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DEVELOPMENT ARTICLE

Team design communication patterns in e-learning design and development

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Abstract Prescriptive stage models have been found insufficient to describe the dynamic aspects of designing, especially in interdisciplinary e-learning design teams. There is a growing need for a systematic empirical analysis of team design processes that offer deeper and more detailed insights into instructional design (ID) than general models can offer. In this paper we present findings from two case studies of team design meetings involved in the development of fully online courses at two well-established European Distance Universities. We applied an activity-based approach to an extended verbal protocol dataset. This method proved to be adequate to describe the emerging team design process by taking into account both cognitive and social aspects of team activity in this specific context. Our findings provide evidence that design is more than problem solving, mainly because the design process is strongly related to the communication process in a team. Some useful patterns of designing emerge, which shed light on the still implicit nature of ID performed by teams. We conclude by presenting guidelines for team designing in the complex field of e-learning.

Keywords Instructional design · e-Learning · Team communication · Patterns · Case study

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Introduction

Empirical research is essential to understand how design actually takes place. It can be conducted both as a direct and indirect observation of experience. In the instructional design (ID) field, several studies have empirically investigated how designers actually design (Bichelmeyer et al. 2001; Gibbons 2003; Kenny et al. 2005; Liu et al. 2002). As a main observation, Kenny et al. (2005) claim: "ID models are useful to designers and inform practice, but few if any designers actually *use* models to confine their practice" (p. 9). Similarly, Tessmer and Wedman (1995) explain that most ID models propose what designers should do, but these prescriptions are typically not followed in practice. In a more recent study, Cox and Osguthorpe (2003) were interested in identifying the Analysis–Design–Development–Implementation–Evaluation stages (ADDIE), as if they were types of potential activities that instructional designers would engage in during their practice. Their survey showed that only 47 % of ID practice consisted of design tasks, whereas the rest 53 % was focusing on organizational tasks, not included in the ADDIE model.

Another group of empirical studies in the ID field focuses on the skills that expert instructional designers show in their work. On the one hand, some researchers emphasize the type of problem solving involved in designing instructional material. Given the particularly ill-defined nature of ID (Jonassen 2002), no one-way problem solution path is appropriate. Instead, expert instructional designers represent problems as deep and rich casual networks of many links (Rowland 1992), and more as challenges rather than constraints to overcome (Ertmer et al. 2008). Other researchers point to the social aspects of designing, thus giving a primary position to communication and to the relation building process between designers (e.g. Allen 1996; Cox and Osguthorpe 2003) or between designers, clients, and subject matter experts (Dicks and Ives 2008). Nevertheless, to our knowledge, no particular attention has been yet paid to the parallel social and cognitive processes taking place during the design of instructional materials by multidisciplinary institutional teams, as in the case of the design of fully on-line courses (e-learning design) by Distance Universities.

Therefore, the goal of this research is to provide an empirical method and application of this method to demonstrate how decisions are taken by an interdisciplinary team of instructional designers in the field of e-learning. We do that by identifying team patterns, meaning sequences of recurrent behavior in design teams that lead to positive outcomes. As patterns describe small and contextualized "chunks" of behavior, we consider them a valid approach to guide team design process rather than larger abstract prescriptive process models (Conole et al. 2008; Dimitriadis et al. 2009). In the following section, we present the passage from the conceptualizion of design as a process to a definition on the basis of concrete activities, which form the component units of a pattern. Right after, we present the goals and research questions of this development article, followed by an extensive description of the developed method. Towards the end, we present initial observations and results that emerge from the application of our patterns-based approach to two case studies. We conclude with concrete guidelines and recommendations for e-learning design practice in teams.

Literature review: from design as process to design as activity

It is generally accepted that e-learning design is both cognitive and social. Some scholars define it as a problem solving process (e.g. Smith and Boling 2009) whereas others as an inquiry process (e.g. Garrison and Anderson 2003). However, the idea that these two processes emerge and intermingle in ways that they repeat and establish themselves as more contextualized behaviors than the ones expressed by prescriptive stage models is still to be developed. In this section, we will present the main conceptualizations of design from a cognitive and a social point of view, and how the perception of design researchers has shifted from conceiving design as a stage-based process to identifying the dynamic activities and objects that emerge during this process. The description of this shift is necessary to build on our proposal of team design communication patterns in e-learning.

The approach of design as problem solving is situated in the cognitive paradigm of Symbolic Information Processing (SIP). Under this view, "everyone designs who devises course of action aimed at changing existing situations into preferred ones" (Simon 1969, p. 111). To narrow down this overly general definition, and distinguish design from non-design processes, a number of conceptual models describing design in a specific context have been proposed. The most known are: (a) The design task environment approach (Goel and Pirolli 1989), which introduces two additional factors to the problem-solving process, namely *time* and *world's feedback*; (b) the meta-design approach (Fischer and Scharff 2000), which introduces users as a main intermediator between design time and use time; and (c) the rapid prototyping approach, broadly used in the ID field (Tripp and Bichelmeyer 1990), in which prototypes are the main catalyst of communication between the components of a design system. Such approaches are valuable, as they tend to integrate the technical, cognitive, and social aspects of design (MacMillan et al. 2001). However, the relation between these aspects remains unclear, which is what would serve designers in their interaction with others and with the design object and components.

On the other hand, the idea that design is above all an inquiry process is mainly inspired by the "reflection in action" approach (Schön 1983) that was proposed after the SIP paradigm and continues to influence design research in several ways. For Schön, design is not a rational search process, but a reflective conversation with the design situation. Moreover, in design thinking, activities of doing and thinking are equally integrated and dependent factors: "doing and thinking are complementary […]. Each feeds the other, and each sets boundaries for the other" (Schön 1983; p. 280). Schön proposes four main activities describing this "thinking-doing" process: framing, naming, moving, and evaluating. One of the main contributions of Schön's theory has been the shift of focus from problem solving to problem setting. Moreover, he suggests that such problem framing is not linear, but passes through spirals of reframing, as the situation talks back to the designer (Schön 1983). The reflective approach of design gives emphasis on the interaction between the elements of design; however, what makes this interaction dynamic, continuous, and efficient is not sufficiently addressed.

Subsequently, the focus in design research has gradually moved from conceiving design as a process that can be a priori defined and described, to identifying the concrete activities that take place during this process (Cross et al. 1996; McDonnell and Lloyd 2009). These activities are generic (Lawson 2006), meaning domain-independent, at least regarding the problem solving and inquiry aspects of designing. Moreover, these activities shape the nature and structure of the design process. In general, there are two types of design activities: The ones that manage the evolution of a design problem into design solution(s), and the ones that manage the design process as the design evolves (Sim and Duffy 2003). The former belong to what is defined as exploration of the "design space," whereas the latter refer to the management aspects of design, should we call it "management space." Both types of activities are oriented towards a concrete design object as shown on Fig. 1.

Apart from this generally accepted view of design as an activity, few efforts have been made to define the specific aspects or structure of the design space or the management space activity, either in individual or in team settings. Since we were interested in

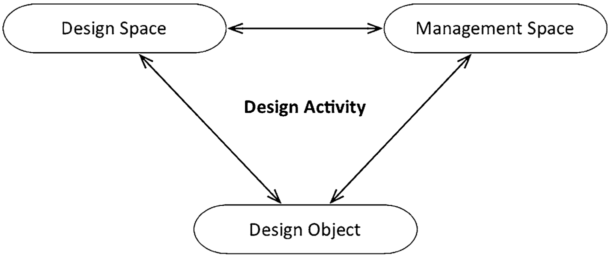

Fig. 1 A generic representation of design activity

identifying the nature of design as it actually emerges throughout team activity, we reviewed studies that combine the following characteristics: (a) They focus on design empirically, i.e. as it actually takes place, (b) they perceive design as a result of teamwork, and (c) they propose some specific categorizations to describe the design and management activities (what the designers do) and the type of object (what the designers talk about). In sum, we reviewed representative development studies that propose analytical categories to describe at least one of the three entities previously mentioned, as they actually emerge during team design in any field. The results of the review are presented on a synoptic table (Table 1).

Based on the nature of the activities and objects proposed, we observe that some of the studies presented in Table 1 address the design space (e.g. studies 3, 4, 6, 12), others the management space (e.g. studies 2, 7, 9, 10), whereas a small number present a balanced approach of both (e.g. studies 1, 5, 8, 11). Very few studies define the objects of the activities, and even when they do so, it is not explicit which of the activities are combined with which of the objects. Finally, the methodological foundation of the studies is not clear in all of the cases. Some scholars justify their selection based on an a priori definition of design as a process, which contains certain activities that serve the goals of this process (e.g. Louridas and Loucopoulos 2000; Valkenburg and Dorst 1998); others use the data of other empirical studies to define the types of activities they use (Darses et al. 2001; D'Astous et al. 2004; Visser 2006). A structured approach of defining team design activity akin to guide team design practice is not evident. This lack contrasts with the increased tendency of design researchers to describe co-design processes as they occur in different fields (for a recent collection of studies see McDonnell and Lloyd 2009). Although design is generally conceived as a generic process, its conceptualization in concrete activities meaningful for the design goals is still under definition. Last but not least, no methodological approach has yet been applied in the e-learning design field.

Research goal

The goal of this development article is to propose and illustrate a generic, design-based approach for eliciting patterns of e-learning design in a team setting. Under this approach, team design is a dynamic process, both social and cognitive, during which designers contribute to the design and management space through their object-oriented activities. During this process, meaningful patterns of team design behavior emerge, which in turn can be useful in guiding designers' practice. In this section, our approach of e-learning design as a sociocognitive activity is discussed. The types and components of this activity form the basis of efficient patterns of team design, as we show later on in this article.

Table 1 Studies proposing types of team design activities and objects

	Study ID	Field	Activity types	Design object
1.	Olson et al. (1992)	Software design	Clarification, digression, walkthrough, summary, project/meeting management	Issues, alternatives, criteria
2.	Maia et al. (1995)	Software design	Rationale, agreement, confirmation, understanding	Value/data, belief/ opinion/preference, feature
3.	Valkenburg and Dorst (1998)	Engineering design	Framing, naming, moving, reflecting	
4.	Louridas and Loucopoulos (2000)	Any	Problem setting, Problem analysis, Evaluation, Resolution	Goal, Hypotheses, Justifications, Design action
5.	Darses et al. (2001)	Software design	Generate, evaluate, inform, interpret	Problem data, solution elements, domain objects, goal, domain rule or procedure, task
6.	MacMillan et al. (2001)	Any	Specifying, assessing, identifying, developing, setting, determining, generating, transforming, selecting, firming up, evaluating, improving	Business needs, requirements, problems, solutions/proposals, project characteristics, concepts
7.	Stempfle and Badke-Schaub (2002)	Engineering design	Clarification, generation, analysis, evaluation, control, planning	Goal, solution, decision
8.	Eggersman et al. (2003)	Chemical engineering	Propose, add, remove, modify, merge, select, request, calculate, estimate, determine, experiment, select, evaluate, justify	Requirement, artifact, attribute, value, synthesis, position, argument, decision
9.	Nelson and Stolterman (2003)	Any	Developing trust, developing common understanding, developing new insights	
10.	D'Astous et al. (2004)	Software design	Manage, introduce, develop, evaluate, hypothesize, inform, justify, accept, reject/cognitive synchronization, review, conflict resolution, alternative elaboration	Solution, project/meeting, result of previous activity
11.	Gero and McNeill (1998)	Any	Propose, clarify, retract, make, analyse, justify, evaluate, consult, look ahead, postpone, look back, apply	Solution, decision, external information, domain knowledge, design strategy
12.	Visser (2006)	Any	Generation, transformation, evaluation	

The view of design as a sociocognitive activity, rooted in the work of Bucciarelli (1984), has two main implications: First, any mental effort related to the task of designing, from now on "design task," needs to be made explicit as a communication message; second, any effort of designers to communicate their ideas, from now on "communication task," needs to be related to the design task to be considered efficient. Our contribution lies in proposing a reusable method of analysing both the design and communication tasks, as they get transformed during interaction. In this way we are able to give an account of the the mutual transformation of the design and the management space of team design activity.

Subsequently, a twofold analysis is necessary to understand team task-oriented interaction: One analysis focusing on the problem space exploration, i.e. the specific design task aspects, and another analysis focusing on the management space, i.e. the communication activities used to explore the problem space. However, a main difficulty of conducting this double analysis with highly interdisciplinary teams, such as e-learning design teams, is the identification and separation of the cognitive from the social aspects of discourse taking place during the meetings, in a way that can be applicable to any team. We consider this distinction necessary to come up with concrete guidelines related to the type of behavioral aspects instructional designers nowadays must develop to efficiently work in teams.

In order to reveal and understand the double, socio-cognitive nature of team design in the field of e-learning, our research questions are formulated as follows:

1. Which are the specific design and communication activities that take place during e-learning design in teams? What types of design objects do emerge?
2. How do these activities and objects relate to each other?
3. Can these relations be interpreted into specific guidelines that instructional designers need to apply when they work in e-learning design teams?

Method

In order to answer the above questions, we followed a descriptive, multiple case study design (Yin 2003) as it provides reliable results based on the comparison of the cases observed, without starting from pre-defined hypotheses. The “case” here refers to the process of designing in team in the field of e-learning. Two cases were selected as being instrumental (Stake 1995), in the sense of representing a highly collaborative design process with advanced quality standards. In addition, we adopted a methodological approach that is both qualitative, based on verbal transcript protocol analysis, and quasi-ethnographic, as we closely observed the participants in some of their practice, either in situ or through video-recorded meetings. More precisely, we followed the paradigm of comparing patterns of designing (Stacey et al. 2002). The term “patterns,” here, refers to interaction stuctures repeating themselves systematically in a specific context. Their identification allows for the reuse of similar behaviors in similar contexts, thus it promotes sharing of good practices and better communication between fields. This serves our upper goal of transferring our results to other cases by applying the abductive mode of naturalistic generalization (Stake 1995), much used in the design field.

The identification of the patterns’ components was based on an interaction analysis (Trognon 1999) coding scheme, composed of three levels: (a) The *micro* level, which refers to how each person behaves as part of the team; (b) the *meso* level, which refers to emerging structures as behaviors of two or more participants; and (c) the *macro* level, which refers to the shared subject focus of the team at a certain time of the discussion. The relation of these three levels to segmentation and coding is explained later on.

Participants

In order to consider the cases as representative of the e-learning design practice, we respected the following criteria-requirements: (a) A high-standard quality course design, as required and verified by specific institution-related procedures; (b) a high level of expertise of the team members in both subject matter and design aspects; and (c) a high level of multi-disciplinarity regarding the field of expertise represented by each team member. The two teams (from now on Team A and Team B) participating in our study fulfill all three criteria, as: (a) they belong to two well-established European Distance Universities; (b) the average of years of experience in the field of e-learning design is high, and also the subject matter of the course itself is "design"; and (c) the participants' fields of expertise vary in-between Product Design, Industrial Design, Interactive Media, Management and Pedagogy, for Team A, and Communication sciences, Philology, and History, for Team B. The fulfillment of these conditions leads to the assumption that the two selected teams are representative of high-quality on-line course design requiring interdisciplinarity, subject-matter knowledge, and design experience. To this, other extra evidence can be added, such as the international recognition of the corresponding institutions and the proven success of the specific courses; as a matter of fact, Team A has won a quality award for this course.

Data collection

The data collection was based on the observation of the two teams, during their instructional design projects. Team A was observed for 1 year (February 2008–February 2009), during the production of a 60-credits Bachelor on-line course on Design Thinking, whereas Team B was observed for half a year (September 2010–February 2011), during the production of a 6-credit Masters on-line course on Instructional Design Models. The 60-credit course is part of a 360-credit Bachelor degree, whereas the 6-credit course is part of a 60-credit Masters degree. Both courses are equally central in the curriculum for which they are designed. Moreover, Team A's course was a first-appearing course, and Team B's course was asked to be re-designed in order to adapt to the most recent technopedagogical contents. Due to their centrality and innovativeness, the two courses were considered representative of high-quality on-line courses.

In total, 15 project meetings (ten from Team A and five from Team B) were video-recorded and 25.7 meeting hours were totally transcribed. Each meeting had an average duration of 1.4 h. In both teams, the meetings were situated in the development phase of design, meaning that the courses′ main structure and objectives had already been decided in previous informal discussions, get-aways, and brainstorming sessions.

The transcribed dataset was segmented in topic-based episodes (McDonnell 2009), and only those interaction moments in which some type of reflective decision-making took place, formed the final dataset. The dataset was further segmented into moves, meaning discourse segments containing complete communication meanings. Moves share the function of utterances, when the latter are defined also by the silent understanding of the hearers (Bakhtin 1986). Many moves together form sequences of moves (Schegloff 2007). In our analysis, sequences are goal-oriented, meaning that two different sequences can address the same topic but expressing a different action. In summary, the macro level segmentation focused on episodes, the meso level on sequences, and the micro level on moves.

Data analysis

The data analysis was composed of two phases. In the first phase, we coded both the moves and sequences into pre-defined categories, which were of two types: the ones referring to the design task, and the others referring to the communication task. All of them focus on a specific design object, in accordance to what was said in the beginning of this paper. In total, the following coding dimensions emerged: design object, design move, design sequence, communication move, and communication sequence. The second phase was composed of statistical analyses and identification of patterns in the whole dataset. More precisely, we devised a software tool to analyze the sequences of codes. It aggregates the codes in increasingly long sequences and computes the frequency of each sequence with respect to the others. This allowed us to clearly identify repeating sequences of codes, which we then analyzed to determine their value as statistically significant patterns.

Design object

Design object is what the team is talking about in each moment of interaction. Usually, a sequence focuses on one primary object, but one or more speakers frequently introduce new, secondary objects without changing the "flow" of the team discussion. So the object or cognitive orientation of the team as a whole can be different than the momentaneous shifts of orientation introduced by individuals during interaction. Either at a team or at an individual level, design object can be one of the following (Darses et al. 2001; Newell and Simon 1972): problem, solution, goal, method, domain object, domain rule, and task. Table 2 shows the codes, definitions, and a representative sample of each coding category (when applicable, we underlined the words that have served as indicators).

Table 2 Design object coding categories

Category	Definition
Problem <P>	Any explicit reference to a concept or state of affairs considered problematic for the design process/product *Example: I'm just nervous that the Pinboard will just become a default area*
Solution <S>	An explicit idea referring either to an artifact that can potentially form part of the design object, or to a design action presented as a solution *Example: What I would suggest you end up doing is that you have a tutor version and then a student version*
Goal <G>	Any explicit reference either to a specific, team/course-related prescribed objective, or to a general idea of how the course should be, without getting concretized into specific solutions or strategies *Example: you want to keep it engaging in a way, you don't want to keep it too academic*
Method <M>	Any explicit problem-oriented strategy. It is distinguished from solution in the sense that method is not a potential part of the design object, but rather an action that guides the problem-solving process. It also refers to any expected learning result *Example: I suppose that helps them (the students) discuss the process, as they are going through it*
Domain object <O>	Any explicit use of an existing tool, artefact (course), or resource, as guide, model or help for the design object at hand. Also, any use of a disciplinary concept as intermediary representation, without "embodying" it in a concrete solution *Example: because in M234 (name of existing course) there is that option which says "Print whole week" or something isn't it?*
Domain rule <R>	Any explicit reference to an existing institutional or discipline-related rule, procedure, or established behavior relevant for the design process at hand *Example: (Using technologies) is a very time-consuming friendship*
Task <T>	Any explicit task co-ordination or assignment between the team members at the present meeting time. Also it is used to code any design relevant past behavior of one or more agents (not necessarily team members) *Example: Can you e-mail the link to this?*

Design move

Design move describes the nature of any verbal act that changes by some means the semantic-cognitive content of the object under discussion. Based on Visser (2006), we propose the following list of design moves, as adapted to our dataset: generate, specify, detail, add, duplicate, modify, revolutionize, merge, and evaluate. Note that the "duplicate" move is the only one that proposes a non-change to the semantic content of the design object; however, it is still considered as a move when the speaker's intention is to "go back" to an idea already proposed. Mere repetitions of the content of an idea by the same speaker do not mark the beginning of a new move. Table 3 shows the codes and their definition, transferred to team design context.

Table 3 Design moves coding categories

Category	Definition
Generate <gen>	Introduce a first-appearing main relevant element. The notion of main is defined by whether this element forms part of an intermediary representation (proposal, constraint, and requirement) or it refers to a new task or object introduced
Specify <spe>	Concretize a previously presented element, either by defining it or by making explicit (aspects of) its qualitative or quantitative nature, without expressing an evaluation towards them
Detail <det>	Expand a concept or event by listing its component concepts and/or events, answering one or more "what else" question(s). The new information provided is usually presented in an "and", "or", "but" relation
Add <add>	Add new information, such as time, place, means/tools, manner, or a whole idea or event to a previously stated idea or event. In the second case the new idea/event is added either because it is considered relevant or because of some type of "logical" relation, such as cause-effect, reason-result, means-purpose, condition-outcome. The goal is always to better contextualize an idea/event
Duplicate <dup>	Reproduce an already generated element by shifting the focus again to it. Such reproduction can be either an exact repetition of a previously stated element e or a clear reference to it as the main focus of discussion for a second time
Modify <mod>	Transform an element *e* into another version *e'* neither detailing it nor concretizing it. Such transformation can either refer to a re-contextualization of the element (e.g. when a problem becomes a solution or when a solution becomes a requirement), or to a change in its epistemic status (e.g. seen from other perspective or replaced by a slightly modified alternative). At any case a conceptual modification needs to be explicit, and not only inferred
Revolutionize <rev>	Replace an element *e* by its opposite or by a totally different alternative *e'* that serves the same function as *e*. Revolutionization can also "stop" at a level of revision or cancelling, without exactly getting to an alternative. Its goal is to doubt or negate the validity of a concept in a specific context
Merge <mer>	In design made explicit visually, disjunctions and adjunctions of elements are very common and are often combined with divergent and convergent modes of reasoning. In the present research, the term "merge" is used to describe each time two (at least) concepts, previously made explicit, are put together in an effort of distinction, comparison, or jointness
Evaluate <ev>	Assess an element *e* by attributing it a value or by expressing an attitude of towards it. Such attitude is usually related to expression of preference/non-preference, but it can also express doubt, reflection, insistence of importance, etc

Design sequence

Design sequence refers to the team design goal expressed in a sequence of interaction. A collective goal is not made explicit as such, unless someone, e.g. the course team chair, states it to guide interaction. In most of the cases, the decision on how the design object is treated by the team, which corresponds to what we consider as a team design goal, is based on the general impression of the analyst regarding what participants actually do at a specific moment of interaction in terms of design. Table 4 presents the main categories considered, adapted from Visser (2006), namely: presentation, transformation, and evaluation. Our definition of these categories takes the team context into consideration. This is important to have in mind, as slight changes may occur to the approach we follow; for example, we re-named "generation" activity into "presentation" activity, emphasizing on the social and verbal aspects of team design goals.

Table 5 shows an excerpt of the dataset, coded with the design categories described previously in this section.

Communication move

Our definition of communication move is close to Bunt's (1999) definition of dialogue act: A "functional unit used by the speaker to change the context" (p. 141). The context here refers to the interaction context, which is influenced by linguistic, semantic, cognitive, physical, and social aspects (Bunt 1999). In team design, the design task is managed by changing the interaction context. In other words, communication moves accompany, complete, or influence on the design moves. To define the most relevant communication moves for team design processes, we were based on a discourse relations model, namely the Connectivity model (Renkema 2009), and more precisely on its interjunction (addresser-addresse) relationships. The reason for choosing discourse relations as our main theoretical guidance in identifying and defining communication moves is based on the flexibility they offer regarding segmentation. A new move is marked when a new type of relation is initiated among itself and its discursive context (i.e. previous and following moves). Moreover, we opted for Renkema's relations, because of their potentially argumentative nature. Other non-argumentative moves, such as "narrate" or "instruct," were added to fulfill the dataset′s needs. Table 6 presents the complete list of communication moves used for this study.

Table 4 Design dequence coding categories

Category	Definition
Presentation <pres>	The goal of the team is to "make known" any relevant facts, possibilities, ideas, considerations, or plans of action regarding a specific design issue-topic, without getting into details, and without assessing their truth, feasibility, or quality
Tansformation <trans>	The goal of the team is to "make understand" a relevant fact, idea, or consideration regarding a specific design issue-topic, by getting into details regarding its acquaintance, adequacy, or need for taking into account, without implying, imposing, or asking for any decision regarding its acceptance
Evaluation <eval>	The goal of the team is to "make believe, accept, or discard" a relevant fact, idea, consideration, or plan of action, considered crucial or influencing for the design task/process. It is oriented towards decision-making, either at a conceptual or at an action level

Table 5 Dataset excerpt coded with design sequences, moves, and objects (beginning concept 'a' is retrieved from previous discussion)

ID	Sp	Transcript	DesSeq	DesMov	Obj
1640	G	Can they have an Elluminate session on their own without a tutor?	trans	spe [a]	S
1641	A	Yeah that's the idea ()			
1642	A	Well I wouldn't have done it ()		ev [a]	
1643	A	I would rather give them enough information to say			
1644	G	Yeah but it's about them having the the access to that space when they need it		gen [b: access]	
1645	A	Like the room the room's set up and the			
1646	G	Yeah			
1647	A	All that stuff			
1648	G	I would actually it might you know it probably is if you've got the room open all the time		det [b]	
1649	G	They probably can't go in			
1650	G	() they can just go in when you don't book it ()			
1651	E	I think it's difficult to have uploaded your thing and have a discussion there and then also have the group discussion at the same …	eval	gen [c: activity space]	(P)
1652	E	It doesn't seem very…natural thing to do …		ev [c]	
1653	A	Yeah			
1654	E	(it would be better) within your Elluminate room		mer [a,c]	S
1655	A	Yeah			
1656	E	Actually I think (that is what) you said as well didn't you so that we ()		dup [a,c]	
1657	A	Well that's a possibility but some people might not be happy with that or you know it's just		rev [a,c]	

Communication sequence

In correspondence to the design sequence, communication sequence refers to the team communication goal expressed in a sequence of interaction. Identifying communicative intention at a team level is not trivial. To achieve it, we identify one communication move per sequence as the main presentation move (Clark and Shaefer 1989), which also gives its name to the whole sequence. Potential main presentation moves are: open, propose, present alternative, verify, clarify, comment, explain, instruct, interpret, oppose, and call for attention. As a consequence, these are also the main communication sequences, which can be identified in our dataset. Table 7 details the same dataset as in Table 5, but coded with communication moves and sequences. Objects are the same for both codings, to keep a sense of consistence regarding the focus of team design activity as a socio-cognitive type of activity. Table 5 focuses on the cognitive aspects of the design activity, i.e. the ones related to the design space, whereas Table 7 focuses on the social aspects of the same activity, i.e. the communication management aspects of it. The object, what designers talk about from a cognitive orientation point of view, is the same as it belongs to the same activity.

Table 6 Communication moves coding categories

Category	Definition
Propose <pro>	Present an element (concept, relation, action) as an appropriate solution at a given moment of interaction
Explain/ expose <exp>	Enhance understanding by giving new information about a statement, somebody's whole idea/saying, or a new concept/tool
Narrate <nar>	Inform others about a sequence of relevant (to the design task) past events of another person or the speaker herself (the focus always being on the events, and not on the related object, if any)
Instruct <ins>	Show how to operate an action or how a tool functions, usually accompanied by gesturing or manipulating objects
Verify <ver>	Request for a clarification about a known or unknown (introduced as new) issue
Clarify <cla>	Enhance understanding about an idea, statement, or state of affairs, either by reformulating it or by making explicit information that was previously taken for granted
Conclude <con>	Make an inference towards a statement or summarize previously stated ideas
Justify <jus>	Give support to the credibility of an opinion, either in the form of evidence, or with another opinion
Comment <com>	Express a neutral opinion related to a previous idea, without explaining/ clarifying it or proposing something new
Assess negatively/ positively <neg>/<pos>	Express a negative or positive assessment related to a previously stated idea or state of affairs
Interpret <int>	Exteriorize understanding of another speaker's statement by reformulating it in an effort to expand it
Postpone <psp>	Cancel or delay acceptance of a proposal or plan of action
Agree <agr>	Express concordance to a previously stated opinion, by repeating its content or by expressing a simple ("good", "nice", "interesting", etc.) positive assessment or acceptance ("OK", "let's do it")
Call for attention <att>	"Alarm" the other speakers by expressing doubt about the truth of an opinion, or call into consideration non-discussed issues
Open <ope>	Introduce a new issue as object of discussion in a natural way, i.e. without calling for a special attention to it
Present alternative <alt>	Present an idea as an alternative to a previously stated one
Oppose <opp>	Express an idea as an opposite to a previously stated one

Findings

As previously described, the goal of this article is twofold: (a) To propose a method that identifies and analyses team design activity in an overall manner, and (b) to verify the applicability and reusability of the above outlined empirical method to gain meaningful insights regarding e-learning design in teams.

In relation to this twofold objective, the study's main findings are divided into the following parts: the calculation of inter-rater reliability, the frequencies and relations between the coding dimensions and categories (corresponding to research questions 1 and 2), and the presentation of the most frequent patterns that emerged in both teams. These

Table 7 Dataset excerpt coded with Communication sequences, moves, and objects (the object in parenthesis means that it was just an instantaneous individual focus, not shared by the rest of the team)

ID	Sp	Transcript	ComSeq	ComMov	Obj
1640	G	Can they have an Elluminate session on their own without a tutor?	VER	ver	S
1641	A	Yeah that's the idea ()			
1642	A	Well I wouldn't have done it ()		com	
1643	A	I would rather give them enough information to say			
1644	G	Yeah but it's about them having the the access to that space when they need it		att	
1645	A	Like the room the room's set up and the		int	
1646	G	Yeah			
1647	A	All that stuff			
1648	G	I would actually it might you know it probably is if you've got the room open all the time		exp	
1649	G	They probably can't go in			
1650	G	() they can just go in when you don't book it ()			
1651	E	I think it's difficult to have uploaded your thing and have a discussion there and then also have the group discussion at the same …	ATT	att	(P)
1652	E	It doesn't seem very…natural thing to do …		jus	
1653	A	Yeah			
1654	E	(it would be better) within your Elluminate room		pro	S
1655	A	Yeah			
1656	E	Actually I think (that is what) you said as well didn't you so that we ()		int	
1657	A	Well that's a possibility but some people might not be happy with that or you know it's just		Com	

patterns of systemized efficient behavior will form the basis of guidance inference (in accordance to research question 3), as discussed in the next section.

Inter-rater reliability

Even though reliability is considered one of the main validation techniques for coding methods (Trujillo 1986), it is hardly ever reported by design researchers (Goldschmidt 1996), mainly because in general it is difficult to obtain a satisfying measure due to subjectivity of inferences. Regardless this general tendency, our proposed coding scheme obtained highly satisfying results. To facilitate its reuse, we briefly describe the process followed.

The inter-rater agreement was calculated for three of the five coding dimensions used: design object, design move, and communication move. The codes for design and communication sequences were inferred on the basis of the design and communication moves: the most predominant move of a sequence also defined its goal, and subsequently its code.

Regarding the 'design object' categories, an inter-rater agreement of 88.2 % (K = 0.72) has been reached, with the first author serving as a "blind" rater for both the second and the third authors separately. This percent was calculated only for the moves that were coded by both raters. It was often the case that the main coder (second and third author) was more descriptive in her coding and considered more object shifts than the second coder. This is due to the personal relation the first coders had with the design process, as they were both participants in the design meetings coded. This personal involvement possibly had an effect on the rich and detailed coding of their own experience. At the same time, the first author, who was an external observer to both cases, was more restrained at the time of marking a cognitive shift. It only happened when a clear to an external person shift was observed. As this difference was noted for both cases, the first author's decisions were considered as a valid external measure, thus any disagreement regarding this aspect was resolved in her favour. Regarding disagreement about the selection of a code, possibilities were discussed, and a refinement of the coding process was achieved. Design and communication moves were also checked for reliability with an external expert to be able to provide a more specific view regarding their coding. Inter-rater reliability score was sufficiently high for both dimensions ($K = 0.71$ and $K = 0.72$ correspondingly), given the context "blindness" of the second rater (an expert in Cognitive Linguistics).

Regarding validity, the second methodological quality criterion in case studies (Yin 2003), we limited ourselves to some internal validity checking, given the extensive nature of the coded protocol. We did that mainly in two ways: By involving two of the participants in the inter-rater reliability process, as described above; and by conducting a Focus group with the teams after the end of the observation period. During these Focus groups, our main external observations were confirmed by the participants themselves. Validating our method with external measures, such as the comparison to design contexts other than e-learning, as not been considered necessary for this phase of the study, since we are interested in the proposal of a domain-independent method and its application in the e-learning design field.

Frequencies and relations

Our first research question pertains to the nature of design as a socio-cognitive activity. We have asked what are the specific design and communication activities that take place during e-learning design in teams and what types of design objects do emerge. To answer it, we identified the frequencies of every coding category we used. Figure 2 shows the frequencies of each one of them in the whole dataset.

Figure 2 shows that the frequencies of "evaluation" and "presentation" design sequences are almost the same (24.6 and 24.7 % correspondingly) for the whole dataset, whereas the activity of "transformation" occupies half (50.7 %) of the total team design activity. Considering the design act categories, a predominance of "detail" and "add" moves can be identified (16.6 and 12.6 % correspondingly), followed by "evaluate" and "generate" moves (10.5 and 10 % correspondingly). As far as the design object types is concerned, the most predominant is "solution" (34.3 %), followed by "method" (26.4 %), whereas "domain object," "task," "problem," and "domain rule" are limited to an average of 9.5 %. Regarding communication sequences, the predominance of "propose" is evident, occupying almost half of the total team activity (45.9 %). The "call for attention," "explain," and "comment" sequences follow, with a frequency of 12.9, 12.8, and 10.8 % correspondingly. Finally, the most frequent communication moves are: "explain," "propose," "comment," and "clarify" (17, 16.2, 14.1, and 10.1 % correspondingly).

To answer our second research question focusing on the relation between design and communication activities, we computed a cross-tabulation and dependency degree for the two parallel processes, i.e. design and communication, at both an individual (move) and a team (sequence) level. We obtained a satisfying co-efficiency measure (Cramer′s V) for both

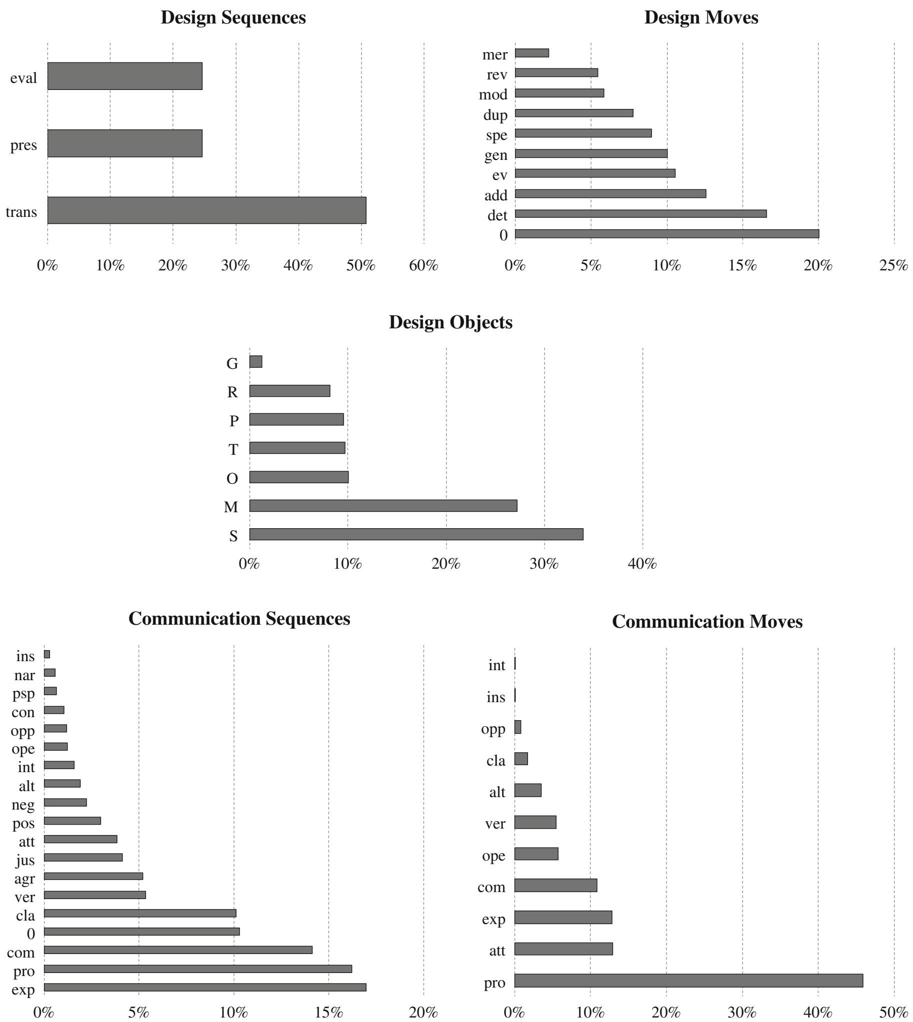

Fig. 2 Frequencies of design sequences, moves, objects and communication sequences and moves

relations, namely the "design move-communication move" relation, and the "design sequence-communication sequence" relation (0.437 and 0.362 correspondingly). The exact crosstabulations between the design and communication categories are shown on Tables 8 and 9.

We summarize our observations regarding the above results as follows:

- Based on the assumption that sequences represent team behavior, some team design behaviors (cognitive level) are especially related to some team communication behaviors (social level). More precisely, design "evaluation" activity is mostly expressed through a team tendency to comment on others′ viewpoints and present alternatives. Design ideas "presentation" is more closely related to introducing issues rather than to proposals, whereas opposition plays also an important role for new constraints and requirements to come up. Design "transformation" is almost exclusively accompanied by explanation, whereas verification behavior is also very common.

Table 8 Crosstabulation between design and communication sequences

DesSeq * ComSeq crosstabulation

Design sequence		Communication sequence											Total
		Alt	Att	Cla	Com	Exp	ins	int	Ope	Opp	Pro	Ver	
Eval	Count	82	164	30	289	36	0	4	11	17	341	59	1,033
	%	0.55	0.30	0.41	0.64	0.07	0.00	1.00	0.05	0.52	0.18	0.26	0.25
Pres	Count	41	125	0	9	49	0	0	116	16	673	7	1,036
	%	0.28	0.23	0.00	0.02	0.09	0.00	0.00	0.48	0.48	0.35	0.03	0.25
Trans	Count	25	254	43	157	454	6	0	116	0	912	164	2,131
	%	0.17	0.47	0.59	0.35	0.84	1.00	0.00	0.48	0.00	0.47	0.71	0.51
Total	Count	148	543	73	455	539	6	4	243	33	1,926	230	4,200
	%	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 9 Crostabulation between design and communication moves

DesMove * ComMove crosstabulation

Design move		Communication move												Total
		agr	cla	com	con	exp	jus	neg	ope	opp	pos	pro	ver	
0	Count	170	227	68	6	103	39	1	3	12	7	7	108	842
	%	0.78	0.53	0.11	0.14	0.14	0.23	0.01	0.06	0.24	0.06	0.01	0.48	0.20
Add	Count	2	15	138	19	46	73	20	0	0	7	132	10	528
	%	0.01	0.04	0.23	0.43	0.06	0.42	0.22	0.00	0.00	0.06	0.19	0.04	0.13
Det	Count	0	7	7	4	444	15	1	0	0	1	12	2	696
	%	0.00	0.02	0.01	0.09	0.62	0.09	0.01	0.00	0.00	0.01	0.02	0.01	0.17
Ev	Count	16	1	211	4	2	13	48	0	2	105	4	6	443
	%	0.07	0.00	0.36	0.09	0.00	0.08	0.52	0.00	0.04	0.83	0.01	0.03	0.11
Gen	Count	0	1	0	2	4	12	8	47	2	0	259	14	421
	%	0.00	0.00	0.00	0.05	0.01	0.07	0.09	0.90	0.04	0.00	0.38	0.06	0.10
Rev	Count	2	1	91	1	2	6	9	0	33	2	13	0	228
	%	0.01	0.00	0.15	0.02	0.00	0.03	0.10	0.00	0.66	0.02	0.02	0.00	0.05
Total	Count	219	425	594	44	712	173	93	52	50	126	681	225	4,200
	%	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

- Based on the assumption that moves represent individual behavior, some individual design moves (cognitive level) are especially related to some individual communication moves (social level). For example: (a) Adding information is more related to negative than to positive assessments; (b) comments can have an evaluative, adjunctive, or revolutionizing function; and (c) some communication moves, such as agreements or verifications, function only in a communication management space, meaning that they do not add further to the process of constructing design representations (this is implied by the "0'' design act code).

Patterns of team designing

As previously said, we choose the notion of pattern to organize the obtained data into meaningful behaviors that are systematically manifested by the two highly experienced teams. Based on the teams′ experience and professional recognition, we assume that their manifested patterns are related to efficient behavior. Accordingly to our multi-level system of analysis, explained in the Method section, patterns can be found in three levels (macro, meso, and micro) and can be of two types (design and communication). Thus, the following types of patterns emerge: (a) Patterns of design objects (DesObj) at a macro level (in topic-based episodes); (b) patterns of design and communication sequences (DesSeq and ComSeq) at a meso level (in team goal-focused sequences); and (c) patterns of moves (DesMove and ComMove) at a micro level (as part of a sequence). We hereby expose the most frequent of each type as shown on Table 10.

We summarize our observations in the following major points:

- Team design activity is problem-centered, as it can be implied from the two most frequent design object pattern types: solution–problem–solutioñ and "method–problem–method." The most frequent patterns are cyclic. The linear problem-solving pattern "problem–solution–method" is the least frequent type. Methods and solutions are discussed and re-discussed after relevant institutional or domain knowledge is introduced, which can be inferred from the circular patterns "method–rule–method" and "solution–rule–solution."

Table 10 The five most frequent patterns of each type

DesObj	DesSeq	DesMove	ComSeq	ComMove
Solution–problem–solution	Transform–present–transform	Detail–detail–detail	Propose–propose–propose	Propose–explain–propose
Method–problem–method	Present–transform–transform	Generate–specify–detail	Propose–comment–propose	Explain–propose–explain
Method–rule–method	Transform–evaluate–transform	Specify–detail–add	Propose–call for attention–propose	Propose–explain–comment
Solution–rule–solution	Transform–transform–transform	Detail–add–detail	Propose–propose–comment	Explain–comment–comment
Problem–solution–method	Present–transform–present	Generate–detail–add	Propose–explain–propose	Verify–clarify–explain

- The starting point or core of most frequent patterns in a design sequence is transformation, meaning making others understand a fact or idea.
- In the design move category, the most frequent pattern "detail–detail–detail" is neither cyclic nor linear, but repetitive. We can observe a similarily repetitive pattern in communication sequences ("propose–propose–propose") at a meso level. To propose is the starting point for all of the most frequent communication sequences.
- In general, circularity and repetition rather than linearity are observed to be the most frequent types of patterns. An exception can be found in communication moves, in which two linear micro-processes emerge, namely "propose–explain–comment" and "verify–clarify–explain." Some communication moves do not form part of patterns at all, such as "justify" and "evaluate."

Discussion

The previous sections answered our first and second research question. Now we turn to our third question: Can relations between design and communication activities be interpreted into specific guidelines that instructional designers need to apply to competently work in e-learning project teams? The following statements translate patterns in our data into action-oriented statements for team design practice in the e-learning field.

Designers continuously introduce new constraints and requirements alongside design solutions

Solutions give rise to new problem constraints or methodological requirements in cycles of activity. The predominance of cyclic patterns of designing such as attending to problems that give rise to a solution but also a new problem has already been conceptualized partly through the notions of "co-evolution" (Dorst and Cross 2001) or "cycles of activity" (Cross 2001) in the design research field, and also through the findings about problem–solution cycles (Poole 1983) and decision recycles (Poole and Roth 1989) in the Small Group Communication field. Design has been described as a non-linear, heuristic, and dynamic process (Carroll and Rosson 1985; Guindon 1990; Hickling 1982; Visser 1994). Our study further shows that this circularity also takes place at a smaller scale of activity. In this way, we can be more precise regarding how exactly problems and solutions co-evolve. We note, for example, that problems do not give place to other problems, or solutions are not transformed into new solutions in an immediate subsequent manner. Intermediary concepts (Basque et al. 2010) play a fundamental role in this dynamic process, as they contribute to the transformation of problems into solutions and back again.

In the following example (Table 11), the Pinboard solution is presented as a problem (line 1); then speaker A introduces the Open Design Studio (ODS) solution as an intermediary concept (lines 2–6), to show that Pinboard is not a problem itself. Finally speaker G expands on A by stating how exactly ODS will serve as an intermediary solution for the correct use of Pinboard (lines 7–9).

Designers are solution negotiators

The predominance of transformation-oriented design sequences, and proposal-oriented communication sequences implies a process of continuous *epistemic negotiations* until a

Table 11 Example of problem-solution co-evolution

Line	Speaker	Transcript
1	B	I'm worried that the Pinboard will become a dead area
2	A	The thing is whether they are using Open Design Studio …I think they'll be going the Pinboard will be in use
3	A	It's it's if they didn't use Open Design Studio
4	A	Then I'd be worried that they weren't using Open Design Studio
5	A	But they are going to be (going) there all the time
6	A	So it's it's just another
7	G	Well we have to show when we make the bit for how to use ODS
8	A	Yeah
9	G	We have to make sure that we say something really positive about the Pinboard
10	C	Yeah

satisfactory state of the design object is reached. During negotiation, self-explanation and verification play a major role as basic communication techniques. This means that team design deliberation does not share the persuasive nature of other public discourse contexts. It is more about promoting understanding and consensus between the team members. In this sense, empathy and multiple personal expertise are considered great value skills, because they help designers to achieve a better co-construction.

An example of this process is clear in Table 5: The "access" solution (line 1644) is transformed into the "activity space" problem (line 1651), which then gives its place to a more sophisticated solution proposal that considers both aspects (line 1654).

Designers frequently use brainstorming in team communication to negotiate solutions across disciplinary boundaries

During the continuous introduction of proposals (proposal follow proposals), designers actually engage in so-called brainstorming episodes. In order to allow people building on ideas, proposals are accompanied by a wealth of explanation and clarification. The need to not only propose but also to immediatly comment on or explain the proposal possibly emerges from the high interdisciplinarity of e-learning design teams. Different types of domain knowledge and experience need to be shared, and perspectives need to merge in order to start a chain reaction of ideas, which is the goal of brainstorming.

Here is an example of team A' s brainstorming regarding the iTunes solution (Table 12):

Designers use three different approaches to frame problems

These are: (a) A "sandwich" problem approach, in which problems emerge in the middle of a solution consideration process; (b) *a* "hidden" problem approach, in which solving known problems is the main team focus; and (c) a "broadening problem space" approach, in which problems give place to solutions and then to methods. As Visser (2006) suggested, design is more than problem solving. Problems have a central place in team design, but their conceptualization and approach is different to "one and for all" information processing behavior as implied by the SIP paradigm. The three approaches to problems explain in more detail how problem solving and communication in a team are related.

Table 12 An excerpt of a brainstorming episode

Line	Speaker	Transcript
1	A	But I mean you can you could upload them to iTunes
2	J	Yeah
3	G	() iTunes
4	A	That's that's when they upload it to iTunes then that's that sort of happens automatically (don't you) because you can subscribe to the Podcast
5	G	Exactly yeah
6	A	Then it automatically goes ()
7	G	I mean that would be the best thing to do
8	A	It would be great
9	C	It would be good
10	G	Plus plus some of the …selected kind of course team things that we've got throughout the course
11	A	Yeah
12	J	Yeah
13	G	Because that you know
14	A	Yeah
15	G	That would make sense

Table 13 The "sandwich" problem solving approach

Line	Speaker	Transcript
1	A	What I thought is the contribute site that I've set up is just a way of quickly getting all the stuff online
2	A	So everyone can see it
3	A	Roughly in the form that students are kind of going to go through it
4	A	And then you, you as TLS or someone else, would transfer it from the contribute site to the structured content
5	B	That's what I sort of envisioned
6	B	But in my view the problem is that if you are talking about a lot of, if you're talking about big documents, it might make the process a bit tricky
7	B	So that's why I would like to have a browse through
8	A	So () if you've set up this page "What is Design Thinking?" [indicates with mouse]
9	A	Ehm, which is pretty much the same as this page, you know, "What is design" [indicates with mouse], something like that
10	A	So it's basically a question of taking the text out
11	B	Copying it out of that…

The example that appears on Table 11 also represents a "broadening" approach, whereas the example of Table 12 corresponds to the "hidden" approach, as described above. Table 13 shows an example of a "sandwich" approach: speaker A presents the solution of a contribute website (lines 1–4), then B intervenes to present the constraint of big documents (lines 5–7), allowing A to explain better his solution right after that (lines 8–10) gaining B′s consent (line 11).

Epistemic negotiation and co-construction, discussed previously, are also evident here. B′s emergent role as a "constraint′s reminder" is similar to the boundary-spanning position of a "gatekeeper" (Sonnenwald 1996). In fact, B belongs to another department of the same institution, and his participation role in Team A′s project meetings is to make explicit any technical requirements or constraints that may be an obstacle to the proposed solutions. This further explains the value of the "sandwich approach" as problems are discussed in-between the solutions.

Conclusion

Prescriptive ID models, as presented in most of the literature, refer to conceptual frameworks that claim to guide design practice. Although they offer a general overview of an idealised ID process, detailed insights into the dynamic and often changing nature of interdisciplinary team design practice cannot be sufficiently represented by a stage model. We introduced the notion of patterns of designing to offer 'smaller chunks' of observed team designing behavior, which appear to be more adequate to guide practice. These 'smaller chunks' of good practice are more context sensitive and can be reproduced dynamically throughout the ID process. They do not replace larger models, but provide deeper understanding of the design endeavour.

This paper presents an approach for eliciting such patterns and demonstrates its applicability in the analysis of two ID case studies. In this approach, we view design in general and ID in particular as a complex sociocognitive interaction process. The analytical approach considers two main types of tasks ID designers deal with: the design task, which concentrates on the cognitive aspects of the activity, and the communication task, which is equally important to the cognitive task when we consider design in teams. Conceiving and describing both tasks is essential to understand team design activity and to elaborate guidelines for action. We introduced an interaction analysis method for eliciting detailed patterns of communication and design according to five entities: design objects, moves and sequences, and communication moves and sequences. We then conducted a second step of analysis that identified repetitive combinations of moves, sequences, and objects in patterns of activity. Finally, we translated these patterns into meaningful efficient behaviors that serve as guidelines for practice.

Based on empirical data, our study confirms a number of previous findings from design and communication research also applying to the ID domain. We summarize them as follows: (a) problems intermingle with solutions throughout the design process; (b) most of the time this happens in small cycles of team negotiation; (c) design is more than problem solving, in the sense it was conceived thirty years ago (e.g. by the SIP paradigm); problems are formed in at least three ways, namely "sandwich," "hidden," and "broadening problem space." Each approach reveals a different rationale of how ID problems are actually perceived by teams, and how solutions are actually worked out. The non-linearity of the process is evidenced by repeated cycles of epistemic negotiation regarding specific aspects of the problem at hand or of the solutions and methods addressing the problem. Concepts are continuously transformed, until they reach a state of completeness and precision that satisfies all participants. Team design activity is more of a knowledge sharing and co-construction activity than a pure cognitive activity.

This last observation paves the way to more communication-based analyses of interaction strategies instructional designers employ while working in teams. Knowledge negotiation, multiperspectivism, and empathic attitude are the ones we identify in this paper. As Bucciarelli (1984) asserts, "I do not find it a matter of 'performance specifications', 'concept formation', 'engineering analysis', 'solution specification' and 'production' set apart in well defined boxes. Rather I see continual negotiation, hear banter and stories, sense uncertainty and ambiguity, listen to participants as they voice their hopes, fears and sometimes condemnations. Design is, in process, a social process" (p. 185).

The conclusions of our study should be interpreted considering the nature of the discussion emerging in both studied teams, which can be characterized as an informal, friendly, and democratic conversation. Most of the members knew each other and had collaborated in previous projects. It bears mentioning that the meetings observed were those following the initial stages of team formation. We would also like to point out that the identified patterns are not intended to be considered representative of the whole design decision-making process, much of it taking place in corridors, individually, or through communication by other means such as e-mail or telephone. More evidence from other ID teams is necessary to validate the method proposed, and to enrich the list of design communication patterns.

Going a step further, this study also confirms the assumption that research about ID should benefit from the adoption of a more generic approach, avoiding completely relying on any particular learning theory or prescriptive stage model. Comprehensive and efficient conceptual and methodological design support solutions appear akin to activity-based approaches, which focus on timely and contextual design aids. The replication of our activity-based method in varied design contexts is necessary for further validation of the method. The comparison of the patterns discussed in this paper with other patterns of team design communication emerging in different social, cognitive, and cultural settings can lead to the enrichment of the outlined guidelines.

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