, prompting learners to rethink their initial argument (Leitão, 2000). Finally, learners construct replies and eventually refine the initial positions. By balancing arguments and counterarguments in order to solve complex problems, participants may learn how to argue within a domain and acquire content-knowledge. With the construction of sequences of argumentation, learners may acquire multiple perspectives upon a problem. The acquisition of multiple perspectives on a problem facilitates learners to flexibly apply the newly acquired knowledge to solve future problems (Spiro, Feltovich, Jacobson, & Coulson, 1991).

1.4 Dimension of Social Modes of Co-Construction

The way how learners solve a task and construct arguments may be distributed to different degrees over several members of one learning group. The social modes of co-construction describe to what extent learners refer to contributions of their learning partners, which has been found to be related to knowledge acquisition (Fischer et al., 2002; Teasley, 1997). Specific social modes differ in the degree to which learners refer to contributions of the learning partners (see table 5).

(1) *Externalization* means that learners make contributions to discourse without reference to other contributions. When externalizing, learners may explicate their knowledge, e.g., writing a new analysis of a problem case. Discussions typically start with externalization. Externalization is mainly motivated by social situations (Cobb, 1988). Learners externalize what they know, e.g., to explain their perspective. This may also make (mis-) conceptions accessible for learners in a group. By externalization, learners need to restructure knowledge into a linear form. Thus, knowledge is simultaneously reorganized when it is externalized (Huber, 1987).

(2) *Elicitation* has been described as using learning partners as a resource by asking questions (Dillenbourg et al., 1995). Elicitation aims at receiving information from the learning partners. Some studies showed that in more successful groups more task-related questions have been asked (e.g., King, 1994). Based on these findings, some approaches successfully foster group learning by facilitating the generation of questions (King, 1999; Rosenshine, Meister, & Chapman, 1996). There are, however, indications that elicitation and reception of help can be detrimental when learners become dependent on this help (Webb, Ender, & Lewis, 1986). Instead of attempting to work on the learning task, students may rather seek help from others, e.g., teachers. Thus, elicitation appears to facilitate knowledge

acquisition only if learners receive help and apply the help in the situation themselves (Webb, 1989).

(3) In order to improve collaboration, learners need to build a task-specific minimum consensus or common ground regarding the learning task in a process of negotiation (Clark & Brennan, 1991). There are different styles of reaching consensus, however. *Quick consensus building* can be described as learners accepting the contributions of their learning partners not because they are convinced, but in order to be able to continue discourse (Clark & Brennan, 1991). In this way, quick consensus building may not indicate an actual change of perspective, but is rather a coordinating discourse move (Fischer et al., 2002; Weinberger, 2003). Even though quick consensus building may be fundamental to manage interaction in CSCL, quick consensus building may be detrimental to individual knowledge acquisition, when learners disregard other forms of consensus building in favor of quick consensus building (Keefer, Zeitz, & Resnick, 2000; Leitão, 2000; Linn & Burbules, 1993; Nastasi & Clements, 1992).

(4) Recent approaches towards collaborative learning stress that collaborative learners may eventually establish and maintain shared conceptions of a subject matter (Roschelle & Teasley, 1995). Learners approximate and integrate each others perspective, synthesize their ideas, and jointly try to make sense of a task (Nastasi & Clements, 1992). In contrast to quick consensus building, *integration-oriented consensus building* is characterized by a take over of perspectives. Integration occurs when individual learners operate on the basis of the reasoning of their learning partners. An indication for integration-oriented consensus building is that “participants show a willingness to actively revise or change their own views in response to persuasive arguments” (Keefer et al., 2000, p. 77). Learners may give up or modify initial beliefs and correct themselves on the basis of peers’ contributions. Studies to

date have produced inconclusive results on integration-oriented consensus building and individual knowledge acquisition (Fischer et al., 2002; Weinberger, 2003). Integration-oriented consensus building appears to take place rarely in comparison to other social modes of co-construction. Learners seem to hardly elaborate a change of their perspectives in discourse.

(5) *Conflict-oriented consensus building* has been considered an important component in the socio-cognitive perspective upon collaborative learning (Doise & Mugny, 1984; Teasley, 1997). By facing critique, learners may be pushed to test multiple perspectives or to find more and better arguments for their positions (Chan, Burtis, & Bereiter, 1997). When building consensus in a conflict-oriented manner, learners need to pinpoint out specific aspects of their peers' contributions and modify them or present alternatives. Thus, learners need to more closely operate on the reasoning of their peers in comparison to, e.g., simple acceptance of peers' contributions.

The extent to which learners operate on the reasoning of their peers has been termed *transactivity* (Teasley, 1997). Transactivity of learners' discourse is positively related to individual knowledge acquisition (Teasley, 1997). Teasley has defined a scale of transactivity on which the different social modes can be allocated. The five social modes of co-construction represent different degrees of transactivity according to this scale. Externalization, for instance, is regarded as the least transactive social mode, whereas conflict-oriented consensus building is the most transactive social mode on Teasley's scale.

In summary, we propose a conceptual framework for the analysis of argumentative knowledge construction in written CSCL discourse (table 1 to 5).

We will illustrate and discuss how to analyze the process dimensions of argumentative knowledge construction with reference to some example fragments of discourses, which have been led by learning groups of three in an online learning environment (see appendix).

2. Organization of the Discourse Corpora

Before analyzing raw discourse corpora (see appendix), the material needs to be organized, which particularly means sampling and segmenting the discourse corpora.

3.1 Sampling the Discourse Corpora

The process-oriented research on collaborative learning is faced with an enormous amount of data. Researchers apply two different heuristics in order to reduce data to a manageable amount. *Time point sampling* means that at specified points in time, parts of the discourse corpora are being selected and analyzed. The discourse corpora are being segmented according to time stamps and only the discourse activity at this time stamp enters the dataset for statistical analysis. This method is based on the assumption that the frequency of certain events is related to the dependent variable, which is typically individual knowledge acquisition in the CSCL context. For instance, under the assumption that the frequency of elicitation is related to knowledge acquisition, at specified intervals, e.g., at each 5th minute, the current discourse activity is categorized as elicitation or not. In contrast, discourse data may be reduced by selecting a *coherent subset on the basis of a criterion*, which is independent from the categories that are supposed to be applied (Chi, 1997). These criteria can be, for instance, the discourse production of a single person or parts of a discussion that can be allocated to a specific theme. This sampling method is based on the assumption that the frequency of events and their contexts relate to the dependent variable (cf. Schrire, this issue). For instance, under the assumption that specific sequences of (a) elicitation, (b) the replies that may follow elicitation, and (c) the way how learners may operate on the elicited information are related to knowledge acquisition (see Webb, 1989), sampling needs to be based on a coherent subset of discourse data. Such a sample provides information about the frequency of events within the subset as well as preceding and following events.

In our case, learners were supposed to discuss three distinct problem cases in different discussion boards (see appendix). In order to reduce data, a subset of discourse corpora was chosen (one discussion on one of the three problem cases), which enabled us to analyze specific sequences within a discussion on one specific theme.

In conclusion, time point sampling is an objective sampling method that should be applied if frequencies of specific discourse activities are being investigated. The discourse activity at the specified time enters the analysis. Subset sampling should be applied if frequencies and sequences of discourse activities are being investigated. The criterion of the subset selection needs to be described and discussed in detail in order to qualify and make the sampling procedure reproducible.

3.2 Segmentation of the Discourse Corpora

Segmentation of discourse means that the text that collaborative learners produce is being divided into units of analysis or segments. Some of these units of analysis are set by the participant of discourse and typically, do not need to be agreed upon by raters, e.g. messages, sentences, words, or single signs. However, these segments may be ill-defined by participants of discourse (e.g., inadequate use of punctuation marks in online discourse). Furthermore, these segments may be too coarsely grained and therefore contain several discourse activities relevant to learning, e.g., within a message, or too fine grained and not well represent learning activities, e.g., a single sign (see Schrire, this issue). In a first step, various raters need to segment the whole sample based on a set of rules and produce comparable segments that capture learning activities. In a second step independent from segmentation, all of these segments are categorized and thus, the frequencies of specific discourse activities can be analyzed that are related to knowledge acquisition according to argumentative knowledge construction. Segments may range from individual signs to complete essays (see Strijbos, Martens, Prins, & Jochems, this issue). The granularity of segmentation is highly dependent on the research questions that are supposed to be investigated. In order to capture cognitive processes of learning to apply and argue with given concepts, the granularity of segmentation needs to be adjusted at multiple levels. In accordance with Chi (1997), we suggest considering multiple grain sizes for the analysis of discourse corpora. Chi states that the segment granularity represents different levels of knowledge in discourse. Macro-level segments represent how learners connect principles and concepts whereas micro-level segments represent the correct reproduction of single concepts. Thus, we segmented the discourse corpora hierarchically on a micro- and a macro-level.

On a *micro-level* we can identify several segments that inform us what epistemic steps learners take to solve the problem, e.g., what relations between conceptual and problem space learners construct, and if these relations are adequate. The micro-level segments were thus categorized on the epistemic dimension (Weinberger, Fischer, & Mandl, 2001). Micro-segments consist of relations between theoretical concepts and/or case information. A micro-segment therefore can consist of a relation between two theoretical concepts to indicate construction of conceptual space, e.g., “Attributions on talent are internal attributions”, a relation between two pieces of case information to indicate construction of problem space, e.g., “Michael’s father was telling a story about his problems in mathematics”, or a relation between theoretical concepts and case information, e.g., “Michael’s attribution is internal and stable”.

On a *macro-level*, we can analyze how micro-segments are related to each other. For instance:

> "The teacher simply cannot understand what's going on with Michael and she somehow doesn't care. You should send her to re-attribution training as well."

On a macro-level we may see in this example that the student is arguing to provide re-attribution training for the teacher (one micro-segment), because she does not take the problematic attribution pattern of one of her students into consideration (another micro-segment). One macro-level segment consists of at least two micro-level segments. In our case, the segmentation of micro- and macro-level is hierarchically nested and scaleable to the macro-level which is composed of segments of the micro-level (see figure 1). This hierarchical segmentation may aid to relate the segments of different grain sizes to each other, e.g., to easier cross-validate results produced with different segmentation granularities.

The different process dimensions of argumentative knowledge construction require different grain sizes. In our series of studies, we analyzed the micro-level to capture how learners related concepts and case information with each other (epistemic dimension). Within one micro-segment, exactly one theoretical concept is related to one piece of case information. Coarser grained segments can capture the construction of arguments (argument dimension) and how learners refer to contributions of their learning partners (social modes dimension). On these process dimensions, we have coded the micro-segments with respect to how the micro-segments are related to other micro-segments in order to acquire an understanding of how learners construct sequences of argumentation and refer to contributions of their learning partners. Different grain sizes thus correspond to different process dimensions on which the discourse corpora can be analyzed (see section "Process

Dimensions of Argumentative Knowledge Construction in CSCL"). Even though single fine grained segments do not provide information on the macro-level, the raters could reliably analyze the macro-level by categorizing each micro-segment with respect to the function it has within a sequence of prior and subsequent micro-segments (see below for kappa values).

How can we assess the reliability of the segmentation? Several raters may segment discourse corpora in order to measure similarity and affirm the reliability of the segmentation. The percentage of agreement on segmentation between two or more raters can indicate inter-rater reliability. With regard to the micro-segmentation applied in our studies we attain a complete agreement of 87% of the segments. This value may be distorted, however. Raters may coincidentally identify the identical segments. In order to exclude coincidental overlap, Cohen's Kappa can be applied ($\kappa = .72$ in our example). Cohen's Kappa, however, measures inter-rater reliability on the categorization of defined units of analysis. Applying Cohen's Kappa with regard to segmentation may easily result in negative values due to the fact that a binary category is being applied (agreement or non-agreement), whereas simultaneously, the degrees of freedom for raters to set the beginning and end of a segment are high (see Strijbos et al., this issue). Therefore Cohen's Kappa can be regarded as a highly conservative indicator of the reliability of the segmentation on a micro- and macro-level.

4. Process Dimensions of Argumentative Knowledge Construction in CSCL

Once a sample of the discourse corpora has been segmented, all segments can be coded with a set of categories. Categories should help to measure the constructs of the research questions. Assuming that collaborative learning does not comprise one single learning mechanism, we need to analyze multiple dimensions of learners' discourse. Whereas dimensions such as participation can be measured objectively and reliably (e.g., by counting the number of words), other dimensions require a qualitative analysis, which includes interpretative work by coders. In order to assure reliability of the interpretative work, a coding scheme has been realized as an explicit comprehensive set of rules to distinguish between categories (Weinberger et al., 2001). Furthermore, raters need to be trained to apply the coding scheme appropriately.

In the following paragraphs, we will describe how we measured the dimensions of argumentative knowledge construction with a coding scheme, namely the dimension of participation, the epistemic dimension, the argument dimension, and the dimension of social modes of co-construction.

4.1 Dimension of Participation

Two aspects of participation will be introduced in this section. First of all, we will illustrate how we measured the overall quantity of participation in CSCL. Second, a measure for participation heterogeneity in CSCL is being outlined.

The *quantity of participation* in CSCL can be easily measured by the words the discussants actually produce, e.g., with the word count function of the text editor used. In the example discourse (see appendix) it would be (in the original German language):

Student Ahorn: 743 words in 9 messages

Student Birke: 118 words in 3 messages

Student Pinie: 481 words in 5 messages

Another aspect is apparent: In the example discourse, student Ahorn contributes more than six times as much as student Birke. The *heterogeneity of participation* can be measured by aggregating the standard deviation of the individual values of quantity of participation on the group level. The group level variable indicates the heterogeneity of participation. The higher the value, the more distance of the quantity of participation values within one group could be found, and the more heterogeneous has been the participation within the group. The lower the value, the more homogeneous was participation within that one group. This method has been developed for measuring team knowledge (Cooke, Salas, Cannon-Bowers, & Stout, 2000) and has been applied by Fischer and Mandl (2001a). However, this measure is problematic with respect to extreme values. For instance, learners with extremely low quantity of participation values in a group may participate more homogeneously. If nobody contributes anything, participation is perfectly homogeneous.

Thus, the relationship of the quantity and the heterogeneity of participation may be only indicative in a well specified middle range, but produce statistical artifacts in the upper and lower extremes. Together with mathematicians, we are currently experimenting with a measure to consider these artifacts and prepare a publication on this issue.

4.2 Epistemic Dimension

The epistemic dimension can be hierarchically analyzed with regard to the questions if students actually discuss the task (on-/off-task talk), how learners work on the task (epistemic activities), and finally, with regard to the question whether learners apply concepts adequately (content-related adequacy of epistemic activities). The epistemic dimension was measured with a sufficient inter-rater agreement (Cohen's Kappa $\kappa = .90$).

Learners may either *work on the task* or may digress *off-task* in CSCL environments. What can be regarded as off-task? For instance, learners may coordinate off-task aspects of their environment, e.g., asking for a cup of coffee. In our approach to discourse analysis we consider any discourse activity as off-task, which does not have explicit reference to learning material to solve the task. This includes statements about the learners or the group, meta-statements on the discourse, commentaries on the learning environment as well as coordinating utterances with reference to neither the problem case nor the theoretical concepts being applied. Furthermore, segments in which learners refer to other contents than the given learning material with goals different from solving the task are considered off-task.

Example 1: “We are a great team, aren’t we?”

Example 2: “I don’t think this is polite.”

Example 3: “Weather could be better.”

In the discourse example (see appendix) none of the learners engaged in off-task talk according to this framework except for student Ahorn when requesting verification from the learning partners.

Learners engage in different *epistemic activities* when they explicitly refer to learning material in order to solve the learning task. An epistemic dimension thus refers to the tasks learners are confronted with, e.g., categorizing or defining new concepts. Learners within our CSCL environment needed to construct the problem space, the conceptual space, and the relations between conceptual and problem space. *Construction of problem space* means that learners repeat or discuss case information without reference to conceptual space. An example for the construction of problem space would be “Michael is at the school counselor and expresses worries on his performance in mathematics. He recalls several statements on his prior performance from his parents and his teacher”. *Construction of conceptual space* means that learners talk about or repeat theoretical concepts and principles without reference to problem space. An example for the construction of conceptual space was “In Weiner’s scheme there is a total of four possible kinds of attribution. One of them would be for instance, that learners attribute towards their talent”. *Construction of relations between conceptual and problem space* means that learners apply conceptual space to problem space.

Examples for the construction of relations between conceptual and problem space can be found in the discourse example (see appendix), when student Birke understands that the case information “lack of talent” – explicated by the case protagonist “Michael” as well as Michael’s parents – is an attribution. In this sample, learners are mainly concerned with constructing relations between case information and conceptual space.

A further step that we took in the analysis of the epistemic activities was to assess their *content-related adequacy*. Do learners relate concepts adequately to case information in comparison to expert solutions? What typical errors can be detected? Do learners use the concepts to be learned or do they apply concepts from prior knowledge? In order to answer these questions, the individual relations between conceptual and problem space that the learners constructed need to be investigated in detail. First of all, we asked experts familiar with the theory, which was to be learned, to analyze the problem cases the learners needed to solve. The expert solutions were characterized by a number of relations between the conceptual space (attribution theory; Weiner, 1985) and problem space (the cases; see appendix).

In a second step, the relations that the learners constructed were compared to these expert relations of the conceptual space and the problem space. Based on this comparison, the learners’ statements could be categorized as *adequate relations of conceptual space of the given (attribution) theory and problem space*, e.g., “The fact that Michael says that he is not talented points toward an internal stable attribution”, as *adequate relations of alternative conceptual space, e.g., other motivational theories, and problem space*, e.g., “Michael may actually be lazy – maybe he simply lacks interest in mathematics” and *inadequate relations between the given conceptual space (attribution theory) and problem space* on which typical errors could be identified, e.g., “Michael says he is not talented, but he is actually only lazy.

That is an internal variable attribution”. For the problem cases used in our studies we have identified an empirical maximum of about 30 different adequate relations between given conceptual and problem space, approx. 20 different adequate relations of alternative conceptual and problem space, and about 40 different inadequate relations between conceptual and problem space per case. The individual relations between conceptual and problem space and their number differ of course from case to case.

4.3 Argument Dimension

On the argument dimension, the construction of single arguments and the construction of sequences of arguments can be differentiated. The argument dimension was measured with a sufficient inter-rater agreement (Cohen’s Kappa $\kappa = .78$).

Toulmin’s model on argumentation comprises the elements *claim*, *ground with warrant*, and *qualifier* with regard to the *construction of single arguments* (Toulmin, 1958). For instance, the *claim* “Michael is a good student” can be *warranted with grounds*, e.g., “Michael is a good student, because he critically reflects the given learning material”. *Qualifiers* define the scope of the argument, e.g., with respect to the above example “but critical reflection of learning material may be dysfunctional at times when he dismisses the learning material altogether”. Thus, the argument dimension can be coded hierarchically. Within the argument dimension, segments are regarded as claims if they do not serve as grounds or qualifiers for other claims. Participants put forward claims that per se lack grounds, e.g., “Michael’s attribution pattern is bad”. With the help of word indicators such as “because”, “due to the fact”, “therefore” etc. and by logical coherence, claims may be additionally identified as warranted claims based on grounds, e.g., “because according to this explanation there is no point in learning”. However, grounds with warrants are not always explicitly connected to claims and claims do not necessarily precede but may follow the grounds, e.g., “Michael says he is not talented. He is attributing internally". Similarly, a claim is coded as a qualified claim when "if", "maybe", "under the circumstances that" etc. precedes it. Similar to grounds with warrants, however, qualifiers are not always explicitly indicated. Qualifier and ground with warrant are independent attributes of claims. Thus, a claim may be simple, warranted, qualified or both, warranted and qualified. Claim, ground with warrant and qualifier of an argument may be distributed over several micro-segments. This opens up the question, what segment should be coded as warranted / qualified claim? In order to assure that the quantitative data represents the share of simple, warranted and/or qualified claims, we coded the micro-segments containing grounds with warrants or qualifiers as warranted / qualified claims. For instance, if the claim "Michael is attributing internal stable" is warranted by the grounds "He is saying he has not talent", the later segment containing the ground is therefore coded as ground for the claim. The learner might have collected more grounds for this claim, such as "because he is saying that it is his own fault" or "this will never change". Each of these micro-segments would then be additionally coded as further ground for the claim.

Sequences of arguments consist first of all of at least one *argument* in favor of a specific point, e.g., "Michael is a good student". Any new (warranted / qualified) claim is coded as an argument that has not been preceded by a conflicting argument. *Counterarguments* consequently attack the existing arguments by putting up contrary or alternative claims, e.g., "Michael is a bad student". Any claim, which challenges and contradicts the earlier argument, is coded as a counterargument in addition to and independent of its coding as warranted / qualified claim. *Replies* consider and differentiate at least two preceding arguments, e.g., "Some of Michael's learning strategies are functional, some are suboptimal" or take the discussion to a higher level, e.g., "We need to define what we mean by 'good' or 'bad' student and analyze Michael's learning strategies with respect to his goal orientation". Any claim supporting points of more than one line of preceding arguments is thus regarded as a reply.

Additional discourse consists of non-argumentative moves if it does not contain a claim. This comprises questions, e.g., "How could the attribution of his parents take effect on Michael's future learning behavior?", coordinating moves like "Now you do this case and I write something about the attribution of the teacher in more detail" and meta-statements on argumentation such as "I will work out my argumentation here".

With respect to the discourse example (see appendix), e.g., student Pinie's contribution is the claim "there will hardly be an improvement of performance", which is backed up by "because Michael ascribes his deficit in math to a lack of talent" and by "he is also affirmed in doing so by the statement of his parents".

4.4 Social Modes of Co-Construction Dimension

On the *social modes dimension*, the discourse segments can be rated with respect to how learners work on the task and formulate arguments together (as opposed to individually). The categories of the social modes dimension were measured with a sufficient inter-rater agreement (Cohen's Kappa of $\kappa = .81$).

For categorization, *externalization* has been defined as new contributions to discourse without any explicit or implicit references to previous contributions. Thus, a first message of a discussion board or a discussion thread typically contains externalization. Assuming that Pinie's message was the first message within the discussion board (see appendix), it would contain externalizations only. Furthermore, contributions in an evolving discussion thread can be rated as externalization, when they do not comment on any other message.

Elicitation has been defined as a segment through which learners actively request information from the learning partner. Typically, elicitation is a question, but does not necessarily need to have the syntactic form of a question. Elicitation thus comprises not only comprehension questions that refer to the gathering of new information due to lack of understanding the theory or the peers' contributions like "Why do you believe that Michael assumes an internal stable cause responsible for his deficits?". Elicitation also comprises requests for feedback that demand an affirmative or a negative response from a learning partner, i.e. a statement on already explicated contents, e.g., "In my opinion, the parents support a negative attribution pattern. Don't you think so?". Furthermore, the requests for specific actions from the learning partners, such as "You need to change your analysis here!" can also be regarded as elicitation. In the discourse example (see appendix), student Ahorn produces an elicitation in form of a request for feedback "What do you think?".

Quick consensus building has been defined as acceptance of a peer contribution without any modification or indication that the peer perspective has been taken over by the learner. This acceptance can be signaled explicitly, e.g., "That's right!" or in form of an unmodified rephrasing of what the learning partner has stated before. Rephrasing means either that learners literally repeat an original phrase or use other words to repeat a statement but do not change the meaning, e.g., student Pinie stating "Michael does not feel like investing effort in mathematics" and student Birke rephrasing "Michael just does not like to learn for this subject". We have coded any slight modification of a statement different than quick consensus building.

Integration-oriented consensus building means that learners take over the perspectives of their learning partners. An example for such an integrative reply would be:

Statement 1: "Michael attributes to internal stable causes"

Statement 2: “You are right, and this attribution pattern is suboptimal with regard to learning.”

A consecutive exchange of contributions leading to integration may be the exception. Instead, learners may integrate different perspectives during a later time in the discussion, e.g., when writing a summarizing analysis of the case after the collaborative phase. In order to categorize integration-oriented consensus building it is important to note that the integrative move significantly differs from a juxtaposition of perspectives, but indicates a further development of the analysis from a learning partner.

Conflict-oriented consensus building means that learners do not accept the contributions of their learning partners as they are. Conflict-oriented consensus building may appear in different more or less explicit guises in discourse. Indicators for conflict-oriented consensus building are the rejection, exclusion or negative evaluation of peer contributions. Rejection may be explicit, e.g., “I don’t think so”, but can also be realized by replacement, modification or supplementation of a peer contribution. For instance, when student A proclaims “The attribution of the teacher is de-motivating”, student B *replaces* this claim with “The attribution of the teacher is beneficial, because it gives Michael the opportunity to accomplish better math grades in the future.” A modification may take the following shape: Student A: “The attribution of the parents is positive, because Michael is being freed of his feelings of guilt”, whereas student B *modifies* “The attribution of the parents is to that extent positive as the parents do not exert pressure on Michael and bear him out in his performance as a matter of principle.” Supplementation may be, for instance, student A stating “The teacher motivates Michael by ascribing his bad performance to his laziness” and student B *supplementing* “The teacher also motivates Michael by evaluating the attributions of his parents.” Thus, not only explicit and absolute rejections, but also slight repairs of peer contributions indicate conflict-oriented consensus building (Clark & Brennan, 1991). In the discourse example (see appendix), student Birke supplements the initial statement of student Pinie and student Ahorn replaces student Birke's contribution.

5. Using the Framework - Exemplary Results of Empirical Studies

This framework has been applied in a series of studies with more than 600 participants that investigated the effects of instructional support in the form of computer-supported collaboration scripts that aim to support specific process dimensions of argumentative knowledge construction on processes and outcomes of argumentative knowledge construction (see Weinberger et al., in press). We investigated the effects of epistemic, argumentative and social script components so far in our studies and applied this framework to analyze argumentative knowledge construction in computer-supported collaborative learning. Thus we could examine if this framework is sensitive enough to measure the specific script effects on the processes and to investigate the relations between specific processes and outcomes of argumentative knowledge construction. Each study was conducted with groups of three learners within a CSCL environment (see appendix for the procedure of the studies). In total, the framework has been applied in more than 200 discussions comprising more than 17,000 coded text segments.

For each study, a number of student coders (ranging from 2 to 6) had to be trained to apply the framework to the discourse corpora. Each coder received a booklet with a detailed description of the framework including all coding rules and examples for each category to ensure coding reliability. The training comprised group meetings, dyadic interaction, and individual practice. At regular intervals, the inter-rater agreement was computed. Disagreements were localized and focused on in the training. Eventually, further rules were added to the booklet in order to regulate specific disagreements and refine the coding rules.

During this training, coders segmented and categorized between 1000 and 1500 segments of the discourse corpora in the separate studies. Inter-rater reliability was analyzed based on the coding of approx. 200 to 500 segments of the discourse corpora in the separate studies. The training for each group of coders required several weeks, or about 500 working hours per study. The coding itself took about one month in each study or about 1200 working hours.

The application of the framework for analyzing argumentative knowledge construction revealed that each script component successfully facilitated participation and the process dimension it was set out for. Simultaneously, however, the script components had in part negative side effects on the process dimensions of argumentative knowledge construction it was not set out for (see table 6 for a short overview of the results of the study). The epistemic script component fostered adequate epistemic activities, but had negative effects on the argument and the social dimensions. The argumentative script components facilitated the construction of arguments, but impeded adequate epistemic activities. The social script fostered transactive social modes, but reduced the construction of arguments. The scripts have been designed to facilitate specific process dimensions and the discourse analysis based on the framework has shown the expected results on the respective process dimensions. These results can thus be regarded as a first cross-validation of the framework and indicate that the framework can measure processes of argumentative knowledge construction on different dimensions.

Applying the multi-dimensional framework also reveals that different process-oriented instructional supports also have different effects and side effects on specific process dimensions. These specific processes also relate to different extends with the outcomes of argumentative knowledge construction. The acquisition of multi-perspective domain-specific knowledge, for instance, is not only related to the construction of conceptual space and construction of relations between adequate conceptual and problem space, but also to specific social modes of co-construction, such as conflict-oriented consensus building (see Weinberger, 2003 for a detailed report on these results). If an one-dimensional framework would have been applied, we could not have inferred the (in-)efficiency of scripts regarding the outcomes to the respective (side) effects on the processes of argumentative knowledge construction.

6. Summary of the Framework and Open Questions

Quantitatively analyzing argumentative knowledge construction requires researchers to decide with respect to several questions. Considering theoretical background and research questions, discourse corpora need to be sampled, segmented and categorized. In a first step, discourse data in the CSCL context typically needs to be reduced. Even though time sampling methods have shown to be reliable means to measure frequencies of discourse activities, the analysis of coherent subsets of the discourse corpora enables the investigation of discourse segments of multiple grain sizes and their interrelations. Thus, the analysis of subsets allows investigation of not only the frequency, but also the patterns and sequences of events in discourse (e.g., Janetzko & Fischer, 2003). We are currently working on semi-automatic sequential analyses of the discourse corpora.

In a second step, the segmentation of the discourse corpora can strongly influence what kind of research questions can be answered with discourse analysis. The coding of multiple processes of argumentative knowledge construction requires different grain sizes.. As micro- and macro-level of segmentation of this framework are hierarchically nested, micro-segments can be categorized with respect to their function on the macro-level.

In a third step, the presented framework aimed to capture multiple process dimensions of collaborative learning based on our approach to argumentative knowledge construction. Our studies have shown that this coding scheme can be fruitfully applied in the CSCL context. With the help of this coding scheme we were able to show that computer-supported collaboration scripts can foster specific process dimensions of argumentative knowledge construction in CSCL (Weinberger, Stegmann, Fischer, & Mandl, 2004). (1) The participation of the learners on CSCL discourse was described in terms of quantity and heterogeneity of participation. These sub-categories of the participation dimension could be objectively measured and may thus pose reliable indicators for learning processes in CSCL environments. (2) We investigate the epistemic dimension of CSCL discourse. Do learners work on the task? How do they work on the task? And how do learners apply concepts to solve the task? (3) We investigated how learners build single arguments and sequences of arguments with respect to how they back up and / or qualify their claims, and with regard to how learners build sequences of arguments, counterarguments and replies. (4) We distinguished five sub-categories on the social dimension with increasing degrees of transactivity ranging from externalization to conflict-oriented consensus building.

This framework has been applied and optimized in several studies in CSCL environments. The results of these studies show that processes of argumentative knowledge construction can be facilitated very specifically. This is an indication of the validity of the framework, as the dimensions are independent of each other to a high degree. The results gained with the coding scheme add substantially to our understanding of specific discourse activities and process-oriented instructional support in CSCL environments for facilitating knowledge construction. Most importantly the results showed, that highly effective process-oriented CSCL interventions may have unintended side effects on other process dimensions. For example, the negative effects of the epistemic script component on the social mode dimension and the argumentation dimension opened up a wider discussion on the design of effective content-related support for collaborative learning on a more general level (Mäkitalo, Weinberger, Häkkinen, Järvelä, & Fischer, in press). The application of the framework may thus contribute to extend our understanding of how patterns of activities on different process dimensions of argumentative knowledge construction may influence knowledge acquisition. Side effects of instructional support could not be revealed without the multiple process dimensions of the framework.

However, some limitations of the approach have to be considered as well. First, we currently do not know how useful the framework would be with respect to the analysis of knowledge construction processes in other content areas of CSCL. The framework has been applied only for complex problems within education and educational psychology. With respect to other domains of knowledge, e.g., natural sciences, we currently strive to adopt the framework for analyzing argumentative knowledge construction in inquiry learning (Kollar & Fischer, 2004). In the context of a EU-funded European Research Team, we are addressing the formalization of script components aiming at specific process dimensions of argumentative knowledge construction. Formalized script components are intended to be re-used in different learning environments and domains. Thus, scripts to facilitate domain-specific processes can be developed and investigated. In these terms, we seek to refine the framework with regard to different contexts and accumulate knowledge on the relation between different processes and outcomes of argumentative knowledge construction in CSCL environments.

Second, even if data reduction through selecting a subset sample of the data might be a successful and feasible approach, the application of the framework is still a challenge due to the enormous work load of analyzing discourse corpora on multiple dimensions on a micro-level and a macro-level of segmentation. In order to reduce this work load we collaborate with computer linguists to provide human coders with a tool called TagHelper, designed for supporting and streamlining the analysis of discourse corpora on the multiple dimensions of argumentative knowledge construction (Donmez, Rosé, Stegmann, Weinberger, & Fischer, 2004).

Future issues in analyzing argumentative knowledge construction in CSCL environments include how patterns of discourse activities can be identified using the framework (see Janetzko & Fischer, 2003). Another important question is how effects can be analyzed with the coding scheme on an individual level and on a group level. Due to restrictions of multi-level modeling, there is little knowledge on methods to analyze how individual participants of small learning groups influence each other and, e.g., converge with respect to their knowledge (Fischer & Mandl, 2001b). Moreover, we regard the question of how we can combine qualitative and quantitative analyses on the basis of the dimensions of argumentative knowledge construction as an important next step in further developing the framework. So far, we have applied case studies to illustrate and expand the argumentative knowledge construction approach in CSCL, e.g., with regard to the function of elicitation as a social mode to reduce uncertainty in online learning environments (see Mäkitalo et al., in press).

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Table 1

Categories of the participation dimension of argumentative knowledge construction

Category	Description
Quantity of participation	Entering a CSCL environment and contributing to online discourse.
Heterogeneity of participation	(Un-)Equal participation of learners in the same group

Table 2

Categories of epistemic dimension of argumentative knowledge construction

Category	Description
Epistemic activities	
Construction of problem space	Learners relate case information to case information within the problem space with the aim to foster understanding of the problem.
Construction of conceptual space	Learners relate theoretical concepts with each other and explain theoretical principles to foster understanding of a theory.
Construction of adequate relations between conceptual and problem space	Applying the relevant theoretical concepts adequately to solve a problem. Learners relate theoretical concepts to case information. A number of concept-case-relations may need to be constructed to adequately solve a complex problem.
Construction of inadequate relations between conceptual and problem space	Applying theoretical concepts inadequately to the case problem. Learners may select the wrong concepts or may not apply the concepts according to the principles of the given theory.
Construction of relations between prior knowledge and problem space	Applying concepts that stem from prior knowledge rather than the new theoretical concepts that are to be learned.
Non-epistemic activities	Digressing off-topic.

Table 3

Categories of microlevel of formal dimension of argumentative knowledge construction

Category	Explanation
Argumentative moves	
Simple claim	Statements that advance a position without limitation of its validity or provision of grounds that warrant the claim.
Qualified claim	Claim without provision of grounds, but with limitation of the validity of the claim (with qualifier).
Grounded claim	Claim without limitation of its validity, but with the provision of grounds that warrant the claim.
Grounded and qualified claim	Claim with grounds that warrant the claim and a limitation of its validity.
Non-argumentative moves	Questions, coordinating moves, and meta-statements on argumentation

Table 4

Categories of macrolevel of formal dimension of argumentative knowledge construction

Category	Description
Argumentative moves	
Argument	Statement put forward in favor of a specific proposition.
Counterargument	An argument opposing a preceding argument, favoring an opposite proposition.
Integration (reply)	Statement that aims to balance and to advance a preceding argument and counterargument.
Non-argumentative moves	Questions, coordinating moves, and meta-statements on argumentation

Table 5

Categories of social modes dimension of argumentative knowledge construction (SOC)

Category	Description
Externalisation	Articulating thoughts to the group.
Elicitation	Questioning the learning partner or provoking a reaction from the learning partner.
Quick consensus building	Accepting the contributions of the learning partners in order to move on with the task.
Integration-oriented consensus building	Taking over, integrating and applying the perspectives of the learning partners.
Conflict-oriented consensus building	Disagreeing, modifying or replacing the perspectives of the learning partners.

Table 6

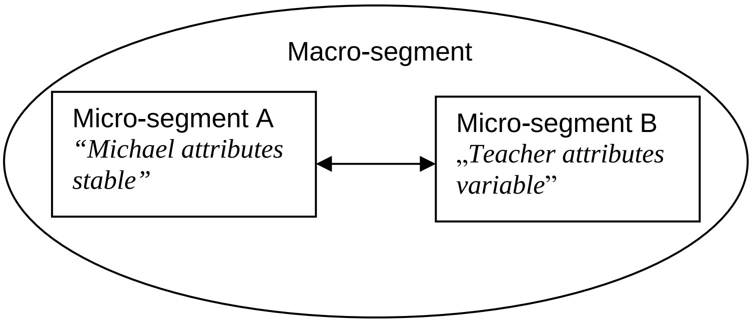
Overview of Effects of the Script Components on the Process Dimensions of Argumentative Knowledge Construction

	Dimensions of Argumentative Knowledge Construction			
	Participation	Epistemic	Argument	Social modes
Script component:				
Epistemic	+	+	–	–
Argumentative	+	–	+	.
Social	+	.	–	+

Note. + = positive effect, – = negative effects, and . = no effect.

Figure Caption

Figure 1. Segments of the macro-level are relations between two micro-segments. Micro-segments are relations between two theoretical concepts, two case information, or relations between theoretical concepts and case information.


Macro-segment
Micro-segment A
“Michael attributes stable”
Micro-segment B
„Teacher attributes variable”

Appendix – The example discourse

The example discourse we present has been led in an experimental online learning environment. Three university students of educational sciences were placed in three different laboratory rooms and communicated and collaborated via the online learning environment that included web-based discussion boards. The task of the three learners was to apply the attribution theory of Weiner (1985) to a problem case.

Attribution theory – the conceptual space

Weiner's attribution theory (1985) addresses the question how students attribute causes for success or failure on the dimensions of locality and stability (see also Heider, 1958). Locality means that attributed causes can be found within (internal) or outside a person (external) who experienced success or failure. Stability means that the attributed causes may be temporally stable or variable.

One of the cases – the problem space

You participate in a school counseling session as a student teacher of a high school with Michael Peters, a pupil in the 10th grade.

"Somehow I begin to realize that math is not my kind of thing. Last year I almost failed math. Ms Weber, who is my math teacher, told me that I really had to make an effort if I wanted to pass 10th grade. Actually, my parents stayed pretty calm when I told them. Well, mom said that none of us is 'witty' in math. My father just grinned. Then he told that story when he just barely made his final math exams with lots of copying and cheat slips. 'The Peters family,' Daddy said then, 'has always meant horror to any math teacher.' Slightly cockeyed at a school party, I once have told this story to Ms Weber. She said that this was no bad excuse, but no good one either. Just an excuse that is, and you could come up with some more to justify to be bone idle. Last year I have barely made it, but I am really anxious about the new school year!”

Learners posted on average 16 messages with a total mean of 552 words on one discussion board. The messages were stored in cascading discussion threads and accessible via an overview page. The preceding messages were quoted out with “>” as in typical e-mail programs or newsreaders. Participants had the neutral code names “Ahorn”, “Birke”, and “Pinie”.

First message:

Title: Analysis 1 - .. Birke, 1.2.2001 – 10:04:07

Because Michael ascribes his deficit in math to a lack of talent and is also affirmed in doing so by the statements of his parents, there will hardly be any improvement of performance.

This message initiates the discussion thread. It is posted on the first of February 2001 at four minutes past 10 a.m. by the participant with the code name “Birke”. The second message below was posted about a minute later by “Pinie”. Pinie did not modify the title of the discussion thread, which reads “Analysis 1”.

Second message:

Title: Analysis 1 - .. Pinie, 1.2.2001 – 10:05:35

> Because Michael ascribes his deficit in math to a lack of talent and is also affirmed in
> doing so by the statements of his parents, there will hardly be any improvement of
> performance.

Exactly, the behavior of the teacher won't add to this, either (attribution of other)

The third message of this discussion thread was posted at 11 minutes past 10 a.m. from the participant with the code name “Ahorn”:

Third message:

Title: Analysis 1 - .. Ahorn, 1.2.2001 – 10:10:54

>> Because Michael ascribes his deficit in math to a lack of talent and is also affirmed in
>> doing so by the statements of his parents, there will hardly be any improvement of
>> performance.

> Exactly, the behavior of the teacher won't add to this, either (attribution of other)

Still, the behavior of the teacher can be regarded as beneficial, because she is holding variable causes responsible for his failure. He may improve his performance if he invested more effort. Should actually motivate him. What do you think?

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