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ASSESSING LANGUAGE QUALITY IN THE INFORMATION SYSTEMS DEVELOPMENT PROCESS – A THEORETICAL APPROACH AND ITS APPLICATION

Completed Research Paper

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Abstract

The necessary knowledge transfer and communication between project members is identified as a relevant issue in information systems development (ISD). Nevertheless, the impact of linguistic communication on ISD and requirements specification in its processual nature is still an open issue. In our research, we claim that effectiveness of ISD depends on the ability to manage how people deal with language in practice and reach a shared understanding. We propose the concept of language quality as a suitable means for analyzing the emergence of concise and meaningful requirements in ISD. By applying the thereby developed language quality dimensions on a real project, we were able to obtain practice-grounded propositions for practitioners to consider and for researchers to further evaluate the consequences of different actions on the interaction and communication processes for this particular field.

Keywords: Information Systems Development, Requirements Analysis, Language, Communication.

Introduction

Information systems (IS) research and related fields provide a vast body of knowledge on structuring and specifying different aspects of the IS development (ISD) process (Hirschheim et al. 1995; Iivari et al. 2004). Besides, the literatures on software and requirements engineering propose many methods and approaches for analyzing, specifying, and designing IS (e. g., Davis 1990; Fichman and Kemerer 1993; Galliers and Swan 2000; Kavakli and Loucopoulos 2005; Loucopoulos and Karakostas 1995; Morrison and George 1995; Sommerville 2001).

IS are often developed in the form of structured approaches such as projects and using design methodologies (Hirschheim et al. 1995, p. 33). The analysis of the ISD process within these projects is a wide field in IS research (Kautz et al. 2007). Challenges follow from the intangible nature of ISD processes (Cule et al. 2000, p. 65) which lead to difficulties in coordinating activities (Kraut and Streeter 1995), uncertainties and ambiguities influencing the result, increased costs and, in some cases, failure of the whole process (Cule et al. 2000). IS research has faced these challenges, adapting different perspectives in order to develop a better understanding and to reach a better management of ISD processes (e. g., Cao et al. 2009; Hirschheim et al. 1995; Lewis 1994; Sambamurthy and Kirsch 2000; Xia and Lee 2005). However, the research necessity remains obvious: results of various studies still point to the problems arising in ISD projects (e. g., Agrawal and Chari 2007; Molokken and Jorgensen 2003) and the challenge of building reliable IS in a controlled and cost-effective way still exists today (Boehm and Basili 2000; Jarke et al. 2009).

The major problems of ISD are not so much technological as sociological in nature (DeMarco and Lister 1987, p. 4; Hirschheim et al. 1995), and recent studies suggest that more attention should be given to the social act and the dynamics of adaptation of IS by organizational actors (Boudreau and Robey 2005; Galliers and Swan 2000; Vaast and Walsham 2005). Especially for the field of ISD research, Kautz et al. (2007) argue that "there is a need for theory and studies about social behavior and processes of communication, negotiation, and learning" (p. 235). Hence, ISD is conceptualized as a process creating a coherent and meaningful model by the consolidation of different stakeholders' perspectives and multiple requirements in an organization (Curtis et al. 1988; Holmqvist 1989).

A central question in ISD research is how consensus on meaningful and coherent requirements can be reached among different stakeholders (Hansen and Rennecker 2006). We argue that effective communication and interaction are critical to the development of mutual understanding in systems design. However, the process by which this mutual understanding is achieved is not well understood (Tan 1994). For example, Hansen and Lyytinen (2009) suggest synthesizing propagation between social and structural distributed cognition in contemporary requirements practice as a response to the increased distribution of requirements processes.

Requirements are usually stated within a requirements document, which at the end of the requirements analysis process is a specification of the system-to-be-built (Pohl 1994). There is no consensus within the literature whether requirements documents should be expressed in (constrained) natural language or in a formal requirements specification language (Kamsties 2001, pp. 16-17; Pohl 1994). Nevertheless, even if in the long run formal requirements supplement natural language requirements, at the beginning of the process the knowledge about the system is expressed using natural language (Pohl 1993, p. 281). As linguistic communication is the main venue for the definition of requirements, we assume that the understanding of the language definition process on the group-level of the interaction is of critical importance.

At the core of our research, we pursue the objective *of assessing language quality in the ISD process*. To fulfill this objective, we suggest adapting the concept of 'data quality' proposed by Wand and Wang (1996). As a result, we propose the concept of *language quality* as a suitable means for analyzing the emergence of concise and meaningful requirements in ISD. By applying the thereby developed *language quality dimensions* on a real ISD project, we were able to obtain practice-grounded propositions for practitioners to consider and for researchers to further evaluate the consequences of different actions on the interaction and communication processes in ISD.

The remainder of this paper is structured as follows. First, we analyze related work in the field of ISD and requirements analysis and discuss the research gap that led to this paper. Afterwards, we outline our research methodology. We suggest the concept of *language quality* for analyzing ISD, which we base on the concept of 'data quality' and concepts from language theory. The feasibility of our approach is shown exemplarily within a detailed field study. After discussing the implications of our findings, we finish the paper in a "Conclusions and Outlook" section and motivate further research.

Theoretical Background

Overview of ISD in IS Research

Over many decades, the question of how meaningful and coherent system specifications can be developed has been subject of different traditions within IS research (e.g., Hirschheim et al. 1995; Lewis 1994; Sambamurthy and Kirsch 2000; Xia and Lee 2005). Traditional proposals for developing software and IS usually range from sequential approaches (Royce 1970) to more cyclic, iterative approaches (Boehm 1988). During the last decade, agile methodologies (Beck and Andres 2004; Beck et al. 2001; Martin 1991) have been suggested for complementing the iterative approach. Agile ISD methodologies appear to head many of the lessons learned during the past (see Cao et al. 2009; Highsmith and Cockburn 2001). To sum up, recent ISD methodologies trade strict control for more flexibility and autonomy so that planning becomes a permanent task. Above all, agile ISD projects highly depend on the skills, talents, and experiences of the developers.

Nevertheless, difficulties with requirements during the ISD processes lead to various implications, such as implementation problems, adaptation problems, increasing costs, and in some cases even failure of the whole project (Cule et al. 2000). Although many requirements research results have found their way at least partially into practice (Hansen 2008), many new challenges have arisen in the meantime and the requirements analysis process is still an issue (Jarke et al. 2009). For example, diagrams and (semi-) formal graphical models are intensively used by software engineers, system analysts, or business process engineers for specifying requirements of new or changing applications and business processes (Davies et al. 2006). Overall, researchers have proposed a wide variety of methods for conceptual modeling (Siau and Rossi 1998), but most of these methods are rarely used in practice (Lang and Barry 2001; Patel et al. 1998). Moreover, the mere understanding of the syntax, or even the specific semantics, of a specialized modeling language or grammar is not the most crucial factor in ISD (e. g., Aguirre-Urreta and Marakas 2008; Burton-Jones and Weber 1999; Khatri et al. 2006). More relevant are the assumptions that reflect the shared ("common sense") knowledge of people familiar with the social, business and technical contexts within which the proposed system will operate (McDavid 1996; Ryan 1993). Coping with knowledge is still one of the inherent problem areas in ISD (Kautz et al. 2007, p. 231). This implies a focus on constant verbal communication and negotiation (Baskerville and Pries-Heje 2004). Although the necessary knowledge transfer and communication between project members is identified as a relevant part of the ISD process (Levina and Vaast 2005; Robillard 1999), the impact of linguistic communication on ISD and requirements specification in its processual nature is not subject to recent discussion: *"It has repeatedly been observed that business and IT professionals 'speak different languages' and apply differential yardsticks for desired outcomes"* (Hansen and Lyytinen 2010, p. 4).

Language, Representation and Meaning in ISD

Language theorists, communication researchers and cognitive scientists describe this shared knowledge with concepts such as "joint attention frame" (Tomasello 2008) or "common ground" (Clark 1996). In ISD, this becomes especially apparent in the use of language. For example, Holmqvist argues that groups of people in the same organization carry out different functions, and that these groups develop different sub-languages on the basis of their professional backgrounds and the nature and organization of their functions; the development of an IS will be influenced by these languages (Holmqvist 1989, p. 73). There are many studies on the relationship between language and IT (e.g., Holmqvist 1989; Kaasbøll 1987; Pernille and Ojelanki 2009; Wynn et al. 2002), and the important role of language in IT-based communication systems has been a special concern of the Language-Action Perspective (LAP) (e. g., Auramäki et al. 1992; Auramäki et al. 1988; Flores et al. 1988; Goldkuhl and Lyytinen 1982; Schoop 2001; Winograd and Flores 1986), of Symbolic Interaction studies (e. g., Gopal and Prasad 2000), and of Organizational Semiotics (e. g., Clarke 2001). The major focus on the analysis of language and its embeddedness in interaction in the field of IS has been set by researchers using LAP. They relate to linguistic communication as the basis for the understanding of IS and the impact of language action on a system. LAP builds on Speech Act Theory and has been focusing on language as a precondition. In contrast, in this research, we pose the question of how the process of language consensus building is shaped. Hence, we focus on the propositional act of language, which corresponds to the act of reference or predication (Searle 1971). This puts us in between the Skinnerean Response View and the Ordinary Speaking View (Lyytinen 1985), with a focus on behavior, interactionistic sense-making, and pragmatics.

In our research, we mainly focus on natural language. This is not because we suggest that the use of natural language for requirements elicitation is superior to the use of conceptual models or more formal specifications. We simply postulate that natural language is always an issue, at least in early stages of ISD, because of the heterogeneity of the involved actors in usual ISD settings (Hansen and Rennecker 2006). Therefore, it should not be left out of consideration; even more, it should be a fulcrum for ISD research.

One of the most striking disadvantages of natural language is its inherent ambiguity – lexical, syntactical, semantic, referential equivocality and vagueness, which provides space for different interpretations of the same requirements (Berry and Kamsties 2003). Natural language's obvious advantages are that it is easier to understand and to access for a huge number of stakeholders. Therefore, several approaches exist that try to apply or facilitate the use of natural language for requirements specification (e. g., Ambriola and Gervasi 1997; Gervasi and Zowghi 2005). These approaches mostly try to (semi-) automate the generation of formal requirements out of natural language by using parsing algorithms, formal grammars, or similar techniques. We challenge this belief that a logical language can bring out and make explicit the complexities and subtleties of natural language. Ambiguities in language are clarified, not by logical extraction, but by looking at how the words or phrases in question are *used* in our daily activities and practices (Blair 2005, p. 1), and how they *represent* the meaning attached to them by the different actors. Scientists have long known the importance of interacted learning for language understanding (Brighton and Kirby 2001; Clark 1996; Deacon 2005; Pask 1975; Smith 2004). People have to experience what the meaning of a sign in specific situations really is (Bühler 1990, pp. 176-179) – "acting and living together" (Kamlah and Lorenzen 1984, p. 36) has to take place in order for people to become a language community. The process during which language concepts are introduced and negotiated in order to create a shared language between the actors is addressed by philosophy of language as *empractical learning* (Bühler 1990; Kamlah and Lorenzen 1984). These concepts have been previously applied to the IS field as the theoretical foundation of communication processes in IS (Holten 2007).

Observing the language-based negotiations between actors from the representational function of language goes along with the conceptualization of the ISD setting as a language development and formalization process (Lyytinen 1985). Consequently, in this research, we aim to address the following two specific research questions:

RQ1: *How does a shared meaning between stakeholders in ISD processes emerge via empractical learning and language use (the "usage" question)?*

RQ2: *How is this shared meaning captured in representations, that is, how are meaningful representations constructed and sustained over the whole ISD process (the "representation" question)?*

How to Address Quality of Representations

To analyze how shared meaning emerges from language use and is carried on during the ISD process, we suggest applying the concept of quality. *Quality* is generally understood as a degree of excellence – how well a thing performs (Martens and Martens 2001, p. 39). It is broadly defined in terms of the discrepancy between one's expectation of a thing's performance and one's actual experience of its performance (Anupindi et al. 2006, p. 245).

We adopt the lens of ontologically derived quality dimensions to specify *the quality of representations* as the degree to which a representation captures and retains the meaning assigned to it, complying thereby with the stakeholder's expectations. One of the most prominent answers about the ability of constructs to represent a certain domain of the real world was given by the ontological approach proposed by Wand and Weber (Wand and Weber 1993; Wand and Weber 1995). According to Wand and Weber, parts of the real world are described as states with limited values or attributes. Therefore, to evaluate the success of a representation, the relationship between the relevant states of the real world and the states implemented in a system needs to be analyzed. Adopting this approach, Wand and Wang described *data quality* as the ability to provide "a representation of an application domain as perceived by the user" (Wand and Wang 1996, p. 88). The user's view is a "standard against which data quality is defined" (Wand and Wang 1996, p. 88).

To create a basis for our concept of language quality, which is presented in the next section, we apply the data quality dimensions derived by Wand and Wang (1996) as *classification criteria* for the quality of representations (cf. Table 1). These criteria result from the mapping between the user's interpretation and its representation. They were developed by observing deficiencies or inconformity during this mapping and deriving therefrom ideal criteria for "good representations" (Wand and Weber 1995, p. 209). Hence, the decisive operation for determining the quality of

representations is the comparison of (a) the user's view of the real-world system with (b) his view of the real-world system as inferred from the IS.

Table 1. The Representational Dimensions: Criteria for Good Representations*		
Dimension	*Description*	*Repair Action*
Completeness	Every state of the real world (RW) has a one-to-one correspondence with a construct of the representation. There is no state of the RW without representation.	
Meaningfulness	Every representation construct is meaningful referring to objects of the real world. There are no constructs of the representation, for which the mapping to one state of the RW is not possible.	
Non-Redundancy	Every state of the RW has no more than one representation. There are no two or more constructs of the representation mapping to one state of the RW.	
Unambiguity	The mapping from the constructs of the representation to the state of the RW is unambiguous. There is no one construct of the representation which maps to two or more states of the RW.	
*Based on (Wand and Wang 1996; Wand and Weber 1995)		Legend: ● real world construct ○ representation construct

Despite productive research in the IS field, there has been some critique on the application of ontological concepts for the evaluation of representations, particularly on the work of Wand and Weber. This critique is concerned with the question of whether the underlying ontological theory is appropriate (Lyytinen 2006; Wyssusek 2006). The main point of discussion is the assumption that a single exhaustive system could possibly "map the world (as it is)" (Lyytinen 2006). This critique mainly concerns fundamental philosophical assumptions of the research. However, elaborations of this point are not our intent. Instead, we simply assume that the real world can only be accessed through people's interpretations of it. We do not focus on the structures in people's mind, but rather on the articulation of those structures, that is, how they are represented on the observable level of language. Notwithstanding, we assume that this is a venue where we can observe shared meaning being constructed during the interaction of stakeholders in ISD. Our goal is to go to the venue, where the specification of the representations is negotiated and empractical learning takes place through language use.

Nevertheless, the strength of the ontological approach is its ability to address the representational issue based on rigorous definitions (Wand and Wang 1996). Likewise, despite his critique on the ontological foundations of Wand and Weber's theories, Lyytinen emphasizes the usefulness of "the articulation of a minimal and consistent set of modeling constructs and consequent derivation of a system ontology" (Lyytinen 2006, p. 81). For our research, we similarly build upon the articulation of a minimal and consistent set of dimensions to characterize language quality. Along these dimensions, the definition process of language during systems development can be evaluated.

The Issue of Quality in Language Definition Processes

Language Quality as a Concept

As our research focus is on the representation and articulation of the stakeholder's view during the ISD process, we first need to translate the ontological concept of quality into applicable quality dimensions for the language development process.

To translate the ontological position behind Wand and Wang (1996) to the language perspective, we draw on the semiotic tetrahedron (Falkenberg et al. 1998) (cf. Figure 1), an adaptation of the semiotic triangle (Ogden and Richards 1923). The semiotic triangle explains the relation between the *real world*, a *meaning* and its *representation* along the three corners of the triangle. Firstly, a *meaning* is derived from the interpretation of a real world object (interpretation act). Secondly, the meaning is addressed using a *representation* of it (representation act). Thus, the relation from representation to real world object is an indirect one, being dependent on an *actor's* (the speaker's)

interpretation of the real world object (meaning). This leads to a fourth node in the center of the triangle, essentially making it a tetrahedron.

Figure 1. Our Research depicted in the Semiotic Tetrahedron (Falkenberg et al. 1998; Hesse et al. 2008)
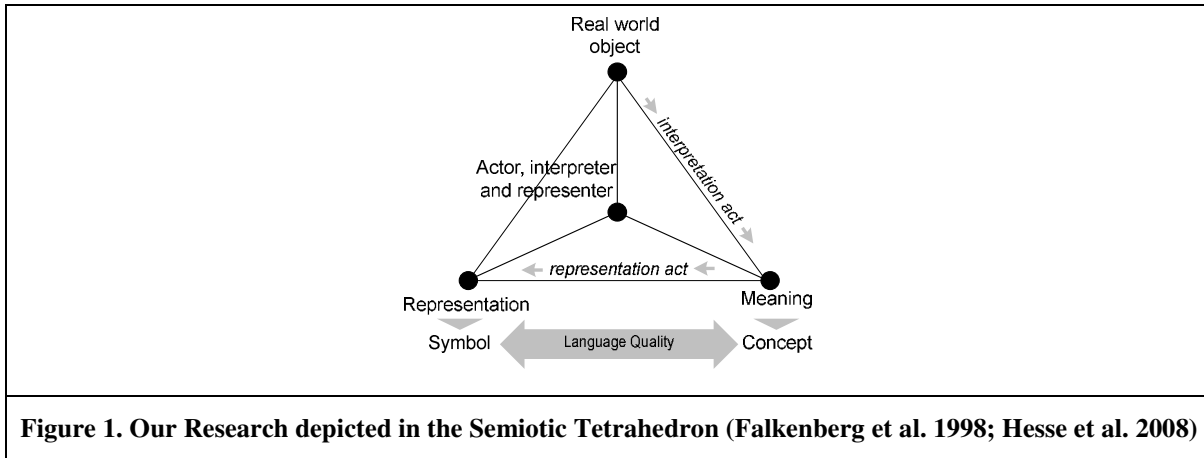
In the following, we focus on *symbols*, which stand for the surface level of language representations. Then, to analyze the meaning a symbol obtains during the interaction, we need to characterize its meaning in a certain linguistic context (Hoppenbrouwers and Weigand 2000, p. 139). On the level of language use, meaning can be identified by analyzing the constitution of a semantic relationship between utterances (Hoppenbrouwers and Weigand 2000), that is, specific *concept-symbol relationships*. This is compatible with our ontological approach, since a symbol acquires meaning by the *properties* ascribed to it (Kamlah and Lorenzen 1984, pp. 26-32).
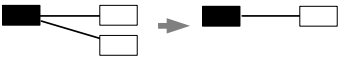
Accordingly, we assume that a *concept* can be unfolded stepwise by analyzing the linguistic context in which the concept-symbol relationship is defined ("constructed") and used in an ongoing language definition process. We hence suggest observing the linguistic context of an ISD process by analyzing how symbols and concepts are introduced and negotiated during the linguistic communication, that is, during the language definition process. Consequently, for this analysis the following premise is given:

> **Language Construct (LC) Premise:** The linguistic construction of a concept-symbol relationship can be observed during the language definition process. The concept appears in its linguistic context and there may be several sides to the same concept. The symbol is used as a representation for given concepts. A symbol that represents one thing in one context may even denote the opposite thing in a slightly different context.

As we understand the quality of representations to be the degree to which the representation captures and retains a meaning assigned to it, we define language quality focusing on the relationship built between concepts and symbols during the language definition process. *Language quality* (LQ) is the degree to which a symbol obtains and retains a relationship to a concept. Furthermore, we assert that, in order to evaluate *language quality* in the language definition process, we need to focus on how well the relationship addressed by the LC Premise is built:

> **Language Quality (LQ) Premise:** The quality of the language built can be observed as mappings between *symbols* and *concepts* given in the language definition process.

Following the previously presented dimensions (cf. Table 1)*,* we assess language quality along the adapted *language quality dimensions* described in Table 2.

Table 2. Language Quality Dimensions		
Quality Dimension	*Description*	*Repair Action*
Completeness	Completeness is given when a representing symbol is given for every concept.	
Meaningfulness	A meaningful representation is given when every representing symbol is linked with one corresponding concept.	
Non-Redundancy	Non-redundancy is given when in every linguistic unit single concepts are linked to one concrete symbol.	
Unambiguity	Unambiguity is given when no two concepts map into the same symbol.	
		Legend: ■ concept □ symbol

We adapt the ontological concept of quality as a lens to analyze the dynamics of language and meaning negotiation. In the first place, the issue of quality focuses on the results of this negotiation. The processual character can be assessed by tracing the realization of language quality during the ISD process.

Research Approach

How to Trace Language Quality during Language Use

In the focus of the empirical analysis of language quality is the language definition process, consisting of single utterances with language defining character, that is, symbols and concepts are introduced and negotiated. For single project-relevant concepts, defined as *objects of definition* (ODs), we trace the process, in which the concept's relationship to a symbol is (re-) defined.

In terms of rationality (Schutz 1962) it is necessary to deduce coding categories that are in line with the theoretical premises of the research. Along with the premises in the prior section, the first category derives from the LC premise. Its sub-categories *symbol* and *concept* are explained and described in Table 3.

| Table 3. Language Construct (LC) Category			
Sub-Category	*Code*	*Coding Description*	*Examples*[1]
Concept	CO	Noun or set of nouns introducing new intrinsic properties.	…[*this is a kind of questionnaire at the end of every phase*]...
		Noun or set of nouns introducing new mutual properties, e.g. relationship to other concepts.	The article [*consists of content elements*]
Symbol	SY	Noun or set of nouns acting as a substantial representation of the concept meant. Stands for the concept.	There are [PHASES], which … There are [SUBSCRIBED MEMBERS], which…
[1] *In quotes, concepts are highlighted italic and symbols are in small caps*			

The second coding category derives from the LQ premise. According to the rationale of our ontological foundations, the analysis of language quality departs from the analysis of deficiencies regarding the language quality dimensions described in Table 2. The resulting inconsistencies serve as a basis for the codes and are explained in Table 4.

Table 4. Language Quality (LQ) Category			
Sub-Category	*Code*	*Coding Description*	*Examples*[1]
Incompleteness	INC	After having described a concept, no symbol is introduced or determined to refer this concept.	A: Is there [*something like in Wikipedia, where in the middle of the text you have blue text for relevant words, then you can click on it and it automatically leads you to another module (…)*]? B: Yes.
Meaninglessness	MLN	After having used a symbol, no definition of the symbol is given and the subsequent utterances make clear that the corresponding concept is missing or unclear.	A: The [USER]… B: What do you mean with [USER]?
Redundancy	RDC	After having used a symbol for the reference of a concept, a different symbol is used for the reference of the same concept.	A: There are [SUBSCRIBED MEMBERS], which… (…) B: The [REGISTERED USERS]…
Ambiguity	AMB	After having used a symbol for the reference of a concept, a different concept can be detected, which is represented by the same symbol.	A: I would have called it "[PERSONALIZATION AREA]" B: Ahm… "[PERSONALIZATION AREA]" is the whole thing. A: Oh, ok.
[1] *In quotes, concepts are highlighted italic and symbols are in small caps*			

The coding performed along the LC category can be interpreted as a preliminary coding (*LC coding*), whereas the coding based on the LQ category complies with the central analysis of language quality presented in this research (*LQ coding*). During the LC coding, utterances are classified as symbols (SY) or concepts (CO) depending on the corresponding OD. During the LQ coding, the relation between previously classified SY and CO codes and vice versa is analyzed. This process is illustrated in Figure 2.

Figure 2. Coding Schema for LQ Coding
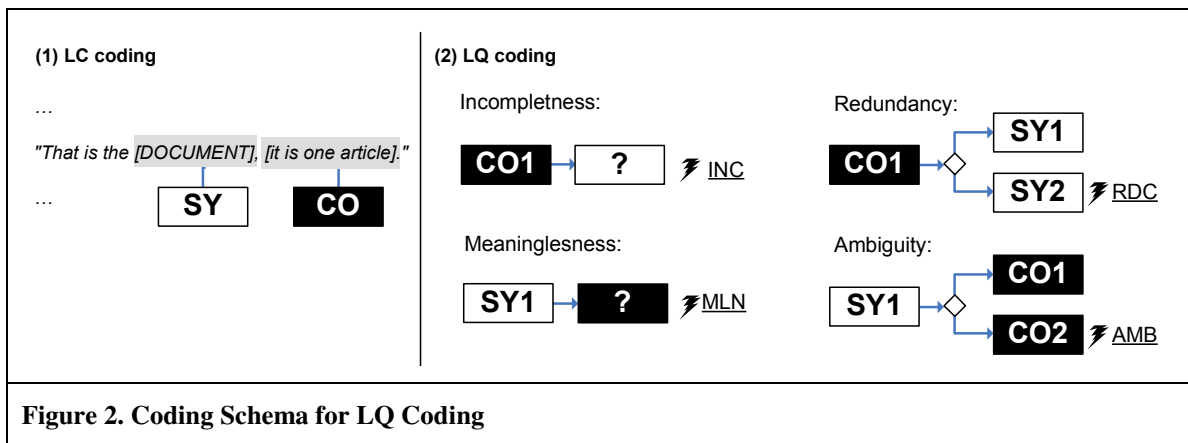
If the relation between SY and CO cannot be identified in the observed sequence, codes INC (inconsistency) and MLN (meaninglessness) are used to encode the appropriate case. That is, for the codes INC and MLN, the codes SY or CO are analyzed in their first appearance form (SY1 or CO1 in Figure 2). INC is assigned, if for a given CO1, no SY1 is determined. MNL is assigned if no CO1 is introduced to SY1. Afterwards, identified relations, that is, concepts with assigned symbols (SY1 and CO1), are further analyzed using codes AMB (ambiguity) and RDC (redundancy). The RDC code is assigned if a different symbol (SY2) refers to CO1. The AMB code is used if a new concept (CO2) refers to SY1.

Research Method and Study Design

We analyzed language quality in an ISD project that developed a content management system (CMS) for analysis, storage and retrieval of market-specific and user-customized information. The project was conducted from December 2006 to September 2009 in Germany. The common language and the project language were German. The

stakeholders involved in the research were three people from a project management team (PM), six from an enterprise team (EN), five from a developer team (DE), and two from a requirements engineering team (RE). One stakeholder of RE was also a member of the research team (RE2). The research was performed from December 2006 until January 2009. The meetings took place in different project member configurations. During the course of the research, we were able to include nine meetings in our analysis. The first four meetings were observed by the participating researcher and the observations of the language definition process were captured as field notes. The following five meetings were audio-recorded and transcribed. From this data, we chose 70 ODs. As the first meetings were observed, but not audio-recorded, our observations do not include the introduction of all signs and concepts involved.

The data collection method for the analysis is qualitative fieldwork. Authentic communication data was recorded and transcribed. The analysis of the language development process focused on the analysis of the transcriptions and field notes made, centering on what has been said. Then, the data was sequentially coded using the given codes (cf. section "How to Trace Language Quality during Language Use").

After the LC coding and the LQ coding, every OD was individually interpreted and analyzed in order to identify reasons why language quality changed. For every language quality dimension (cf. Table 2), we analyzed the factors that had a positive or negative impact on language quality. This finally led us to derive a set of propositions. These propositions were gained by our explorative qualitative analysis of the codes and codings (induction). They are also examples for the usefulness of the adoption of our language quality dimensions for ISD research. Two exemplary OD sequences with the respecting codes are presented in Figure 3 and Figure 4. An overview of ODs, in which deficiencies in LQ were identified, and their respective codes are listed in Table 6 in the appendix.

Analysis of the Language Definition Process in ISD

From 70 ODs, we observed 53 which showed deficiencies related to the language quality dimensions. For the dimensions *completeness* and *meaningfulness,* we identified deficiencies in 23 and 15 ODs respectively. 24 and 10 ODs were observed for the dimensions *non-redundancy* and *unambiguity* respectively. Some of the observed deficiencies refer to symbols or concepts involved in other ODs. For instance, for the dimensions *non-redundancy* and *unambiguity*, we identified 13 cases in which the redundant symbol of a particular OD was, at the same time, the symbol in another OD, fulfilling the assertions about deficiency in *unambiguity*.

The analysis and interpretation of the observed data revealed different insights, which are subsumed in the following set of propositions (cf. Table 5). In the following section, we give an overview of the emergence of these propositions by presenting the results of the qualitative analysis for all four language quality dimensions. To link specific results to the here presented propositions, we include in the following section an arrow and the corresponding proposition number in brackets for each finding (e. g., in the form "($\rightarrow$ P1)").

P#	Proposition
P1	An early agreement on symbol and concept relationships has a negative impact on the emergence of volatile symbols.
P2	The absence of representing symbols for relevant concepts has a negative impact on the interaction time.
P3	The absence of symbols leads to insecurity about mutual understanding.
P4	If agreements about symbols are not renewed over the interaction process, they are subject to change.
P5	Meaningful concept-symbol relationships are abolished if some symbols are not quite easy to adopt.
P6	Clearness in stating a request for the definition of concepts has a positive impact on the effectiveness of requirements negotiation.
P7	Explicitness in the request for the definition of symbols and/or concepts has a positive impact on the effectiveness of requirements negotiation.
P8	Explicitness in the request for the standardization of symbol and concept relationships has a positive impact on the effectiveness of requirements negotiation.
P9	The existence of partially similar symbol-concept relationships requires a higher consideration of language quality.

Table 5. Propositions

Completeness

All 23 cases that showed deficiencies in *completeness* share the fact that a concept was introduced or explained. From this starting point, we analyzed whether and how a representing symbol was assigned to this concept. In 19[1] of 23 ODs, we could identify representing symbols which addressed the described concept. In the remaining ODs, no symbol was assigned to the concept at all.

Among the former ODs, we observed the most evident purposeful action to achieve completeness in two cases,[2] in which the same speaker who previously described and explained the concept formulated the explicit request for a symbol. For example, in OD-31:

Speaker	*Linguistic Utterance*
DE3:	I think about this… how is it called? [[*description of the concept*]].
RE1:	[MORPHOLOGICAL BOX]

Here, the requesting speaker was aware that a symbol for referring to the concept existed.

In four other cases[3], although there was no purposeful requesting action for a symbol, corresponding symbols were spontaneously included in the feedback. For example, in OD-3:

Speaker	*Linguistic Utterance*
PM2:	Is it possible to [[*description of the concept*]]
DE3:	[AUTOMATIC TAGGING] is too difficult.

Although these cases suggest that the effort and strive of people to achieve completeness in language definition may be self-evident or straightforward, the other cases show a different course of action. In these cases, in which no symbol for a concept was defined, when the stakeholders needed to refer back to these concepts that had already been discussed, they helped themselves by using single words of the already uttered description[4]. In OD-23 for example, the stakeholders were discussing either storing genuine, self-generated data in the CMS or just displaying the data of other news platforms:

Speaker	*Linguistic Utterance*
DE3:	In terms of practicability I would rather [*forward directly to other websites*]. (…)
RE1:	I also think that the platform can be understood as [*a display for other's news*].
(…)	
PM2:	I also think so, the [DISPLAY THING] is better.

This seemed sufficient at the time to make clear what was meant, as all the stakeholders were involved in the ongoing discussion. Nevertheless, it can be assumed that, a couple of weeks later, it may be difficult to refer back to the same concept as the "[DISPLAY THING]", as this symbol is clearly of a volatile nature. On the other side, in the prior examples (e.g. OD-3 and OD-31) we could observe that an early agreement on adequate symbols to address the given concepts eliminated the necessity for such a volatile symbol ($\rightarrow$ P1).

Furthermore, in yet another set of cases, the interactions that followed after explaining the concept did not yield new symbols to represent it.[5] Instead, stakeholders reacted only with general feedback, such as an affirmative or a judging utterance. For example, in OD-13:

Speaker	*Linguistic Utterance*
PM2:	Is there [*something like Wikipedia, where in the middle of the text you have blue text for relevant words and then you can click on it and it automatically leads you to another module (…)*]?
RE2:	Yes.
PM2:	I mean [*so that you can jump immediately to another topic…*]

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[1] ODs 3, 5, 6, 7, 8, 17, 19, 20, 24, 27, 31, 33, 35, 39, 41, 43, 45, 46, 52.
[2] ODs 31, 53.
[3] ODs 3, 39, 41, 46.
[4] ODs 6, 8, 21, 22, 23, 35, 43, 46, 48.
[5] ODs 13, 21, 22, 23, 35.

RE1:	I do not know if that happens automatically.
PM2:	No, [*I mean…*]

Here, PM2 tries to explain the concept behind OD-13. Although he already received an answer to his question after the first run, he repeated the already given parts of the concept to ensure that they were talking about the same concept ($\rightarrow$ P2, P3).

Meaningfulness

In all cases where we observed that a symbol was introduced, we analyzed the subsequent interaction to identify deficiencies in the dimension *meaningfulness* and to examine how these deficiencies were addressed. From then on, we analyzed whether and by which actions the missing meaning was adjusted. Among all observations, two main courses of action could be discerned. In the first one, for which we identified 7 ODs[6], stakeholders gave definitions of terms spontaneously without others requesting them. For example, in OD-1:

Speaker	*Linguistic Utterance*
DE3:	I am thinking about [ANCHORS]. These are […]

In the second one, with five observed ODs[7], we identified explicit questions of speakers for the meaning of symbols that had been already introduced. For example, in OD-53:

Speaker	*Linguistic Utterance*
PM1:	What is the [SYNONYM LIST] exactly?

Both observations allowed the stakeholders to integrate concept-symbol relationships as new project requirements and made a discussion of meaningful requirements possible. As the analysis of deficiencies in meaningfulness is only possible if they really are explicitly expressed, we suppose that not all cases could be identified. Especially in these cases, the analysis of difficulties can bring more insight into this process.

However, we also observed some problematic cases. For example in OD-53 and OD-46, the symbols that were given seemed to appear so alien to some stakeholders, that they had difficulties adopting them. For example, in OD-53, the given symbol was "[VOLATILITY SCALE]". Later on, one of the stakeholders referred to it as "the vola… whatsit..." ($\rightarrow$ P4, P5).

Another problematic case was OD-29. Figure 3 presents this case in more detail. In OD-29, the concept addressed by the symbol "[M-N RELATIONSHIP]" was not understood by one of the stakeholders. Although he made it clear that there was a misunderstanding, he did not explicitly articulate the reason for his confusion. This led to the definition of other ODs by both involved stakeholders ([Document] and [Article]). After some discussion, PM2 finally expressed explicitly that the symbol "[M-N RELATIONSHIP]" was unclear for him (underlined sentence in Figure 3). At this point, deficiencies due to meaninglessness could be identified (as suggested by the dotted arrow). As the case of OD-29 suggests, the meaningless symbol is not always the first subject of discussion when it comes to misunderstandings due to unspecified requests ($\rightarrow$P6, P7).

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[6] ODs 1, 11, 16, 20, 36, 49, 53.
[7] ODs 29, 33, 44, 51, 53.

Quote		OD-[M-N relationship]		OD-[Document]		OD-[Article]	
		LC-Code	LQ-Code	LC-Code	LQ-Code	LC-Code	LQ-Code
RE3:	Exactly that was the question of the [M-N RELATIONSHIP] between 'articles' and 'modules'. That is why I did it like that. Because it was… according to the ERM it was so, that is why I did it like that, i.e. I separated the 'articles' and 'modules'.	SY	MLN				
PM2:	Well…						
RE3:	Is it clear what I mean?						
PM2:	When I take the articles and… no… I don't know…						
RE3:	That is the [DOCUMENT], [*it is one article*].			SY |CO			
PM2:	If I choose one [ARTICLE], does it [*automatically show the top of the module or something like that?*] That is what I mean.					SY |CO	
RE3:	Yes, exactly.						
PM2:	Exactly….						
RE3:	That's why, because it is a [M-N RELATIONSHIP], it is not possible to deduce from one of them to the other.	SY					
(silence)							
PM2:	Well, this [N RELATIONSHIP]… I don't understand what it means…						
RE3:	Ehhh, [*different modules can be assigned to different articles. That means, different modules can be assigned to one article.*]	CO					

Figure 3.   Coding Example OD-29

Non-Redundancy

In all ODs in which two or more symbols addressed the same concept, we analyzed how redundancy emerges and if we could observe actions of the speakers aiming to repair it. The following examples refer to the use of different words that have a similar meaning with regard to their interpretation (synonyms)[8], for example, in OD-14.

At an earlier stage of the project, the stakeholders agreed on integrating another company's experiences as a particular document type in the CMS. Here, we observed discrepancies resulting from the use of the symbols "[FIELD REPORT]" and "[CASE STUDY]", which different speakers used to refer to the same concept. Although all stakeholders seemed to link both terms to the same concept, the use of each term apparently brought confusion, as the stakeholders showed insecurity, for example, by beginning a sentence using one symbol and ending it with the other. Nevertheless, there was no explicit request for the adoption of one of both symbols. It took two meetings until the use of "[FIELD REPORT]" seemed to be implicitly adopted by everyone. Then, in the ninth meeting, a new concept was introduced because one of the project documentations addressed "[FIELD REPORT]" as "[EXPERIENCE REPORT]". During this meeting, one of the stakeholders emphasized the redundancy by explaining:

Speaker	*Linguistic Utterance*
RE1:	In the ERM we called it [EXPERIENCE REPORT] instead of [FIELD REPORT]. The terms are not really consistent.

In the following utterances he addressed the concept as "[CASE STUDY/ EXPERIENCE REPORT]", until after some discussion rounds he switched to just "[FIELD REPORT]".

Similarly, in OD-8 two symbols were used to refer to the smallest text field in the CMS: "[CONTENT ELEMENT]" and "[INFORMATION COMPONENT]". This seemed to be clear to everyone. However, at one point during the second meeting, one of the stakeholders explicitly requested the future use of "[CONTENT ELEMENT]" as he had different associations with "[INFORMATION COMPONENT]".

In the first case, the explicit indication of redundancy came across only after a while, motivated by a second redundant symbol referring to the concept. In the second case, a clarifying request was stated together with the first

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[8] ODs 4, 7, 9, 10, 11, 12, 14, 30, 51.

redundant symbol. In both cases, we distinguish two different, purposeful clarifying actions. On the one side, we observed *explicit signaling of redundancy*. On the other side, we observed *explicit requesting for the standardization* of just one of the redundant symbols, in this example motivated by a "false" interpretation due to his subjective knowledge base of another concept. Notwithstanding the motivation, the standardization in the second case allowed the stakeholders to address the symbols more effectively than in the first case, where an implicit standardization occurred only after some discussion rounds (→ P8).

In a third set of ODs, we observed the impact of subjective interpretations in order to introduce new concepts. In OD-[Module] (OD-30), for instance, the concept of [Module] was introduced to different stakeholders in two different meetings by using the symbols "[MODULE]", "[THEMATIC BLOCK]" or "[CHAPTER]" as synonyms. This introduction served as an explanation of the concept. The redundant use was only observed in the beginning of the explanation. In the further interaction the symbol "[MODULE]" was adopted and we observed no further problems.

In all presented cases so far, we observed no similarity regarding the words that comprised the symbols. On the other side, several deficiencies in unambiguity were identified resulting from the additional use of either shortened or generalized versions of the original symbols.[9] In these cases we could identify deficiencies in non-redundancy and in unambiguity. These cases are exemplary discussed in the next paragraphs in OD-51.

Unambiguity

To analyze deficiencies in *unambiguity* we focused on two types of cases. First, we analyzed cases in which we could recognize out of subsequent utterances if the given symbol stood for a second concept[10].

In two of the ODs[11], the clarifying action was performed by the same stakeholder, as in OD-17:

Speaker	*Linguistic Utterance*
RE1:	There you have a [*header*] [H1]. Well, *not* a [H1 ENGINE], but a [H1] [*HTML tag "method descriptions" and there…]*

In two other ODs[12], the stakeholders who were not using the ambiguous symbol made the request for clarification. For example, we can recognize the request underlined in the fourth quote of Figure 4 for OD-51.

Secondly, we focused on cases in which the stakeholder's utterances did not address ambiguity in the first place. Instead, we analyzed the symbols used and compared them with symbols of other concept-symbol combinations in the same project. Thereby we could recognize several additional deficiencies in unambiguity as the ones explicitly pointed out by stakeholders.

For example, OD-51 shows several deficiencies in unambiguity, but also, as stated before, in non-redundancy. An exemplary overview is provided in Figure 4. In the project, the concept of OD-[User] has been defined as a general class of objects, referred to by the symbol "[USER]". In addition, various specializations of this general class, such as [Administrator], [Author] or [Registered user], were initially addressed by corresponding symbols such as "[ADMINISTRATOR]", "[AUTHOR]" and "[REGISTERED USER]". On the one side, we observed that stakeholders employed different symbols in order to refer to the concept of [User]. We observed the use of four different symbols: three German nouns standing for "[OPERATOR]", "[END-USER]", "[VISITOR]" and "[USER]". On the other side, we noticed that this redundancy turned even more confusing, as the stakeholders used the symbols linked with [User] to address some specializations of [User], that is, to address the ODs [Author] or [Registered user]. Figure 4 shows exemplary quotes of OD-51 and its codes. For example, during the discussion about editing access rights of [Authors] (Quote 1, Figure 4), DE1 referred [Author] using the symbol "[OPERATOR]". As observed in the feedback of RE1, he introduced the symbol "[AUTHOR]" again in the discussion, but without making any comments about redundancy.

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[9] ODs 16, 33, 34, 35, 38, 40, 43, 46, 51.
[10] ODs 4, 17, 45, 51.

[11] ODs 4, 17.
[12] ODs 45, 51.

Quotes		OD-[User]		OD-[Author]		OD-[Registered user]	
		LC-Code	LQ-Code	LC-Code	LQ-Code	LC-Code	LQ-Code
1	DE1: An [OPERATOR] can add one article, right? Are [*the articles written by*] one [OPERATOR], or by different [OPERATORS]? RE1: (…) Well, in fact by everyone who is an [AUTHOR].	SY		CO	AMB RDC		
2	RE1: System in which the [USER] [*can log in*].	SY				CO	AMB
3	RE1: Every [USER] [*has a profile*] (…).	SY				CO	AMB
4	RE1: For instance, one dimension is: from which area does the [OPERATOR] come from? (…) However, thereby we can [*charachterize how far the*] [USER] [*is*]…	SY				CO	AMB RDC / AMB
	DE1: Wait, what do you mean with [USER]?	SY				CO	
	RE1: The one who [*has registered*] DE1: Ok, so really the [USER], the [REGISTERED USER]	SY				SY	AMB

Figure 4. Coding Example OD-51

In the other quotes in Figure 4, the analysis of the descriptions clearly suggests that the concept addressed here was that of OD-[Registered user]. Nevertheless, in these examples, the symbols previously assigned to [User] were applied here as well. However, some actions during the interactions can be interpreted as clarifying actions in terms of unambiguity or non-redundancy, for example, the use of the symbol "[AUTHOR]" in the first quote or the explicit request for the definition of the symbol "[USER]" in the fourth quote. Nevertheless, we observed no explicit request for the adoption of just one non-redundant and unambiguous symbol in the entirety of OD-51.

A similar situation was given for instance between the concept of OD-[Document] and its specializations [Field report], [Article] and [Method description]. Here, an observed problem was the use of the symbol "[ARTICLE]" to refer to the concept of OD-[Document]. Discussions of editing rights for "[ARTICLES]" thus had to be reconsidered for the concepts of OD-[Method description] and OD-[Field report].

However, one reason for the (initially) undiscovered ambiguity between related concepts and symbols can be accounted for by the fact that these related concepts have similar attributes. For example, as observed in the OD [User] and [Document], cases that show similar or related symbol-concept combinations are more susceptible to produce deficiencies in unambiguity and non-redundancy. OD-51 suggests that the similarity of symbols can lead to the use of a shortened version of accorded symbols ("[REGISTERED USER]" to "[USER]"). On the other side, the similarity between concepts can provide the stakeholders with misleading evidence that everyone is referring to the same concept. Therefore, the risk of remaining undetected can be interpreted as being higher (→ P9, P4). We assume that this assumption is especially of relevance in the field of ISD, as the differentiation between superclass and subclass belongs to one of its fundamental constructs.

Discussion

Led by the questions of how a shared meaning between stakeholders emerges through language use and is captured in linguistic representations over the whole ISD process, we adapted ontological criteria for the evaluation of representations to the field of linguistic communication. We propose the concept of language quality for evaluating the language definition process. It consists of a coherent set of criteria: the language quality dimensions (completeness, meaningfulness, non-redundancy, and unambiguity, cf. Table 2). The application of these dimensions to data of real ISD situations was preceded by a translation of our two theoretical premises (LC Premise and LQ Premise) into suitable research categories (LC and LQ category) of a coding scheme. By applying the concept of language quality to recorded and transcribed conversations of a real, concrete ISD project, we obtained a set of propositions about the quality of the language definition process in ISD projects that we derived from our interpretation of the data. This gives evidence for the practicability and utility of our concepts.

The application of the concept of language quality can be of great help in the attempt to trace and analyze the emergence of formalized, useful requirements and shared understanding from a more diffuse, colloquial language and individual sense-making during the language definition process. Consequently, we primarily consider our concepts as a lens for researchers looking for a suitable means for analyzing the emergence of linguistic consensus in ISD processes. At the same time, we provide practitioners with first insights emerging from real ISD projects. Our propositions create awareness for possible language definition deficiencies and pitfalls. For example, we conclude from our findings that it might be very useful to strive for an early explicit agreement on representing symbols for relevant concepts in order to avoid the emergence of volatile symbols, long discussions, or insecurity regarding mutual, shared understanding (P1, P2, P3 and P7). Language quality is not something static; it requires a constant attention and revision (P4 and P5). Furthermore, our findings indicate that effectiveness in the achievement of language quality depends on how the negotiation of symbol-concept relationships is conducted (P6 and P8). Finally, language quality is definitely of importance in the field of ISD, especially with regard to requirements elicitation and negotiation (P9).

However, the analysis of language quality during the language definition process in ISD is challenging for different reasons. It is not only the volatile nature of verbal communication that makes it difficult to deal with it. More important is the fact that language use is an attempt to bring different kinds of individual knowledge to the surface of social communication. For instance, the use of narrative elements in examples of ISD cases suggest that a low language quality is inherent to early stages of the ISD process (Alvarez and Urla 2002). While we do not assert that it is possible to avoid low language quality during early stages of language definition processes, we argue that there are important concepts and definitions in every ISD process for which a low language quality, in the long run, is (1) unnecessary and (2) disadvantageous. We suggest that our concepts provide a first building block for benefiting language quality during the language definition process in ISD.

Our findings can help both researcher and practitioners to better understand the diversity of ISD projects, the dependence on developers' knowledge, and the relationship between structure and ISD practice (Kautz et al. 2007). For example, observing and tracing language quality could allow us to explore how complexity and diversity are reflected in and dealt with by the communication processes of ISD project members, both on an individual and on the group level. At the same time, this might help to investigate what kind of knowledge is acquired and negotiated between different ISD project stakeholders through the use of language, and how important language use is for these sense-making and negotiation processes. Similarly, the observation of language use and communication could allow us to explore how formal and social structures in ISD projects are perceived and established by and between individual stakeholders and groups because structures are linked to communication by interpretive schemes of human actors; these interpretive schemes are "the modes of typification incorporated within actors' stocks of knowledge, applied reflexively in the sustaining of communication" (Giddens 1984, p. 29). Of course, our findings and propositions also need to be matched with existing theories that try to explain these phenomena in the field of ISD, for example, complexity theory (Vidgen and Wang 2009), control theory (Maruping et al. 2009), or structuration theory (Chae and Poole 2005).

It is also important to note that our analysis focused only on the *observable level* of communication. That is, we can only observe concept-symbol relationships; thus, we are only able to deduce different concepts and meanings by interpretation of these observations and their context. We do not claim to develop a universal approach that describes how language definition in ISD has to be performed, neither do we intend to derogate from the use of conceptual models and other methods used to finally conceptualize the future IS. Instead, we aim to close the gap between requirements gathering and conceptual models. Moreover, we do not ask whether concepts and symbols generated by stakeholders are really relevant for the real world. This issue is the core question addressed by the concept of data quality (Wand and Wang 1996) and the Bunge-Wand-Weber approach (e. g., Wand and Weber 1990). In addition, we do not imply that (natural) language is the only communication channel used in ISD. Other areas dealing with the dynamics of social communication, such as the analysis of gestures, problems of culture or issues of social power are acknowledged as important (e. g., Rowlands 2009). Pragmatically, there may be several reasons why language quality may be disturbed. In our research, we only focus on causes that emerge from the semantic level, as observed through the pragmatic level.

While we cannot generalize the importance of language quality for other fields where language plays a secondary role, we can assume that in our observed field of ISD this issue has a relevance, which needs to be assessed. With this research, we hope to provide a useful approach for language quality analysis while at the same time contributing to practitioners' views of the ISD language definition process. In general, we assert that the ontological lens of quality can provide a useful approach for analyzing and understanding the processes of language development. This

seems to be a suitable method for the analysis of natural language communication, especially in the field of ISD. For practitioners, it will be helpful to know the consequences of different actions on language quality, which certainly requires a deeper analysis of them, what we were able to present during this research. For example, our concept of language quality could be used to complement approaches such as storytelling or the persona-scenario method (Madsen and Nielsen 2010).

Although the observational data was limited to a single project and data analysis was restricted, the results of this research can provide qualitative evidence and have the capability to develop analytical and statistical generalization by the application to various and larger ISD projects. For example, further research that builds on a broader data basis can address the ability of different stakeholder groups to achieve and retain a shared meaning. A comparison between different degrees of expertise or domain-specific knowledge in the field of ISD may bring to light more suitable strategies on how to successfully address misunderstandings and unnecessary low language quality. As this kind of research can provide useful propositions for practice, we also encourage using it in the application of other research methods, for instance qualitative and quantitative experiments or action research.

Conclusion

In this paper, we have proposed an approach to analyze language use and communication in ISD projects in a unique and novel way. We emphasize that language is an important "variable of interest" (Pondy 2005, p. 133) and should become a central feature of study in ISD. We suggest that our concept of language quality illuminates some of the factors that lead to specific patterns and phenomena in ISD. We encourage others to comment on and challenge our conceptualization. In this way, we hope that we may advance the development of theory in ISD beyond the mere adoption of theories from other disciplines. Our next steps are to confront our propositions with more empirical data in order to corroborate our conjectures. If our concepts find acceptance in the ISD research community, they can be used for the study of ISD phenomena and for better understanding the ISD process. We hope that our concepts will be useful for other ISD researchers and practitioners.

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Table 6. Excerpt of Codes for Objects of Definition with observed Deficiencies in Language Quality

#	OD English/German		LC Codes and LQ Codes
1	Anchor	SY	X
		CO	_ X
		LQ	M
2	Article/Artikel	SY	X _ _ X
		CO	_ X X X X
		LQ	_ _ _ M
3	Automatic Tagging	SY	_ X
		CO	X
		LQ	I
4	Author/Autor	SY	X _ X _ X X X X
		CO	X X X X X X X _ X
		LQ	A _ R _ AR R AR AR
5	Breadcrumbs	SY	_ X X _ X X _ _ _ X
		CO	X _ _ X _ _ X X X X
		LQ	I _ _ _ R _ _ I _ _ R
6	Change History/ Änderungs- historie	SY	_ _ _ _ X
		CO	X X X X X _ X X
		LQ	I
7	Contact Objects/ Kontaktobjekte	SY	_ _ _ X X X X
		CO	X X X X X X X X
		LQ	I _ _ _ _ R AR R
8	Content Element Link/ Content Element Verlinkung	SY	_ _ X
		CO	X X X X X X X X X X X X
		LQ	I
9	Content Element	SY	X X X _ _ _ X X X X
		CO	X X X X X X X X X X X
		LQ	_ _ R _ _ _ _ R
10	Document/ Dokument	SY	X _ _ _ _ X
		CO	_ X X X X X X X
		LQ	_ _ _ _ AR
11	Edit Permission/ Editieren von Inhalten	SY	X _ X X X _ X X _ X X
		CO	_ X X X X X X X _ X _ X
		LQ	M _ R _ R _ _ _ R _ R
12	Edit Protection/ Schreibschutz	SY	X _ X X X
		CO	_ X X X X X
		LQ	_ _ R
13	Embedded Hyperlink/Einge betteter Link	SY	_ _ X _ X
		CO	X X X X X X X _ X
		LQ	I _ _ _ _ R
14	Field Report/ Fallstudien	SY	X X X _ X _ X _ _ _ X X X
		CO	X X _ X X X X X X X X X X
		LQ	_ R R _ _ R _ _ _ A R R
15	Format Of Input Data/Eingangs- datenformate	SY	X
		CO	_ X
		LQ	M
16	Full Text Search/ Volltextsuche	SY	X
		CO	_ X X
		LQ	M
17	H1 Tag/H1-Tag	SY	X X _ X X
		CO	X _ X X X
		LQ	A I _ I I
18	Hierarchy/ Hierarchisierung	SY	_ X _ _ X
		CO	X X X X X X X
		LQ	_ _ _ M
19	Home Button/ Homebutton	SY	_ X
		CO	X X
		LQ	I
20	Homepage/ Startseite	SY	_ X X X
		CO	X X X X
		LQ	I R R AR
21	Integration Of News 1	SY	_ X
		CO	X
		LQ	I
22	Integration Of News 2	SY	_ X
		CO	X
		LQ	I
23	Integration Of News 3	SY	_ X X
		CO	X
		LQ	I _ R
24	Key Identifier/ Eindeutiger Bezeichner	SY	X _ X _ X _ _ X
		CO	X X X X X X X
		LQ	I R _ R
25	Knowledge Platform / Wissensplattf.	SY	X
		CO	_ X X X X X X
		LQ	M
26	Mth.Description / Methoden- beschreibungen	SY	X
		CO	_ X X X X X X
		LQ	M

#	OD English/German		LC Codes and LQ Codes
27	Module Overview Page/ Modul- übersichtsseite	SY	_ _ _ X _ _ _ _ _ _ _ _ X
		CO	X X X X X X X X X X X X X
		LQ	I _ _ _ _ _ _ _ _ _ _ I A
28	Module Link/ Modul-Link	SY	X X X X
		CO	X _ X
		LQ	_ R AR
29	MN Relationship/ MN Beziehung	SY	X X X
		CO	_ _ X
		LQ	M
30	Module/Modul	SY	X X _ _ X _ X _ X X
		CO	X _ X X X X X X
		LQ	_ R
31	Morphological Box/Morphologi- scher Kasten*	SY	_ X
		CO	X
		LQ	I
32	Paper Prototyping	SY	X
		CO	_ X X
		LQ	M
33	Personalization Concept/Persona- lisierungskonzept	SY	_ X X
		CO	X _ X X
		LQ	_ _ R
34	Phases Overview Page/Phasen- übersichtsseite	SY	X _ _ X X
		CO	X X X X X
		LQ	_ _ _ AR
35	Phrase search/ Phrasensuche	SY	
		CO	X X
		LQ	I
36	Procedure Model/ Vorgehensmodell	SY	X _ X X
		CO	_ X _ X
		LQ	M
37	Questionnaire/ Fragenkatalog	SY	X X X X
		CO	X X X X
		LQ	R R
38	Registered User/ Angemeldete Besucher	SY	X _ _ X X X
		CO	X _ X _ X X
		LQ	R _ R AR AR
39	Revision Control/ Versionierung	SY	X
		CO	X
		LQ	I
40	Search Function/ Suchfunktion	SY	X
		CO	X _ X
		LQ	M
41	Search Suggestions/ Suchvorschläge	SY	X
		CO	X X X
		LQ	I
42	Short Description/ Kurzbeschreibung	SY	X X
		CO	X X
		LQ	R
43	Structure P&M/ Struktur Phasen u. Module	SY	X X _ _ X _ _ X _ X X X X X X
		CO	X X X X X X X _ X
		LQ	_ _ _ R _ I _ _ R R R R R R
44	Synonym List/ Synonymliste	SY	X X
		CO	X X X X
		LQ	M
45	Synonym	SY	X
		CO	X X
		LQ	I
46	Toggle Function/ Toggle-Funktion	SY	X _ _ X
		CO	X X X X
		LQ	I _ _ RI
47	Tracking	SY	
		CO	X
		LQ	I
48	Typing/ Typisierung	SY	X
		CO	X X X
		LQ	I
49	Update Relationship/ Aktualisierungs- beziehungen	SY	X
		CO	X X
		LQ	M
50	User Profile/ Benutzerprofil	SY	X X _ X
		CO	X X X _ X
		LQ	R _ AR
51	User	SY	X X _ X
		CO	_ X X X
		LQ	R
52	Visualization PM/ Visualisierung VM	SY	X X _ X _ _ X
		CO	X _ X X X
		LQ	R I _ AR
53	Volatility Scale /Volatilitätsskala	SY	X _ X
		CO	X
		LQ	M

Legend: LC codes are in rows 'SY' and 'CO'. LQ codes are in row 'LQ': "I"=INC, "M"=MLN, "R"=RDC, "A"=AMB.