Changing face-to-face communication

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5 The Learning Environment of the Classroom

> The transition from Aristotelian to Galilean concepts demands that we no longer seek the "cause" of events in the nature of a single isolated object, but in the relationship between an object and its surroundings.
>
> *Kurt Lewin*[1]

In chapter 2, we already mentioned that we carried out the research in the classroom. In fact, the research environment within which we studied collaborative learning was also an authentic setting for learning. The students that participated in the research were not experimental subjects in the classical sense; in the first place, they were students who came to the classroom to learn. It means that the interventions that are discussed in this thesis are no isolated events in a carefully controlled setting; they can only be understood by taking into account the different elements that comprise the learning environment of the classroom. In contrast to an experimental approach, we did not neutralize the influence of these elements. Therefore, before we discuss the collaborative tools, we give an overview on the learning environment that incorporates these tools. The learning environment will be discussed from the perspective of two learning methods: direct instruction and collaborative learning.

5.1 Two Learning Methods

We argue that the way the learning environment will look like in practice depends on the learning method that is adopted by the teacher. To make this clear we refer throughout this chapter to two learning methods: direct instruction and collaborative

[1] Kurt Lewin (1936), *Principles of topological psychology.*

learning.

We choose to describe direct instruction because it is a common approach for teaching (Killen, 2007). This method will be contrasted with collaborative learning that recently appeared in the classroom as a "new learning" method. Collaborative learning is frequently used as an alternative learning method that undoes some of the disadvantages associated with direct instruction. In practice, we observed that two methods frequently mingled. The students that participated in the study discussed in chapter 9, for example, worked together in small groups to discuss a topic after a series of lectures. The small-group activities encouraged students to apply the knowledge acquired during the lectures in an authentic learning situation that resembles real-life practice.

Direct Instruction

Direct instruction has been shown to be an efficient way to teach factual knowledge or procedures that are difficult for students to discover on their own (Palinscar, 1998; Klahr & Nigam, 2004). Direct instruction is a teacher-centered approach: the teacher directs the learning activities that go on in the classroom. The teacher fully explains the concepts and procedures that students are required to learn and defines the learning strategies for acquiring the knowledge (Kirschner, Sweller & Clark, 2006). The emphasis is on teaching in small steps, providing students with practical assignments after each step, guiding students during initial practice, and providing all students with a high level of successful practice (Rosenshine, 1987).

Direct instruction can be typified by a teacher-centered communication pattern: communication follows a pervasive pattern of teacher initiation, student response, and teacher evaluation or feedback (Mehan, 1979). For example, the teacher asks a question, a student answers and the teacher evaluates that answer. These questions are used to determine prior knowledge or to monitor student's progress. The teacher uses the student's response to fine-tune the teaching practice so that it closely matches with the abilities of the student.

The spatial arrangement of the classroom supports the asymmetrical communication pattern illustrative for direct instruction; usually the teacher stands or sits in front of the class while the students are seated with their faces oriented towards the teacher, which makes communication with the teacher quite easy.

Collaborative Learning

Collaboration between learners may be part of a teacher-centered learning method like direct instruction. For example, a discussion between students helps them to better process new information. Characteristic for these discussions is the central role for the teacher. The teacher guides the discussion by bringing forward topics, asking questions, and giving additional information. Collaborative learning, in this case, rests on cognitive theories of learning. It can be contrasted with the social-constructivist perspective that is emphasized in this thesis. The latter approach can be characterized by a changing relationship between the teacher and the learners. It marks a shift in responsibility from the teacher towards the learners. Learners operate more autonomously; to a large extent they are responsible for their own learning activities. The students organize their own learning and monitor progress, often in collaboration with their peers. It is assumed that the capacity to learn increases when the students have greater autonomy (Brockbank and McGill, 2000). It gives students the opportunity to construct their own perceptions (Driscoll, 1994).

Collaborative learning is a method where students work together in groups that are *small enough* so that everyone can participate on a collective task that has been clearly assigned (Cohen, 1994). It stresses that students construct knowledge in interaction with fellow students with the aim to make sense of their mutual learning experiences. Students draw upon their own knowledge, beliefs and judgments, share these concepts with their group members, and explore their assumptions and consequences.

The spatial arrangement of the classroom should differ when students learn in small groups, although the classroom does not always allow for an optimal layout. Several small groups sit together in the classroom, more or less separately from the other groups, with their faces directed towards each other. This guarantees free interaction between the group members without much disturbance from outside. The teacher remains more at a distance and monitors the learning activities from the various groups on the fly. The teacher walks around, goes from one group to another, paying attention to a group when this is needed. Exactly this situation is the focus of the research that is discussed in this thesis.

5.2 The Classroom Learning Environment

The learning environment of the classroom mainly provides *interpretations* of the natural world for students to interact with (Winn & Windschitl, 2001). These interpretations are brought to the learner by the teacher, their fellow learners or by different kinds of media like books or computers. These three elements of the learning environment represent the knowledge domain to the learner (Kanselaar, de Jong, Andriessen & Goodyear, 2000). Learning can be considered as an upshot of the learner's interaction with these three elements (Figure 5.1).

Resources

The three elements – teacher, media and fellow learners – draw upon different kinds of resources to direct the interactions with the learner. These resources are used to represent the knowledge domain to the learner. They are for the most part deliberately arranged to create the optimal conditions for learning. The three elements and the different resources they call into play lead to divergent interaction patterns and distinct opportunities for learning. The interactions of the learner with the teacher, for example, differ in character from the interactions that occur among the learners. The relationship between the teacher and the learners can be characterized as one between

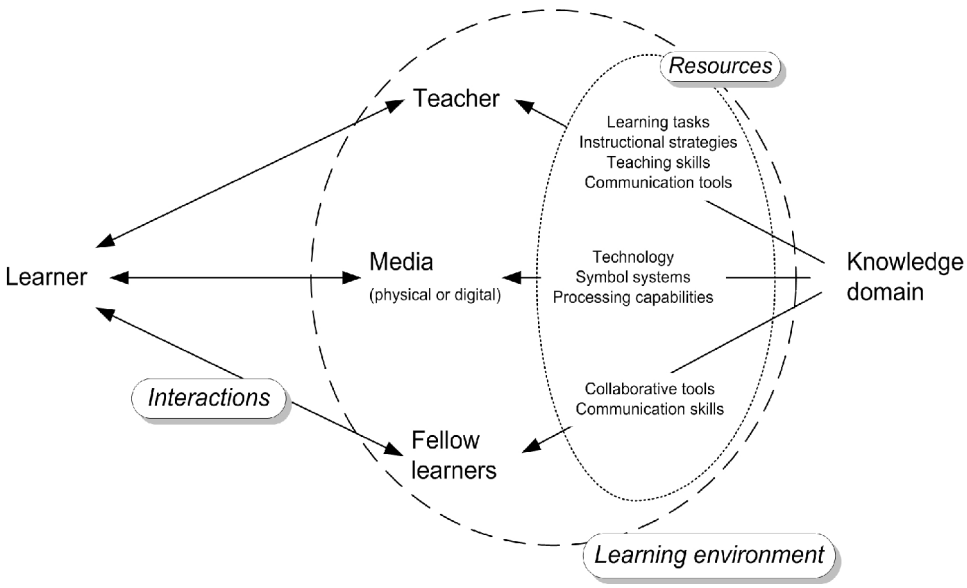

Figure 5.1: The learning environment of the classroom.

an expert and a novice. The teacher who is an expert in the knowledge domain under study, employs specific instructional strategies and teaching skills to present the subject matter to the learners. Learners who explore a topic together usually do not possess that kind of knowledge and skills. They interact as *equal interlocutors* with more or less similar conceptual models. Collaborative learning capitalizes on these interactions. When learners interact with each other, they engage in a "progressive discourse" (Wells & Arauz, 2006) during which they explore each other's understanding of things. Such a discourse must be of a high cognitive level, that is, it needs to include the mutual exchange of ideas, explanation, justifications, speculations, inferences, hypotheses, and conclusions (King, Staffieri & Adelgais, 1998).

Reciprocal Relationship between the Learner and the Three Elements

The three elements of the environment do not affect learning in a direct way. Students do not merely reproduce what is communicated but they actively integrate new information within their cognitive framework. It results in new knowledge and increased understanding based on what they already know and believe (Bransford, Brown & Cocking, 2000). It is through these mutual constitutive interactions that learning gets its shape: the teacher, media and fellow learners share their interpretations of the knowledge domain but the learner also brings in his or her own prior knowledge, feelings, motives to make sense of what is communicated.

Reciprocal Relationship between the Three Elements

The three elements that comprise the learning environment, and the interactions they give rise to, do not operate independently from each other. For example, they way that the teacher communicates with the class affects the way learners communicate with each other, while the opposite is also true. For example, the teacher may apply a specific instructional strategy to stimulate specific patterns of communication between the students. When the teacher asks questions that have multiple possible answers and stimulates learners to build upon each other's contribution, it is more likely that a productive discussion between learners will occur (Wells & Arauz, 2006).

5.3 The Teacher

Learning is not solely an individual activity; it is also the result of the learner's interactions with other people. The person who comes first to mind is the teacher. Classroom learning is usually centered around the teacher who serves as an important point of reference. The teacher performs various tasks: the teacher has to instruct students effectively, deal with them as a group and respond to individual needs, establish and maintain order in the class, and handle the discipline and adjustment of individual students (Emmer & Stough, 2001). The way the teacher deals with these tasks influences the motivation and achievement of the students. Research indicates that the appropriate teacher-student relationships can be characterized by a high rate of teacher influence and cooperative behavior towards the students (Wubbels & Brekelmans, 2005).

Teacher-student interaction does not proceed in a one-way direction. Students bring in their own thoughts, feelings and motives towards the learning activities that go on in the classroom. The teacher has to address the cognitive, as well as the affective and behavioral dimensions of students' performance. Both learning methods – direct instruction and collaborative learning – recognize the active role of the learner within the teacher-learner relationship. However, their practical implications differ.

With *Direct instruction,* the teacher regulates the learning process although the teacher has to take into account prior knowledge of the students. If their initial understanding is not engaged, students may fail to grasp the new concepts and information that are taught (Bransford, Brown, Cocking, 2000). The teacher has to present the subject matter in a way that best fits with the abilities of the learners. Information presented by the teacher should be relevant, meaningful and, if necessary, useful to the learners (Ebbens & Ettekoven, 2005).

With *collaborative learning*, the students have a more active role. To a large extend they shape their own learning. The students explore a subject matter collaboratively often without close guidance from the teacher. Fellow students serve as an important reference to mirror student's belief system. The role of the teacher shifts from an expert who controls the learning processes, towards a facilitator who creates the proper conditions under which the group may learn from and with each other.

The teacher draws upon various resources to direct the teacher-student interactions. The teacher shapes learning by means of:

1. the learning task,
2. the instructional strategy,
3. the teaching skills, and
4. the communication tools that support the interactions between the teacher and the learners.

The Learning Task

A learning task exists of an assignment allocated to an individual or a group of learners to create a specific opportunity for learning. It is a way to engage students in the teaching practice. When students carry out a learning task, they are actively involved instead of listening to a teacher passively. A learning task may serve several educational goals. It can be used to motivate students, to strengthen knowledge and skills, for transfer of learning, or to engage students actively in the construction of knowledge.

Problem Solving Task

In this thesis, we concentrate on problem solving as the means by which the students develop a deeper understanding of a subject matter. Problems are commonly defined as a gap between a disruptive situation and a desired end state that can be bridged by the activities of one or more human actors. Two additional conditions are essential for problem solving to occur. First, the human actors must perceive the problem-solving task to be important enough to inspire current and prospective solution activities (Smith, 1988). This condition seems trivial but in an educational setting it cannot be taken for granted. It has a strong motivational connotation; students must perceive the problem-solving task as meaningful so that they are willing to participate in the problem-solving activities.

Active participation can be further stimulated by establishing interdependence between group members. Cohen (1994) identified three structures of interdependence that foster participation:

1. positive goal interdependence,
2. positive resource interdependence, and
3. reward interdependence.

Collaboration will be stimulated when students depend on one another to achieve the group goal, when they have to use one another's resources to attain that goal, and when they receive a group reward that is based on the performance of each individual member (Cohen, 1994). The three structures of interdependence do not affect participation directly. Their effect depends on factors such as task characteristics and motivation. Together they determine what kinds of interactions do occur. Reward interdependence, for example, does not appear to be necessary for achievement when students are motivated to complete a challenging and interesting group task that requires everyone's contribution for a good outcome (Cohen, 1994).

A second condition for students to engage in problem-solving activities has to do with the gap between the disruptive situation and the desired end state. It must be difficult but not impossible for students to bridge the gap between the disruptive situation and the desired situation. Not all situations that require purposeful actions of a human actor can be labeled as problematic (Smith, 1988). Only when a solution is not ready at hand or the steps to bridge the gap are not clear, the learners must allocate energy for problem solving.

Well-structured and Ill-structured Problems

Problems can be categorized along various dimensions like the kind of knowledge required to solve them or their complexity (see Robertson, 2001). A frequently used distinction takes the complexity of problems as the starting point: problems can be situated on a continuum that goes from well-defined to ill-defined problems.

Well-defined or well-structured problems provide the students with sufficient information that enables them to solve the problem. The problem description contains information about the problem as it stands now (initial state), what the situation should be when the problem is solved (the goal state), and what actions should be taken to solve it. It does not mean that the students have all the necessary information, as they are not told what objects to perform the action on (Robertson, 2001). Robertson (2001) gives the example of algebraic problems. There are four basic arithmetic operations: multiplication, division, addition and subtraction. Students usually know these operations; it is more difficult for students to know how to apply these operations.

Wyndhamn and Saljö (1999) studied collaborative problem solving for a well-defined problem where students had to count the days between a certain calendar

period. They provided the students with a clear description of the initial state and goal state. The conditions that they created varied between the kind of information that makes students aware of the strategy to solve the problem. The groups, who received the proper information through the assistance of an adult or an artifact like a calendar, were able to solve the problem. If the groups lack the proper information, they were not able to solve the problem correctly. When the students discussed the problem, they became aware of their lack of knowledge and they were only able to solve the problem when an outsider provided them with the adequate information. The task that the students had to solve can be characterized as *uncertain*: students lack the proper information and they have to search for additional information.

With *ill-defined or ill-structured problems,* the students do not know in advance the conditions that apply to the problem-solving process and the actions that lead to a solution of the problem. Both the given state, the desired end state, and the barriers are transparent (Frensch & Funke, 1995). These *novel problems* require considerable knowledge or experience to solve them. They involve complicated situations or statements that are unfamiliar and difficult to understand for the students. Insights with regard to the exact nature of the problem and possible solutions emerge during the problem-solving process and constitute each other, i.e. specifying the problem goes hand in hand with solving it.

A number of studies into collaborative learning focused on novel problems. These studies stem from different knowledge domains such as biology (Coleman, 1998), physics (Roschelle & Teasley, 1995; Baker, 2002; Hogan, Nastasi & Pressley, 2000), mechanics (Kneser & Ploetzner, 2001), the study of a text (Keefer, Zeitz & Resnick, 2000), or mathematics (Sfard & Kieran, 2001).

Hogan, Nastasi and Pressley (2000), for example, studied a learning activity where students had to understand the characteristics and behaviors of solids, liquids, and gases. These students collaborated in groups to build a mental model of the nature of matter and used their model to explain the characteristics of solids, liquids, and gases. Before they entered into a discussion, they gained experience with the three states of matter by means of experiments and demonstrations.

Complex, novel problems may give rise to different interpretations and misunderstandings that can only be resolved by extensive scientific reasoning. According to Schwartz (1995), the different perspectives held by the learners create

opportunities for higher-order thinking. When learners address their differences in thinking, they develop a deeper understanding of the problem. The process of participating in arguments or even listening to others arguing and justifying their opinions or solutions may be enough to enhance learning (Slavin, Hurley & Chamberlain, 2003).

The research that is discussed in this thesis focuses on ill-structured problems. These problems are complicated, multidimensional and relatively novel for the learners. They give rise to multiple interpretations and must be resolved by extensive inquiry and reasoning.

Authentic Tasks

Learning from a social-constructivist point of view requires the active involvement of the learner's believe system, while better understanding is acquired through meaningful experiences. One way to engage students with meaningful experiences is to present them with a learning task that incorporates *authentic* activities based on real-life situations. Romiszowski (1984) defined different kinds of tasks that use reality as the basis for learning (Figure 5.2). Although each category uses real-life data, there is a shift in pedagogical goals and, subsequently, a shift in the representation of the real life situations.

The studies that are discussed in this thesis used "case study" and "role play" as authentic learning task. These studies examine the collaborative activities of students

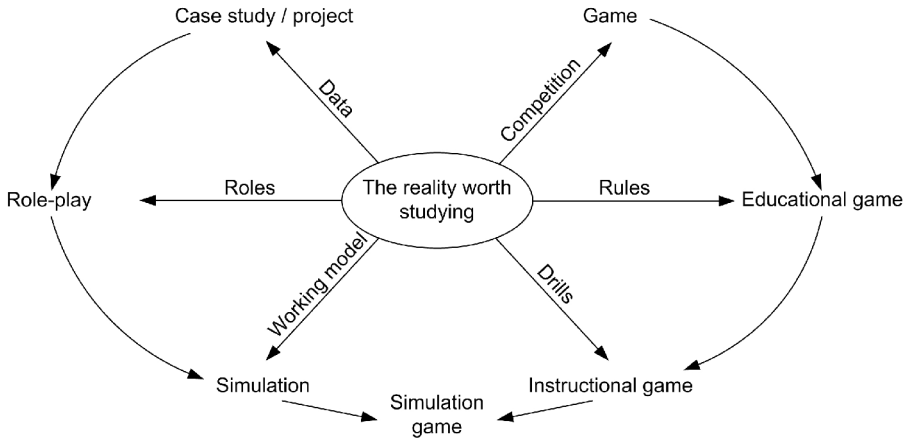

Figure 5.2: Different kind of tasks that are based on 'real life' situations.

who discussed a topic whereby they draw upon a case description or they approach the topic from different roles.

A *case* describes a problem, situation or event from an actual context (Lkoundi & van Woerden, 1997). It presents information about a situation or a process-in-action, for analysis and discussion by a student or by a group (Romiszowski, Mulder & Pieters, 1990). Although a case is based on authentic data, it is not an exact description of a real problem, situation or event. A case differs from the latter because it takes into account the learning processes and goals. For example, the complexity of the situation or the task may be "simplified" for reasons of coherence and intelligibility.

In a *role-play,* students take a role and act them out in a play. A role play represents a relevant social situation in such a way that the focus is on the perspectives and behaviors of the various roles and the relationships between the roles. Role play provides students with a framework to analyze a situation and to develop ways of coping with that situation (Joyce and Weil, 1980). When students take a particular role, they use a repertoire of behaviors that are expected of the role in that situation (Holsbrink-Engels, 1998).

Instructional Strategies

Another resource that the teacher draws upon is an instructional strategy. An instructional strategy specifies how the students learn effectively. It consists of a set of guidelines or a plan that directs student's learning towards the achievement of the learning goals. An instructional strategy takes the form of a lesson plan or a set of product specifications for mediated materials (Gagné, Briggs & Wager, 1992). They reflect a number of decisions about the arrangement of the learning environment with the aim to create the proper conditions for learning.

In the case of *direct instruction*, the teacher clearly instructs students what they have to do. The teacher explains to the students: 1) the assignment, 2) how to carry it out, 3) what kind of aids they have at one's disposal, 4) how much time they may use, 5) what will happen with the outcomes, and 6) what they should do when they finish the assignment (Ebbens & Ettekoven, 2005).

For *collaborative learning,* the picture is much more diverse: students may be given more freedom to arrange their learning themselves. Instructions help students to construct their own meaningful and conceptually functional representations (Jonassen,

1991). For example, the teacher only presents the assignment, while it is up to the students to determine how to carry it out and what kind of aids they want to use. The students are responsible for defining their learning outcomes and for choosing the road needed to achieve these outcomes (Reigeluth & Moore, 1999).

Instructions as the Link between the Technology and the Learners

In this thesis, we focus on the instructions that make the collaborative tools applicable for a certain context of use. While the tools stay more or less the same over different contexts, its use will vary. Groups can use a collaborative tool in many ways that can be more or less appropriate to the group's purpose and practices. Just introducing the tools in the classroom is not sufficient. In our case, the introduction of the collaborative tools is accompanied with an instructional strategy that makes the support suitable for a specific learning situation. The use of instructions results in a support environment that is "optimally adapted to the microstructure of local conditions and constraints" (Lea, 1994). The instructional strategy consists of a set of procedures and guidelines that enable the teacher to adapt the support environment to a specific learning practice. It helps the teacher to stimulate communication and behaviors that, in our case, are associated with a constructive dialogue.

Brigss, de Vreede, Nunamaker and Tobey (2001) introduced the concept of ThinkLets as a means for less experienced users to apply a groupware tool within their practices. They define ThinkLets as the "smallest unit of intellectual capital required to create repeatable, predictable patterns of thinking among people to work towards a goal" (Briggs et al., 2001). A ThinkLet has three elements:

1. *A tool* that refers to the specific support that the group uses.
2. *A configuration* of the tool that specifies how the tool is presented to the users.
3. *A script* that describes the sequence of events and instructions given to the group.

The notion of ThinkLets was used to development an instructional strategy that guides the introduction of the collaborative tools in the classroom. For every study, we develop a lesson plan in close cooperation with the teacher. That lesson plan describes: 1) the learning goals, 2) the different kind of activities that the students have to carry out, 3) the expected outcomes, 4) the learning materials they receive, 5) the tools they use, and 6) the configuration of these tools.

Teaching Skills

Teachers are skilled professionals who have been trained to teach students effectively: they have learned the principles of good teaching and how to apply them in the classroom (Slavin, 2000). Good teaching requires specific knowledge, attitude and skills. Teachers must have a thorough understanding of the knowledge domain and they must be able to communicate that knowledge in an attractive manner. They must understand their students and known how they learn and behave. Teachers have to monitor class activities, reflect on their teaching practice and adapt their teaching if necessary. Furthermore, teaching requires the appropriate communication skills like explaining, questioning, summarizing, use of voice, listening, eliciting and giving feedback (Kyriacou, 2001; Slavin 2000; Cohen, Manion & Morrison, 2005).

The research in this thesis does not focus that much on the teacher's behavior; rather it concentrates on the communication between the students. This choice has to do with the fact that collaborative learning considers the interactions between students as the primary vehicle for learning. It does not mean, however, that the teacher does not play a significant role. During the preparation and the evaluation of the studies, we made use of teacher's knowledge and experiences. The teachers that participated in the research helped us to develop the proper instructions to integrate the collaborative tools within the existing learning environment. In the final study – that is discussed in chapter 9 – teacher's interaction with the groups was analyzed with the aim to build a better picture of the performance of the groups.

Communication Tools

Usually, the teacher delivers knowledge and instructions verbally. Communication between the teacher and the class can be supported by various tools; the teacher may use certain media in addition to the verbal, face-to-face communication. The most striking example is the blackboard or chalkboard that has been part of the classroom from the beginning of the 19th century (Coulson, 2006). More recently, electronic devices like interactive whiteboards or handheld devices have been introduced in the classroom to supplement the verbal communication between the teacher and the students. For example, the teacher may use a handheld device to collect responses from students to questions, display them to the class and use that feedback to trigger and

sequence a class discussion (Boyle & Nicol, 2003). Alternatively, learners may ask questions to the teacher by using personal wireless devices (e.g. Ratto, Shapiro, Minh Truong & Griswold, 2003).

5.4 Media

The learner can study a subject matter by consulting the media available in the classroom such as a textbook or the internet. These physical or digital media represent the learning material in distinct ways. Each medium provides a particular representation of a knowledge domain that influences what can be learned and how to learn it. The attributes of a medium affect the way the learner interacts with the medium and the kind of learning that emerges from these interactions. It influences the way that information is selected and transformed in the acquisition of general cognitive skills (Clark, 1983).

Kozma (1991) came with a classification that takes into account aspects of the medium, of the learner who uses the medium and of the learning activity that the medium tends to support. He classified media by three attributes:

1. the technology,
2. the symbol systems, and
3. the processing capabilities.

Technology

Technology refers to the physical, mechanical, electronic or digital properties of the medium that determine the range of possible representations and the activities that can be performed with these representations. A textbook, the most common medium in the classroom, consists of a set of sheets that are bound together. Such a book contains text and pictures.

Learners do not interact so much with the technology. The technology enables and constrains the other two attributes of the medium. Meaning is derived from the other two attributes of the medium: the symbol systems and processing capabilities. These two attributes have more direct implications for the interactions between the learner and the medium and the cognitions that emerge from these interactions (Kozma, 1994).

Symbol Systems

Symbol systems are "structures of appearance" (Goodman, 1976) that determine how the knowledge domain is expressed by the medium. A symbol system consists of a set of elements like words, textual objects, algebraic notations or pictures that can be arranged by rules or conventions *and* point to a certain knowledge domain (Goodman, 1976). Different symbol systems are correlated with distinct meanings and bring about differences in information processing (Salomon, 1979). Certain symbol systems may be better at presenting certain tasks. Graphical representations such as Euler diagrams (Figure 5.3), for example, are most suitable for teaching abstract reasoning because their elements specify information in a distinct number of classes. Such representations permit a limited range of abstraction and are therefore easy to process (Stenning & Oberlander, 1995).

Processing Capabilities

Information is not only presented in memory; it is also processed (Kozma, 1991). The p*rocessing capabilities* of a medium refer to the cognitive operations that are triggered by the medium and the actions that the learner can perform with that medium. The processing capabilities can be described along several dimensions like perspective, precision and complexity (de Jong, Ainsworth, Dobson, van der Hulst, Levonen, Reimann, Sime, van Someren, Spada & Swaak, 1998).

Perspective refers to decisions about "how and what to see" with regard to the knowledge domain. A software program, for example, can be looked at from different perspectives as a set of instructions that specify its operations or as a set of functions

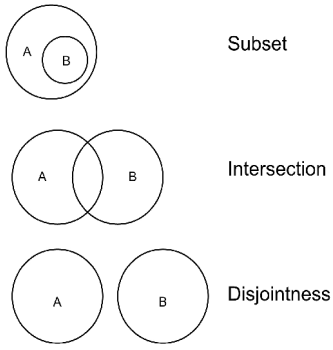

Figure 5.3: Examples of Euler diagrams.

that describe the purpose of the different elements of the program. Each of these perspectives provides a valid description taking into account the kind of knowledge that should be communicated.

Precision indicates how accurate or exact the knowledge domain is presented to the learner. There are situations where learners need precise descriptions of the knowledge domain that are correct in every detail. For example, programming techniques can best be explained in detail by representing the source codes of program. For users of a software application it is not necessary to go into so much detail. For them a program can be explained by the interfaces that specify the external behavior of the program.

Complexity has to do with the amount of information and how that information is organized. Complexity relates to the information content but what is considered as complex depends on those who perceive that information.

Conclusion

The characteristics of the medium determine the kinds of learning activities that will occur. The structural appearance and processing capabilities of a medium make certain actions available. This also holds true for the collaborative tools that are discussed in this thesis. The collaborative tools represent the information that is communicated in distinct ways.

In the next chapter – where we discuss the design of these tools – we refer to these two attributes of the medium that were discussed in this paragraph. These attributes emphasize that a medium represents knowledge in distinct manner. In our case, they underline certain aspects of the problem space while it "masks" other aspects. It made us aware of the different representational capabilities. That is why two collaborative tools were developed that represent a group discussion in two different ways.

5.5 Other Learners

The teacher is not the only relevant person in the classroom; interactions with fellow learners also influence the course and outcomes of the learning process. Learning methods like collaborative learning explicitly capitalize on these learner-learner interactions. There is an important difference between teacher-learner and learner-learner interaction. Teachers rely on a variety of resources like the instructional strategy and teaching skills to guide their interactions. Learners who collaborate usually have

less means at their disposal to organize their communication effectively. For example, students may lack the appropriate discourse strategies that enable them to discuss scientific ideas effectively (Linn & Burbules, 1993). The learning environment of the classroom has to anticipate on this lack of resources. Actually, this observation provides the rationale for the design of the collaborative tools: the collaborative tools aim to facilitate a learner-centered communication that enables a group to learn without direct support of the teacher.

Computer Support for Collaborative Learning

Computers in the classroom can serve different kinds of goals. They can be used to deliver information about the knowledge domain just as the teacher does. Computer-assisted instructions and intelligent tutoring systems are examples of this approach. These systems base their instructions on a cognitive model of the competence that the student is being asked to learn (Anderson, Corbett, Koedinger & Pelletier, 1995).

The use of computer tools from a social-constructive perspective serves a different purpose. Jonassen (2000) considers computer tools as learning tools that students learn *with*, not *from*. Computer tools should be used as engagers and facilitators of thinking and knowledge construction (Jonassen, Peck & Wilson, 1999).

Jonassen (1999) makes a distinction between cognitive tools and collaborative tools. *Cognitive tools* interact with the learner to support their thinking and reasoning. They may help the learner to better represent the problem or task (visualization tools), represent what they know (knowledge modeling tools), offload some of the cognitive activities (performance support) or they may help learners to gather important information (Jonassen, 1999). Collaborative tools, in contrast, support the collaborative activities of a group of learners who carry out a common task. They mediate the interactions between learners with the aim to support their joint learning activities. These tools may have similar properties as the cognitive tools, only its effects are situated on the level of the group rather than on the individual level. They mediate and regulate the communication with the aim to stimulate communication that is positively associated with learning. Precisely, these tools are the focus of the tool design that is discussed in the next chapter.

5.6 Summary

The existing learning environment within which the new collaborative tools are integrated has a number of characteristics. These characteristics partly determine what kind of collaborative tools will be developed. Two characteristics are of crucial importance for the development of the collaborative tools:

1. the learning task, and
2. the instructional strategy.

The Task

The collaborative tools support small groups of students who are co-located and already communicate face-to-face. These groups work together on a *problem-solving task* that aims to establish a deeper understanding of the subject matter associated with that task. The problem-solving task can be further specified by its complexity. The problems that the students discuss are *ill-structured*, they refer to complex situations that are relatively unknown for the students and difficult to comprehend. To solve these novel problems, students have to enter into a constructive dialogue during which they explain their thoughts, build upon other members' understanding of things and discuss alternative interpretations.

Instructional Strategy

The collaborative tools stimulate communication that is associated with a constructive dialogue. The tools cannot be set apart from the *instructional strategy* that accompanies their introduction in the classroom. The instructions make the tools suitable for a specific learning situation. Such a strategy consists of procedures and guidelines "to create repeatable patterns of acting and thinking" (Briggs et al., 2001). It means that the design will not be limited to the technology but also takes into account how the technology will be made applicable for a specific context of use.