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Changing face-to-face communication

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3 Social Reality Explained: Systems and Functions

Nor would we explain the power of water to extinguish fire by deriving it from the powers of its constituents, for oxygen and hydrogen are highly inflammable.

Andrew Sayer¹

When we study a particular scientific problem, we first need to specify what social reality is and how to begin to explain it (Archer, 1995). Therefore, before we enter into an exploration of the research topic, we discuss the ontological claims and the methodological statements that frame the research. We follow the sociologist Margaret Archer (1995) declared that a social ontology, an explanatory framework, and a practical theory constitute each other and should therefore correspond. In this thesis, the complexity of social reality is approached from a *Systems perspective*. Systems thinking is just one way to get a hold over the complexity of the social reality. It acknowledges that the intricacy of everyday life cannot be captured in one, unifying framework. A Systems perspective describes reality on various levels of complexity, each with its own distinct properties.

Social reality from a Systems perspective consists of functional entities or systems that are related. This makes it possible to come up with functional explanations. In our case, it allows us to describe the performance of groups in terms of the effectiveness of the communication processes. A basic premise of the functional perspective is that performance depends on how well communication satisfies the requisite conditions for successful learning (Waldeck, Shepard, Teitelbaum, Farra & Seibold, 2002). The functional perspective is in accordance with the Design-based research strategy that was discussed in chapter 2. A basic premise of design-based research is to create particular

¹ Sayer, A. (1992). *Method in Social Science: A Realist Approach*.

forms of learning in naturalistic learning settings. A functional perspective provides the explanatory framework for such an approach. Functionalists often design interventions to control and regulate interactions with the aim to create desired group behaviors (Hollingshead, Wittenbaum, Paulus, Hirokawa, Ancona, Peterson, Jehn & Yoon, 2005).

3.1 Way of Thinking

An ontology implies a way of thinking that pervades how we understand the world in general (Sol, 1982; Morgan, 1986). It contains a number of basic choices with regard to “how and what to see in the world”. These choices differentiate on fundamental aspects of social reality and lay down the possible explanations of the social phenomenon under study. The ontology dictates what kind of explanatory mechanisms a theory contains.

The dominant ontology within a scientific discipline may vary: reductionism, for example, is the leading ontology to study the natural world. It describes physical phenomena in terms of a limited number of particles, like atoms and molecules, which are responsible for “nearly all the properties of matter that have shaped the world around us” (Beiser, 1981). For social phenomena, the picture is more complex: for example, within a scientific discipline like Sociology there is a vivid debate about the social ontology that should govern social explanations (see e.g. Bunge, 1979; Archer, 1995).

Reductionism

As mentioned before, we approach social reality from a systems perspective. A Systems perspective can be contrasted with a Reductionist and a Process ontology. Social reality from a *Reductionist ontology* is broken down to a limited number of entities that behave in a regular manner. Explanations that can be associated with Reductionism decompose social phenomena to the individual: every possible object is either an individual or a collection of individuals (Bunge, 2000). For many years, theories of collaborative learning tended to focus on how individuals function in a group (Dillenbourg, Baker, Blaye & O'Malley, 1995). These theories conceptualize the processes and outcomes of collaborative learning in individualistic terms. Research within this tradition, was mainly concerned with how individuals process information, and not so much with the

dynamic nature of group processes.

Reductionism entails a basic problem of ontological nature: it denies the social dimension of human performance (Archer, 1995). It neglects that human beings create social structures that have an existence of their own. It is found wanting for making no room for social relations or emergent properties (Bunge, 1979). Group interactions and social structures that are illustrative for collaborative activities serve only as a background for individual activity rather than as a focus of research in itself (Dillenbourg, et al., 1995).

Process Ontology

A *Process ontology* considers human activity as the quintessence of social reality: individuals and social structures can only be conceptualized by looking at the activities they play a part in. The two have no meaning outside the activity. A Process ontology regards the individual and the environment as *inseparable*; it holds that only processes that bring these two together are real. Individuals and the sociocultural environment within which they are situated can only be studied by looking at human activities.

Sociocultural theories of learning can be typified by a process ontology (Packer & Goicoechea, 2000; Sawyer, 2002). The basic unit of analysis of these theories is the social activity (Dillenbourg et al, 1996). Learners are viewed as coming into contact with, and creating, their surroundings as well as themselves through the actions in which they engage (Wertsch, 1991). Sociocultural theories stress that human thinking only exists in relation to the social practice and the cultural artifacts that frame human thought.

A Process ontology brings about methodological problems. A true Process ontology is holistic: it views the individual as inseparable from the sociocultural environment and it does not distinguish between distinct processes (Sawyer, 2002). Because a Process ontology examines a single process in the present tense, issues surrounding the relative independence, causal influence and temporal precedence of the components have been eliminated (Archer, 1995). It means that for those who are engaged in educational design it is almost impossible to make any inference about the effects of the design because an intervention has no meaning outside the practice or activity. Instructions, tools or tasks receive their meaning when they are used in practice and they cannot be set apart from that practice. This makes it almost impossible to come up with an intended design.

3.2 Systems Thinking

We adopt a Systems perspective to study collaborative learning. Systems thinking can be traced back to the work of Ludwig von Bertalanffy who developed a general framework to study phenomena in the natural world. He introduced the concept of an *open system* that maintains itself in exchange of materials with the environment (von Bertalanffy, 1950). An open system consists of a collection of elements or components that are linked with each other and with a common environment. Such a system can be contrasted with a closed system that has no inputs or outputs and, therefore does not change internally.

Ontological Claims

Reality, according to the Systems perspective, consists of a large number of systems that behave in a regular manner. Pickel (2007) gave an overview of the ontological claims that can be associated with Systems thinking (Table 3.1). Early concepts of systems thinking define an open system in terms of the output that the system produces. It assumes that systems have clear objectives that can easily be identified by their outputs. This perspective has more or less been abandoned when scientists applied Systems

Ontological claims of systems thinking

Systems are the basic entities of the natural and social world.

Systems are real entities.

There are material, mixed, and non-material systems.

Each concrete system is directly or indirectly related to all other systems which form their proximate or distal environment.

While some systems are nested and ordered hierarchically, others are non-nested and overlap.

Systems have a different spatial and temporal reach.

A system consists of components and their relations with each other. Particular important are, in addition, a system's environment as well as the key processes that make it work.

In addition to linear or proportionate causal effects, there are non-linear or disproportionated causal effects.

Table 3.1: A modern systems ontology (Pickel, 2007).

thinking to understand the social world. System behavior cannot be captured by a straightforward reference as the output when humans are part of that system. Such a “hard” reference ignores the variations of human action and the underdeterminacy of social structures. Human beings have, within certain rational limits, the freedom or autonomy of choice. They seem to enjoy a kind of “bounded autonomy” (Child, 1997).

Modern Systems thinking acknowledges that social systems do not have any hard reference such as the output of the system. Still, a basic aspect of a system is the regular patterns of behavior that distinguish the system from its environment. The sustaining mechanism identified by modern Systems thinking is *homeostasis*, defined as the maintenance of equilibrium by a tendency to compensate for changes in the system or in its environment. This equilibrium needs not to be static; it can be dynamic and indeed may respond to outside disruptions (Harrington, 1991).

Methodological Statements

Systems thinking does not only make ontological claims, it also contains a number of methodological statements. Methodology, broadly conceived as an explanatory framework, is the necessary link between a social ontology and practical theory (Archer,

Methodological statements

The conception of system is basic to and relates all sciences and disciplines. Individual humans are both systems and components of systems.

Systems exist independent of the models, conceptualizations, or theories through which we try to understand and explain them.

Materialist and idealist reductionism in the social sciences are rejected.

Conceptualizations in terms of ‘part-whole’ or ‘base-superstructure’ are insufficient to capture the complex order of real social systems.

Time and space are crucial dimensions in accounting for systems.

While the concept of system as entity may suggest stasis, the mechanisms or dynamics of any system are central in explaining emergence, persistence, and dissolution of concrete systems.

Causal relationships cannot be inferred from linear correlations.

Table 3.2: Systems methodology (Pickel, 2007).

1995). The explanatory framework of systems thinking consists of a set of basic principles that characterizes interpretations associated with a certain ontology. These principles lay down the kind of explanatory mechanisms that a theory may contain. Table 3.2 gives an overview of the methodological statements of Systems thinking (Pickel, 2007). These statements provide us with a framework to study groups as complex and dynamic systems.

Dynamic Systems

To capture the complexity of the social reality, modern System thinking stresses the dynamic nature of systems. Humans, and the systems they create, are characterized by a number of features of dynamical systems, most notably nonlinearity, multiple interactive parts, and system evolution (Burlingame & Fuhrman, 1997). A social entity from a dynamic perspective is a self-contained set of components that interact in complex, often nonlinear ways to form coherent patterns. (Levine & Fitzgerald, 1992; Vallacher & Nowak, 1994). The properties that emerge from these interactions may change over time. It means that the essence of a complex system can only be identified by capturing the evolution of a system's behavior on some time scale (Abraham & Shaw, 1982).

Organized Complexity

Systems thinking emphasizes the stratified nature of social reality; its complexity cannot be captured in one description. This idea is typical for the social world, which became the subject matter of systems thinking (Checkland, 1981). On each systematic level of complexity, one can identify properties or qualities that cannot be explained on other levels. These *emergent properties* set Systems thinking apart from Reductionism. To speak of emergence implies a *stratified social world* including non-observable entities, where talk of its ultimate constituents makes no sense, given that the relational properties pertaining to each stratum are all real (Archer, 1995). The citation of Sayer (1992) at the beginning of this chapter about the characteristics of water and its compound components eloquently makes this clear: oxygen and hydrogen are highly inflammable, while water extinguishes fire.

The notion of organized complexity implies that some structural properties – like group norms or the rules to organize a sequence of talk – are situated at the level of the group. These properties cannot be reduced to the characteristics of the individuals who

form a group. Furthermore, these properties are real, and have autonomous causal powers, just like real properties at any other level of analysis (Sawyer, 2003). Due to these emergent properties, a group as a system cannot be derived from its parts. The group is an independent framework in which the parts are placed (Angyal, 1941). The notion of organized complexity has important implications for the analytical framework. A behavioral pattern that can be observed at one level should be described by taking into account 1) the elements of that systematic level, 2) the structural connections between these elements, and 3) the properties that emerge from the collection of elements that are coupled into a specific dynamic structure and allowed to change over time (Levine & Fitzgerald, 1992).

3.3 Collaborative Learning: Three Levels of Complexity

A central notion of Systems thinking is the idea that collaborative learning can be described at various *levels or strata of complexity*. These levels can be typified by their own emergent properties.

A group from a Systems perspective consists of a limited number of *students* who *interact* with each other. When these students interact as a group, a different kind of dynamics occurs with its own properties. In fact, the educational rationale behind collaborative learning rests on the assumption group learning is based on distinct learning mechanisms that cannot be reduced to individual cognition.

The idea of emergent properties and several levels of complexity have important implications for the analysis of collaborative learning. The dynamics of interacting students must be studied at various systematic levels, where each level has its own specific patterns and properties. We make an *analytical* distinction between three levels: the individual, the group, and the learning environment of the classroom (Table 3.3).

The Individual Learner

If one wants to understand aspects of group interaction process, one must take the group members' properties into account (McGrath, 1984). Group members are an important antecedent variable that needs to be foregrounded when studying group communication (Keyton & Frey, 2002).

Characteristics of the individual can only be observed from external observable cues (Ajzen, 1988). In our case, the most important cues are the communicative

Social strata	Observable behavior	Examples of properties
Classroom	Classroom interaction	Classroom culture
Group	Patterns of intragroup communication.	Group norms Rules and conventions to organize the sequence of individual talk
Individual	The communicative actions of individuals.	Cognitive responses Affective responses Behavioral inclinations

Table 3.3: Three levels of complexity to study collaborative learning in the classroom.

actions of the individual group members. These behaviors reflect group member's thoughts, feelings, and behaviors about the topic of discussion. This distinction between thoughts, feelings and behaviors is used to classify the different communicative acts (Hilgard, 1980; Ajzen, 1988):

1. *Cognitive responses* are expressions of beliefs that link an object of discussion with certain characteristics or attributes. It reflects the reasoning processes of the individual learner whereby the learner makes an appeal to the knowledge that he or she has with regard to the topic of discussion. In chapter 6, we refer to these responses as task-related communication.
2. *Affective responses* have to do with evaluations of, and feelings towards a topic of discussion. The object of discussion may vary: it may include responses that refer to the task, other group members or the group as a whole. In chapter 6, we call these affective responses social-emotional communication.
3. *Conative responses* are behavioral inclinations, intentions, commitments, and actions that can be observed during a discussion. The analyses of the computer-mediated communication patterns that are discussed in chapter 7, 8 and 9 take these conative responses into account.

An example of a property that can be situated on the individual level is dominant behavior of a group member. Dominant behavior can be considered as an individual

trait that manifests itself by behavioral inclinations such as coercively taking turns or interrupting other speakers. However, interpersonal dominance manifests itself differently in various groups. The way a dominant person exerts his or her influence depends on structures that are positioned at the level of the interacting group. For example, the group's authority structure influences the occurrence of dominant behavior of individual group members (Bales, 2002).

The Group of Interacting Learners

The group level focuses on processes and structures that frame the interactions between the group members. In this thesis, we focus on the *communication patterns* that join together the group members as a social system (Mabry, 1999). It differs considerably from the individual level of analysis, in the sense that the group is approached as a collective unit with an emphasis on the patterns of intragroup interaction (Poole, Keyton and Frey, 1999).

On this level, we make a distinction between: 1) the communication problems that the groups experience during their collaborative learning activities, 2) the communication patterns that causes these problems, and 3) the underlying mechanisms or structures that explain these patterns (Figure 3.1).

The analysis that is discussed in this thesis starts with the identification of problems that prevent the groups from creating the proper conditions for learning. The

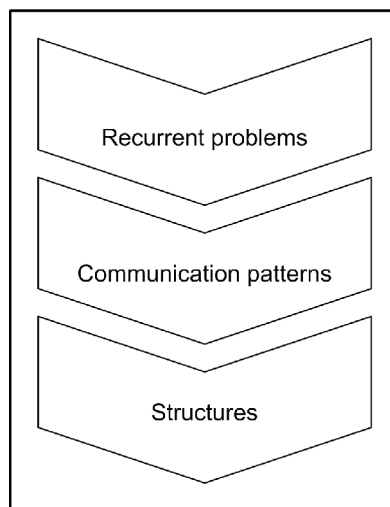


Figure 3.1: Group level: processes and structures.

analysis concentrates on those problems that can be traced back to the communication processes. These problems are described in terms of observable patterns of interaction. These patterns refer to the regular sequence of communicative acts. They are further described in terms of the underlying structures that organize the individual actions into a coherent and meaningful whole. These structures govern and guide the coherence of recurring patterns of group behavior (Cushman & Kovacic, 1994). By focusing on these structures, we make the underlying root causes visible. Examples of underlying structures include role differentiation and authority. In this thesis, we concentrate on the structures of the medium that organize individual exchanges into a sequence of coherent and meaningful talk. We identify two media for communication, i.e. a human medium for verbal face-to-face communication and a digital medium to support computer-mediated face-to-face communication.

The Classroom

The level of the classroom situates the group in the larger learning environment. This level focuses on the interactions that go on in the classroom. Important elements of the classroom environment are the teacher and different kinds of media that bring the knowledge domain to the learner. The teacher, for example, is an important actor on this level who shapes the learning processes. Teacher communication encompasses both establishing and maintaining order, designing effective instruction, dealing with students as a group, responding to the needs of individual students, and effectively handling the discipline and adjustment of individual students (Emmer & Stough, 2001).

The communication processes that can be situated on the level of the classroom are not an object of detailed analysis. In this thesis, we mainly focus on the communicative actions of the individual and the communication patterns of the group. The research examines the relationships among people, tools, and tasks, activated by individual behavior and group structures that change and evolve as the group interacts over time (Arrow, McGrath & Berdahl, 2000). The level of the classroom is used as background that enables us to position the research within the larger classroom environment. This level is further described in chapter 5.

3.4 Understanding Groups: A Functional Perspective

Systems thinking makes it possible to understand collaborative learning from a functional perspective. Functional descriptions call for a concrete and detailed account of the mechanisms, which operate to perform a designated function (Merton, 1967). This perspective accords with the design-based research method that has been discussed in chapter 2. A major objective of design-based research is to generate descriptions in terms of organization and function (Simon, 1996).

Performance Differences

The functional perspective provides us with a general theoretical framework to study groups. It acknowledges that groups who learn together may differ in their performance: the processes and outcomes of groups may vary, even if they all work within the same learning environment. The functional perspective focuses on the origins of these performance differences. It is a preferred research approach of researchers who seek to understand group performance effectiveness (Wittenbaum, Hollingshead, Paulus, Hirokawa, Ancona, Peterson, Jehn & Yoon, 2004). It offers researchers a chance to test hypotheses about the success or failure of groups (Cummings & Ancona, 2005).

The functional perspective states that communication is the instrument by which group members, with varying degrees of success, achieve their learning goals (Gouran & Hirokawa, 1996). The perspective guides much of the research into collaborative learning (see e.g. Barron, 2003; Kneser & Ploetzner, 2001; Sfard & Kieran, 2001; Hogan, Nastasi & Pressley, 2000; Keefer, Zeitz & Resnick, 2000). All these studies observed that the performance of groups varies and they trace these performance differences back to variations in the communication patterns. They aim to identify communication patterns that promote or hamper group learning. For example, a number of studies identified elaborative patterns of interaction as the most productive pattern for group learning (Hogan, Nastasi & Pressley, 2000; van Boxtel, van der Linden & Kanselaar, 2000). Typical for an elaborative pattern is that students build upon each other's contributions by means of evaluating, adding or refining the explanations shared by the group.

Core Assumptions

The functional perspective aims to understand group performance in terms of inputs and interaction processes. It assumes a sequential, causal string: input factors influence interaction processes, which in turn influence group performance outcomes (Wittenbaum et al., 2004). The relationship between input and output is not a direct one; it is mediated by processes that occur during group interaction. The functional perspective can be defined by four core assumptions (Hollingshead et al., 2005):

1. Groups are goal oriented.
2. Group behavior and performance varies and can be evaluated.
3. Interaction processes have utility and can be regulated.
4. Internal and external factors influence group performance via interaction.

Groups are Goal Oriented

Groups have one or more goals that they want to achieve. These goals may refer to the task, the accessibility of resources or the social-emotional well being of the group members (Stangor, 2004). Much of the research from the functional perspective has focused on the effective accomplishment of task-oriented goals (Hollingshead et al., 2005). This also holds true for the research that is presented in this thesis. In our case, it means that we focus on the goals that has to do with learning achievement. The groups that are the object of study have to obtain a learning goal.

Group behavior and performance varies and can be evaluated.

The functional perspective assumes that the performance of groups varies and that it can be evaluated by some standard (Hollinghead et al., 2005). In our case, we evaluate the performance of groups against the criteria of a constructive dialogue during which students collaboratively explore their thinking and develop a shared understanding. These criteria served as a reference for the research and design activities that are discussed in this thesis.

Interaction processes have utility and they can be regulated.

The functional perspective states that the groups should perform certain learning behaviors in order to be successful. Not all groups will display these learning behaviors to the same extend. Steiner (1972) spoke in this context of “productivity losses” due to

faulty individual and collective behaviors like frustration, competing motivations or inadequate understanding. To increase the likelihood that groups will meet their goals, functionalists often design interventions to stimulate the occurrence of certain interaction that make the desired patterns of action during group interaction more likely (Hollingshead et al., 2005). In our case, the intervention will be in the form of a collaborative tool that mediates and regulate part of the face-to-face communication so that a group is better able to carry out a constructive dialogue.

Internal and external factors influence group performance via interaction.

Internal and external factors influence group performance. These factors can be positioned at the level of the individual, the group or the larger learning environment. Internal factors like the composition of the group or external factors like the instructions they receive affect the communication that goes on in the group. Two external circumstances that regulates the communication will the focus of the research: 1) the medium for communication, and 2) the learning instructions that the students receive. The aim of the research is twofold. First, two collaborative tools will be developed that offers the group an alternative medium for communication. Secondly, an instructional strategy will be formulated that makes these tools suitable for a specific context of use.

The functional perspective views group outcomes as a linear function of inputs and processes, it cannot explain cyclical, nonlinear group dynamics, or reverse causality (Hollingshead et al., 2005). The perspective might be a too simple framework to explain the complex and dynamic character of groups as a whole. Still, the functional perspective enables us to zoom in to specific communication patterns and relate these patterns to distinct mechanisms that affect the learning achievement of student groups. However, we need to keep in mind that the reality is much more dynamic.

3.5 Summary

Table 3.4 summarizes the essential elements of the methodological framework that guides the research activities that are discussed in this thesis. The human activity system that is the object of study is the group that consists of a limited number of students who communicate face-to-face. These students participate in a problem-solving discussion with the aim to develop an increased understanding of the topic of discussion.

Characteristics	Description
Ontological claims	A systems perspective towards social reality. Groups can be described at different levels of complexity. Each level of complexity is characterized by its own <i>emergent properties</i> .
Explanatory framework	A functional perspective towards group performance. Communication processes will be explained in terms of organization and function. Functional theories focus on performance differences. These performance differences can be traced back to communication patterns that emerge during a problem-solving discussion. Some patterns are positively associated with learning while other patterns hamper learning.
Mode of inquiry	Design-based research.

Table 3.4: Research strategy to study collaborative learning in the classroom.

We adopt a *Systems perspective* that differentiates between three levels of complexity: 1) the individual learner, 2) the interacting group, and 3) the larger learning environment of the classroom. Each level of complexity can be described by its own emergent properties.

Systems thinking considers a group of students as a purposeful system. This opens up explanations in terms of coordination processes and function. System thinking is associated with a *functional perspective* that focuses on performance differences and relates these differences to specific patterns of group communication. In our case, we aim to understand the functions of communication relevant for the learning task and the various constraints that might prevent groups from effective communication (Waldeck et al., 2002).

The functional perspective is in accordance with a Design-based research approach that intervenes within an existing learning situation to create desired patterns of communication and learning outcomes. These interventions should not only solve the problems that a group faces but they must also lead to an increased understanding about communication, mediation and learning of groups who interact face-to-face.