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A value-oriented and culturally informed approach to the design of interactive systems ☆

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ABSTRACT

Cultural aspects such as values, beliefs, and behavioral patterns influence the way technology is understood and used, and the impact it may cause on the environment and on people. Although there is influential literature devoted to the subject of values and culture in Human–Computer Interaction, there is still a lack of principled and practical artifacts and methods to support researchers and practitioners in their activities. In this paper, we present a Value-oriented and Culturally Informed Approach (VCIA) to sensitize and support Computer Science and Engineering professionals in taking values and culture into consideration throughout the design of interactive systems. The approach is grounded on theoretical and methodological bases of Organizational Semiotics, Building Blocks of Culture, and Socially Aware Computing. VCIA offers a set of artifacts and methods articulated to support the design process in its different stages and activities: from the identification of stakeholders and their values, to the organization of requirements and the evaluation of the designed solution. In this paper, we present VCIA's principles, artifacts, and illustrate its usefulness in bringing values into consideration, supporting a socially aware system design.

1. Introduction

Interactive systems are a growing reality worldwide, and people use them for different purposes, through different devices, and in quite different and complex contexts. We are surrounded by both positive and negative examples of what interactive technology causes in our social environment: from privacy protection to security issues, from digital exclusion to people's autonomy, from services availability to excessive techno-dependency, to name a few. Although new techniques and technologies have been developed, they are most often presented in theoretical isolation, and as a solitary technical solution (Bødker, 2006).

Winograd (1997) had already argued that the designer's role goes beyond the construction of an interface to encompass all the interspace in which people live, requiring a shift from seeing the machinery to seeing the lives of people using it. The author suggests the existence of a complex interplay between technology, individual psychology, and social communication, which demands that attention be given to relevant factors that become hard to quantify and even identify—values and culture are surely among them.

Bannon (2011) provides interesting examples of the need for values to be considered in the context of "Ambient Assisted Living". He argues that designers and researchers often conduct their researches and develop their products hoping they will support elderly people living independently, so as to better their quality of life at home instead in an institution, and to prevent them from becoming a burden on other people or on the state as they grow older. Nevertheless, although much of this work aims at empowering elderly people through independent living, they are in fact providing 24/7 remote monitoring rather than adding quality of life, dignity, or empowering this group of people to remain autonomous.

Sellen et al. (2009) highlight transformations that are changing the way people relate to and through technology. The authors recognize values as a critical issue when designing technologies for the digital age, as people are not just using technology, but living with it. The authors highlight that human values, in all their diversity, should be investigated and understood according to the way they are promoted or inhibited by technologies. In Bannon (2011)'s example, the real needs, concerns, and values of the involved people are secondary. Thinking of technology development or medical assistance before understanding the different stakeholders and their values may prevent the understanding of more basic issues, such as people's need to be in contact with family, friends, and neighbors in a natural way; the need to manage their privacy and autonomy; etc.

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Evidence of the implications of values (or their lack) in the design of computer systems are present everywhere. However, they are usually too subtle and only noticed when a social rule is violated, a behavioral pattern is broken, or a conflict of interest arises. In fact, as Knobel and Bowker (2011) discuss, because conversations about and analysis of values in technology generally occur after the product design and launch, values are often highlighted as a disaster that needs to be managed. As Friedman (1996) highlights, although the neglect of moral values in any organization is disturbing, it is particularly damaging in the design of computer technology because, unlike people with whom we can disagree and negotiate values and their meanings, we can hardly do so with technology.

Some authors have even suggested the emergence of a new moment in the field of Human–Computer Interaction (HCI). Harrison et al. (2007) discuss the emergence of a third paradigm for HCI; while the first and second ones focus on issues of ergonomics and cognitive factors respectively, the third paradigm must deal with the establishment and multiplicity of meaning in situated interactions. Bødker (2006), in turn, speaks in terms of a third wave in HCI where new elements of human life are included, such as culture, emotion, and experience; the third wave focus is on culture and on an expansion of the cognitive to the emotional.

These new elements, traditionally left to the margin of approaches to technology design, should be moved to the center. Considering all these different issues and speaking in terms of either waves or paradigms, the fact is that we are experiencing a new moment in the HCI field that requires a revision of its theories, methods, practices, artifacts, and tools. Bannon (2011) claims that a reformulation of the HCI discipline demands an exploration of new forms of living with/through technologies that give primacy to human actors, their values, and their activities. Sellen et al. (2009) assert that HCI experts must broaden the field's scope and search for new methods to be used in the 21st-century sociotechnical environments.

Of the core areas in Computer Science listed by ACM[1] (Association for Computer Machinery), HCI is the area that must deal with issues that are universal and transversal to other areas and, in parallel, must consider specific aspects (social, cultural, economic, political, and geographic) of the environment in which its application occurs. This highlights the inherent complexity that characterizes the area and the need for a multidisciplinary view. Nevertheless, curricula in Computer Science and Information Technology traditionally do not provide opportunities for students to deal with social issues in technology design. Moreover, authors, such as Bannon (2011), Baranauskas (2009), Bødker (2006), Miller et al. (2007), Sellen et al.(2009) and Schikhof et al. (2010), emphasize the need for developing and publishing studies that support practitioners and researchers as they manage the complexity and varied requirements that current technologies demand. More important than including issues related to values and culture in the agenda, is the need to facilitate the recognition of these issues by professionals who are unfamiliar with the social sciences, thereby supporting designers not only in what they must do, but in how they can do it.

In this paper, we introduce VCIA: a value-oriented and culturally informed approach to design that offers artifacts and methods to address values and culture in a theoretically founded and explicit way. VCIA is grounded on the Organizational Semiotics theory (Liu, 2000), the Building Blocks of Culture (Hall, 1959), and the Socially Aware Computing view for design (Baranauskas, 2009, 2014; Baranauskas and Bonacin, 2008). VCIA encompasses different design stages: from the problem clarification and the organization of requirements, to the evaluation of prototypes and the final solution. We have experienced VCIA in different design contexts and it has shown promising results for supporting design activities within the HCI's new moment.

Previous literature has acknowledged the importance of addressing values and cultural aspects in technology design and adoption, (e.g., Del Gado and Nielsen, 1996; Friedman, 1996; Isomursu et al., 2011; Marcus, 2001; Noiwan and Norcio, 2006). Moreover, as Schikhof et al. (2010) show, there is a lack of solutions, explanations, and examples of how to deal with these issues in an explicit manner. Our research adds to the existing literature by integrating culture and values issues, articulating theoretical bases, and offering a set of artifacts and methods to support designers throughout the design process. The discussion and examples presented in this paper illustrate VCIA in action, and may inspire researchers and practitioners in other contexts.

The paper is organized as follows: Section 2 discusses background research on values and culture in design. Section 3 introduces and discusses VCIA, its main principles, theoretical and methodological foundation, and artifacts. Section 4 instantiates VCIA in a practical setting related to the design of a social network for Brazilian teachers in the special education field, presenting and discussing results. Section 5 discusses the main issues about VCIA and the case study. Section 6 concludes and indicates directions for future research.

2. Background: Values and culture in interactive systems design

In the field of Design, the concern with peoples' culture and values has been somewhat present in design practices and theories. Papanek and Fuller (1972), for instance, challenged the way design was understood and practiced, claiming for a socially and ecologically responsible design of products, tools and infrastructures. In the HCI domain, defining, understanding and dealing with values and culture has been a challenging task. Authors, such as Bannon (2011), Friedman (1996) and Sellen et al. (2009), draw attention to the importance of thinking about values when designing interactive systems, and agree that the HCI discipline must revisit its methods and techniques in order to support researchers and practitioners in their activities.

In fact, the concept of value has been an important matter of discussion across several disciplines, receiving different focus and interpretations. Williams (1979) discuss how the term "values" has been used to refer to interests, pleasures, preferences, moral obligations, desires, wants, goals, needs, attractions, and other kinds of selective orientations, defending that the core phenomenon in values is the presence of criteria or standard of preference. The author highlights the challenge of assuming a definition for values, arguing that while a comprehensive initial view for the field of valuing must identify generic characteristics, for specific purposes more restrictive conceptions should be formulated as needed.

In this paper, we consider values from Williams' (1979) perspective: as core conceptions of the desirable within individuals and society that serve as standards or criteria to guide not only action, but also judgment, argument, evaluation, choice, etc. This perspective is in accordance to Schwartz (2005) definition for values: desirable and trans-situational goals that vary in importance and that serve as principles that guide people's lives. Moreover, this perspective also encompasses Friedman et al. (2006)'s definition for values in the context of technology design: something that is important to a person individually or to a group of people.

Hall (1959) also defends the cultural nature of values suggesting the importance of technology as both cause and result of cultural changes in a society. Indeed, technology itself does not

[1] ⟨http://www.acm.org/education/curricula-recommendations⟩.

have values—people do. Depending on the way technology is designed, it will afford behaviors that are intrinsically related to individuals and the complex cultural context in which they are using it. Individuals will interpret and behave through the technology influenced by their cultural systems (e.g., values, beliefs, behavioral patterns). Their behavior may be in disagreement or agreement with their values and the values of other people. This, in turn, will promote or inhibit certain values over others.

Some initiatives have explicitly focused on values in technology design. Steen and van de Poel (2012) show that design is beset with values from the start, drawing attention to the need for making values explicit during the design process. Cockton (2005) proposes a framework to support what he named a Value-Centered Design, suggesting some activities and artifacts to support designers in the development of value-centered systems. According to him, the focus of his framework is on the understanding of technology design as a process of delivering something valuable. From a different perspective, Friedman (1996) has been working on an approach she named Value-Sensitive Design. This approach is intended to support the concern with values in the design of computer systems, especially ethical values.

Other authors have reported experiences with design activities where the concern with values was made explicit. Schikhof et al. (2010) explored the role of monitoring systems in small-scale housing for elderly people with dementia. The authors incorporated principles of Value Sensitive Design in a human-centered design process. However, they identified a lack of guidance in HCI terms to support the process of understanding how to focus on human values, how to identify those that are critical and that must be considered in a design context, and how to actually conduct value-oriented design.

Isomursu et al. (2011) proposed a method based on Schwartz's circular model (Schwartz, 2005) for modeling the subjective value perceived by users of a new technology. The model was used in the context of value analysis to test the adoption of a technology-supported attendance control system (e.g., smart cards, mobile phone, web portal) in a primary school. The results indicate the importance of considering values during the first stages of the design process and the authors conclude that the product could have met the target users' values if values had been explicitly considered when the system was designed.

Although there are some initiatives which contemplate values in technology design, Le Dantec et al. (2009) and Isomursu et al. (2011) claim that the existing models and approaches usually restrict the analysis to a set of preconceived values, rather than encourage professionals to inquire about other values that may appear and that are relevant to a particular usage context. Isomursu et al. (2011) also highlight that models which consider global values and do not account for their cultural nature, if strictly followed, may prevent the identification and understanding of some important culturally specific values.

Moreover, although the relationship between values and culture has been clearly recognized, these two issues are usually approached separately. Some authors have dealt with the subject of culture in technology design, particularly by investigating cultural issues in usability evaluation (Del Gado and Nielsen, 1996; Winschiers and Fendler, 2007), as well as proposing new methods (Salgado et al., 2012) and studying current HCI design methods from a cultural perspective (Gasparini et al., 2011; Maunder et al., 2007; Salgado et al., 2011; Yeo, 2000). Culture is underlying researches related to Internationalization/Globalization (Marcus, 2001), although values are not usually explicitly approached.

El-Shinnawy and Vinze (1997) examined the impact of technology and culture on the process and outcomes of group decision-making. Their findings indicate that group decisions are a function of the medium of communication and the cultural setting in which the decision is taken, confirming the importance of considering cultural aspects when studying group processes. According to the authors, technology affects group decision-making, and the extent of the impact varies according to the group's cultural norms.

Noiwan and Norcio (2006) investigated the effects of animated graphic colors on attention, and perceived usability by users from different cultures, concluding that culture influences users' overall performance, overall retention, and overall self-reports of usability. Swigger et al. (2004), in turn, investigated how cultural factors affect the performance of distributed collaborative learning teams, and identified that the teams' cultural composition is a significant predictor of their performance on programming projects.

In the context of persuasive computing, Vasalou et al. (2010) investigated social network sites focusing on how designers motivate users to create content and to keep coming back to the website. In this study, the authors identified that experience with the website and culture have effects on users' motivations, the way they use the website, as well as on the time they invest on it.

Noiwan and Norcio (2006) argue that although HCI researchers recognize culture as an important factor, cultural studies in HCI are still unsubstantial. They mention that recommendations regarding interface design for international users are mainly based on collective knowledge, personal experiences, and few case studies. In fact, as Sellen et al. (2009) highlight, despite recent efforts there is still a need for developing ways to support the design of technology for the digital age.

In the context of HCI and culture, Hofstede (1991) investigated cultural differences in an international technology company, and proposed a framework with five cultural dimensions (Power Distance Index, Individualism, Masculinity, Uncertainty Avoidance Index, and Long-Term Orientation Index). His framework has been used to support the analysis of cross-cultural issues. However, similar to the value-oriented frameworks cited previously, it does not favor the identification of aspects that may emerge from the context being analyzed, such as the ones related to behavioral patterns that do not fit the framework dimensions (e.g., play, fun, subsistence).

Contextual Design (Beyer and Holtzblatt, 1997) is a user-centered design process that offers a set of methods to support the design of products based on the collection, interpretation and use of data about users in the field. This process provides the Cultural Model: a model to support designers to represent the most important culture and policy that influence how the work is conducted in an organization, how people are constrained and how they deal with those constraints to conduct their work (Holtzblatt and Beyer, 2013). The model supports designers when analyzing the collected data; no model is offered to support designers to think about values and culture in other stages of the process, such as the data collection and requirements clarification (e.g., Contextual Inquiry stage) and the evaluation of the designed solution.

In a certain way, the Personas Technique may support designers to make cultural issues explicit and to think about the values of different stakeholders. Popularized by Cooper (1999), a persona tries to characterize and describe a typical user of the proposed solution as though s/he was a real person. Holtzblatt and Beyer (2013) suggest that personas require a rich contextual data in order to be relevant. In fact, this technique heavily relies on designers' background and ability to create representative personas, not favoring the identification and understanding of cultural values in the design context and its different stakeholders.

From the previously cited works that address issues related to values and culture in technology design, the Value-Sensitive Design has been perhaps the most influential. According to Friedman et al. (2006), Value-Sensitive Design is a theoretically grounded approach to the design of technology that accounts for

human values throughout the design process. It involves an integrative and iterative tripartite methodology that consists of conceptual, empirical, and technical investigations, encouraging moral discussions in relation to the development of products and services (Miller et al., 2007).

On the one hand, our work adds to Value-Sensitive Design and Contextual Design by proposing artifacts and methods that may support some of their different activities, such as the identification of stakeholders and their values, the analysis of existing technical solutions, the organization of requirements related to values, and the mapping of the possible impact of these requirements on the stakeholders. On the other hand, it differs substantially from Value-Sensitive Design and Hofstede (1991)'s cultural dimensions by explicitly addressing the cultural nature of values, and by integrating the proposed artifacts and methods into a well-defined design process.

3. The value-oriented and culturally informed approach

In many different ways, culture influences what people pay attention to and what they ignore, the way they behave and the way they interpret someone else's behavior, what they value and what they do not. For Hall (1977), the natural act of thinking is strongly modified by culture. Values are learned and determined by culture (Hall, 1959; Rokeach, 1979; Schwartz, 2005) such that it is not possible to fully understand them outside their complex cultural context. In this sense, if we are to approach values in technology design, we must pay attention to their cultural nature and complexity.

VCIA is a Value-oriented and Culturally Informed Approach to the design of interactive systems that involves a set of artifacts and underlying theories and methods articulated to support the explicit consideration of values and their cultural nature during different design stages. VCIA aims to address important issues pointed out in the HCI literature by having three key-principles: (1) Values and Culture are intertwined and inseparable; (2) Designers need practical artifacts and methods to support their activities; (3) Designers need a well-defined design process.

First principle: Values and Culture are inseparable. VCIA *considers values and culture in an articulated way informed by different theoretical and methodological basis*. While a value indicates something that is important and needs to be taken into account, the cultural context explains why such value is important, helping designers to understand the possible implications of its promotion or negligence, and other issues that are direct or indirectly related to it. As presented in Section 2, although there are important works in literature addressing both culture and values in technology design, to our knowledge, no existing approach supports the involvement of both culture and values in an explicit, informed, and integrated way throughout the design process.

Second principle: Practical artifacts and methods are needed to support a value-oriented and culturally-informed design. VCIA addresses the gap identified in literature which claims the need for *theoretically grounded artifacts and methods for supporting professionals that have little (or no) experience with social subjects to account for culture and values*. The artifacts were created to support designers in their different activities. On the one hand, the artifacts interact with each other providing inputs and outputs that suggest a natural order of use; on the other hand, they are independent and could be used in isolation for specific purposes according to users' needs. Each artifact is intended to lead designers to think beyond obvious issues, expanding and clarifying their understating of the problem domain and the solution to be designed. They look for a balance between offering guidance and supporting critical and creative thinking.

Third principle: A well-defined design process, in which values and culture are embedded concepts, is needed to support a value-oriented and culturally informed design. The literature in HCI also indicates a lack of guidance regarding how to concretely address values and culture in design activities. VCIA *integrates the artifacts in a design process* that articulates informal, formal, and technical aspects of information systems and *that favors interactive systems designers to think about values and culture, keeping them in mind during design activities*. VCIA supports the use of the proposed artifacts to move from informal discussions to the design of technical solutions in a socially responsible manner.

VCIA draws upon Baranauskas' Socially Aware design model (Baranauskas, 2009, 2014; Baranauskas and Bonacin, 2008) and proposes artifacts to serve specific purposes—see Fig. 3. The artifacts and their usage were created on the grounds of Organizational Semiotics theory (Liu, 2000) and the Building Blocks of Culture (Hall, 1959).

3.1. Theoretical and methodological foundation

Hall (1959) recognizes culture as a term that has been given different meanings, and uses it to refer to people's ways of life, their learned behavioral patterns, attitudes, values, and material things. To him, culture is related to the very different ways of organizing life, of thinking, and of conceiving underlying assumptions about the family, the state, the economic system, and even of mankind. Hall approaches culture as a form of communication, giving emphasis to the nonverbal form. What people are able to communicate verbally would only be a fragment of an entire complex system of communication, and probably the most obvious one. Aiming at formalizing the characterization, analysis, and comparison of different cultures, he proposed 10 Primary Messages Systems, or areas, named the basic Building Blocks of Culture: Interaction, Association, Learning, Play, Defense, Exploitation, Temporality, Territoriality, Subsistence, and Bisexuality.

In Hall's theory, a culture is understood as an evolution of human behaviors and interactions mapped by a combination of the 10 areas. Moreover, cultures also develop values with regard to the ten areas. For instance, values in "Defense" are related to the rules, strategies, and mechanisms developed in order to protect space (physical or personal), the objects used to guarantee protection, the medical therapy adopted/preferred, etc. In this framework, religions may be understood as a way of protecting the society from itself by inhibiting potentially harmful behaviors. Values in "Play" are related to the kind of sporting activities preferred in a society, the importance given to leisure and the day of the week used to rest, preferred places for playing, and so on. Values in "Exploitation" are related to the preferred tools, objects, instruments, and procedures for working, playing, learning, protecting, eating, etc.

Values may also be developed in the intersection of different areas. For instance, Britannica[2] defines identity as "the distinguishing character or personality of an individual". The value of "identity" in a society may be understood as a value developed in the intersection of all the ten areas. Identity refers to individuals' "self", the expression of elements of a person's personality and individuality: who the person is in space and over a period, in its widest sense. The conception and importance of "identity" vary according to the culture being considered.

Besides the attempt to structure and organize the study of culture, perhaps one of the most important contributions of Hall's works is the introduction of the notions of informal, formal, and technical

[2] ⟨http://www.britannica.com/bps/dictionary?query=identity⟩, last access: Jul 24th 2014.

levels in which humans operate and understand the world (Hall, 1959). According to him, each level is present in any situation, but one will always dominate in a given instant of time, and is dealt with separately. Sometimes, the shifts (and boundaries) between these levels are subtle and rapid, but understanding them is the basic requirement to understand the process of change.

The Organizational Semiotics theory proposes a structure named "Semiotic Onion" (Stamper et al., 2000) to explain how these levels coexist in the context of organizations and information systems—see Fig. 1: the key idea is that any technical artifact is embedded in a formal system that, in turn, is embedded in an informal one. The informal system represents the organizational culture, customs, and values that are reflected as beliefs, habits, and individual behavior patterns of its members. The formal corresponds to aspects that are well established and accepted, becoming social conventions, norms, or laws. Finally, the technical, situated at the core of the onion, represents aspects that are so formalized that they can be technically approached and supported.

The Organizational Semiotics considers an organization and its information system as a social system in which human behaviors are organized by a system of norms (Liu, 2000). For Stamper et al. (2000), these norms govern how the members think, behave, make judgments, and perceive the world, and are directly influenced by culture and values. The Organizational Semiotics explores the use of signs and their effects on social practices, and provides a set of methods (e.g., Problem Articulation Method, Norm Analysis Method) and artifacts (e.g., Stakeholders Identification Diagram, Semiotic Ladder, Ontology Charts) to deal with information and information systems in a balanced way, taking into account technological issues as well as human aspects of information resources, products, and functions.

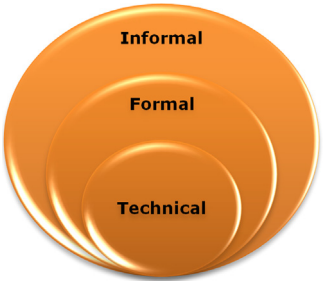

Fig. 1. The Semiotic Onion.

In her Socially Aware Computing view of design (Baranauskas, 2009; Baranauskas and Bonacin, 2008), Baranauskas articulates ideas inspired by Organizational Semiotics (Liu, 2000) and Participatory Design (Schuler and Namioka, 1993), proposing a framework that considers a dialogue with design materials and, mainly, among individuals in their different roles (e.g., designer, developer, user, other stakeholders) in order to conduct participatory work in interactive system design. In her view, the technical aspects of a system design depend on and impact on the formal and informal aspects of organizations and society. A technically centered perspective prevents those involved in a design context from a wider sense-making of the problem being handled and the solution being proposed.

In this sense, Baranauskas (2009, 2014) argues that any design process must be understood as a movement from the outside to the inside of the Semiotic Onion, crossing the informal and formal layers of signs towards the construction of the technical system, because this movement favors the identification, articulation, and formalization of relevant aspects of the social world (e.g., values and culture)—see the arrows in Fig. 2. Yet, the movement returns back from the technical system impacting the formal and informal layers, and the society in an informed way, reflecting an understanding of the social world, making sense to users and, potentially, promoting acceptance and adoption.

The dashed ellipse in Fig. 2 indicates the design process in action. It starts in the social world, crossing the informal layer where activities are conducted to clarify the problem (e.g., identify the stakeholders, their cultural differences, interests, and expectations). Design progresses from the informal to formal layer where activities support the elicitation of requirements, the decision-making informed by the knowledge constructed during problem clarification, and the solution modeling. The design process continues towards the construction of a technical system through activities that support interactive prototyping, the codification, experimentation of design alternatives, and their evaluation.

As the ellipse indicates, the process does not finish in the technical level, but continues crossing back to the formal and informal layers. This means the design product will potentially trigger changes that may require updating the model, reviewing agreements, justifying design decisions, as well as it may impact established processes, formal norms and laws. Therefore, the design product also impacts the shared understanding about the problem and solution, its importance to the different stakeholders, and so on. The process will progress iteratively and incrementally as much as necessary.

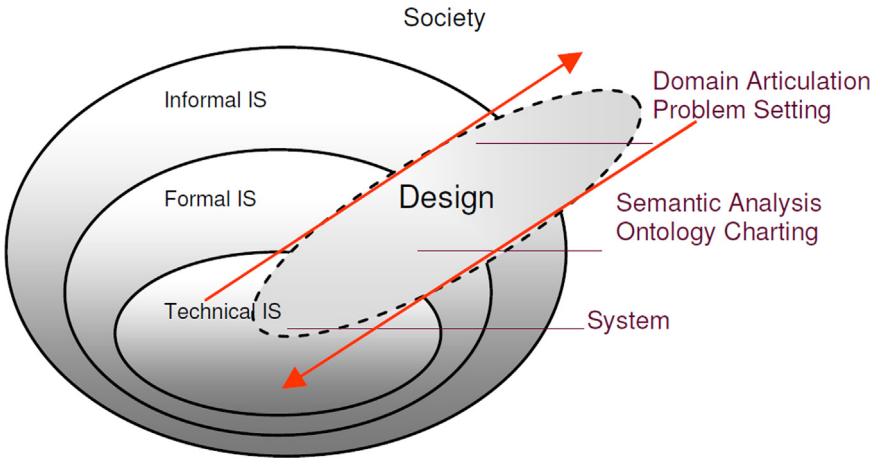

Fig. 2. The Socially Aware Computing approach to design (Baranauskas, 2009).

3.2. The VCIA model

Underlying the VCIA model is an understanding that the design of solutions that make sense to people, meet their demands, respect their values, culture and other social requirements, and, ultimately, does not produce harmful side-effects, requires an understanding of the way different stakeholders value and react to a proposed innovation, seeing the world from their view and cultural particularities.

VCIA considers three main design stages proposed by Baranauskas and Bonacin, (2008): Analysis, Synthesis and Evaluation. These happen in a non-linear order, indicating that understanding and describing a problem, finding a solution, and implementing it, does not occur in fixed, predefined sequences, but in an interactive, iterative and incremental process.

The stage of *Analysis* happens mainly when designers are clarifying the problem and conceiving a solution. It also occurs when designers are defining, organizing, and evaluating requirements as well as investigating existing solutions, technical possibilities, restrictions, and so on. The stage of *Synthesis* occurs mainly when the results of discussions are converted into requirements or project decisions, and materialized into design solutions. It can also occur when the problem is being clarified and technical alternatives are being considered. The stage of *Evaluation*, in turn, is clearly visible during the inspection of prototypes and the justification of design decisions; but also occurs when models are validated, decision are made to solve conflicts, and when expectations, values, meanings, and intentions are shared and confronted.

Fig. 3 shows an overview of the VCIA model, with the artifacts created or adapted to support design activities surrounding the Semiotic Onion. The artifacts are placed within the layer of the onion in which they contribute the most, suggesting a feasible, although flexible, order of use. These artifacts articulate the theoretical and methodological basis previously presented, leading designers to keep values and cultural aspects in mind, considering such aspects explicitly throughout the design process.

Each artifact has a specific purpose and supports different activities for a value-oriented and culturally informed approach to design.

- Stakeholder Identification Diagram (Kolkman, 1993): helps designers think beyond obvious classes of stakeholders (e.g., user, client, manager), paying attention to the parties' different levels of involvement, interests, and expectations.
- Value Identification Frame: invites designers to think about the different values each stakeholder brings to the project and that must be considered in the design activities.
- Value Comparison Table: supports designers in the comparison between different design alternatives when they are investigating existing/related solutions.
- Culturally Aware Requirements Framework: helps designers identify and organize requirements related to the values and culture of the different stakeholders involved in the design context.
- eValue: helps designers evaluate whether the solution was designed accordingly, i.e., whether design decisions are reflecting the understanding about the values and the culture of the different stakeholders.

In VCIA, the design process does not have a pre-defined number of iterations, but continues as far as the problem and its solution need to be improved. All the stages encompass different activities, are supported by different artifacts and methods, and cross the informal, formal, and technical layers, although they are more concentrated in one of them. The artifacts presented in Fig. 3 are intended to support designers in their practices, serving as a complement to the techniques and tools they already use.

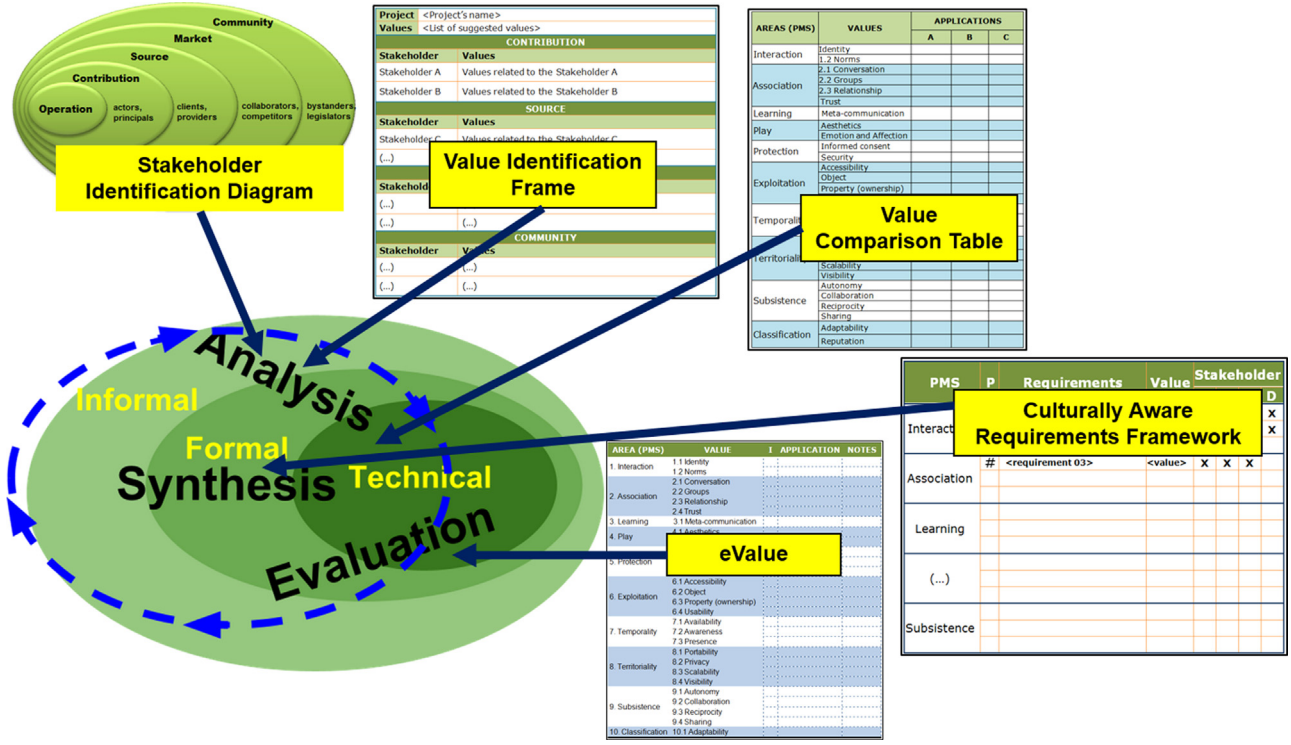

Fig. 3. Illustration of the design model for VCIA.

3.3. The artifacts and their methods

During the Analysis stage, the identification of stakeholders is one of the first activities to be conducted. Different stakeholders bring different perspectives to the innovation being proposed, and have different interests, views, needs, values, and culture.

The *Stakeholder Identification Diagram* has five layers (see Fig. 5 for details). The project/solution to be designed is represented by the core of the artifact ("Operation"), and stakeholders are distributed into different categories: from the actors directly involved in the design ("Contribution") and the sources of information ("Source"), to the partners and competitors ("Market"), and the people who may not use the solution but may affect, or be affected by, it ("Community"). The closer stakeholders are to the core layer, the more they are directly impacted by the solution (and vice-versa). The artifact's input is the problem being clarified, and the output is a map of the different stakeholders involved in the problem and its solution.

Practical steps for using the Stakeholder Identification Diagram:

1. Start with a brief description of the problem being clarified.
2. Highlight all the interested parties (stakeholders) that appear in the description.
3. Find the most suitable layer in the artifact for each stakeholder.
4. For the layers of the Stakeholder Identification Diagram, answer:
   - Who are the principal actors responsible for finding and building a solution to the problem?
   - Who are the clients and providers that will require and supply resources (information, budget, people)? Who will be the direct users of the solution?
   - Who are the collaborators that may contribute to the design, and who are the main competitors?
   - Who are the legislators and other entities whose activities and resolutions may influence the design context? Who are the bystanders who will not use the solution but may be positively as well as negatively affected by its design and use?

Some stakeholders may be related to more than one layer of the artifact, indicating it has different roles and influences that should be considered. The key issue when filling the artifact is not to identify the correct layer in which the stakeholder should be placed, but to map these different stakeholders according to their different levels of involvement with the problem.

The *Value Identification Frame* may be used as soon as any stakeholder has been identified. The artifact's input is the list of stakeholders identified through the Stakeholder Identification Diagram, and its output is a list of the values each different stakeholder brings to the design problem.

Practical steps for using the Value Identification Frame:

1. Select each stakeholder from the Stakeholder Identification Diagram.
2. For each stakeholder, answer:
   - What are the main values for this stakeholder?
   - What are the needs and expectations about the problem and its solution?
   - What should characterize an ideal solution for this stakeholder?
   - What positive or negative impact the solution may cause on this stakeholder?
   - Is there any conflict between the values already listed for this stakeholder? And between other stakeholders' values?
3. From the answers to the questions in step 2, list the concepts that represent values for the related stakeholder and highlight possible conflicts.

When completing this artifact, designers need to look beyond their own experiences and consider the point of view of stakeholders with different levels of involvement. The Stakeholder Identification Diagram and the Value Identification Frame help designers think of the diversity of stakeholders and their values, keeping them in mind during the design of a solution.

The *Value Comparison Table* was created to support both analysis and evaluation from a technical perspective, helping designers in the comparison of different existing solutions. With this artifact, designers explore existing solutions, questioning and analyzing how they reflect values. The artifact has a column for the areas of culture, a column for the list of values to be analyzed (and other values that may be identified during its usage), and a column for each solution that will be analyzed. The artifact's inputs are the areas of culture, a list of values, and the solutions to be analyzed. The output is a mapping of the way different solutions reflect values.

Practical steps for using the Value Comparison Table:

1. Select the existing solutions to be analyzed.
2. Explore the main features of each solution.
3. For each area of culture, list the values that will be investigated for all the analyzed solutions.
4. For each value:
   - Explore each solution and evaluate the way it is (not) supporting the value, taking notes.
   - If a new value is identified, insert it into the corresponding column and analyze it.

Once completed, the Value Comparison Table provides designers with a map of how values are reflected by/on/through each solution: each cell presents reasoning about a given value in a specific solution; each line makes it possible for designers to identify the pros and cons of each application regarding a given value, and allows designers to highlight which values might inspire them when designing a new solution, or alert them about what they should avoid. Additionally, each column provides a picture of the values perceived in a given solution, the way they are being supported, and designers' impressions about them.

During the stage of Synthesis, it is necessary to define and specify the way stakeholders' values and culture would be effectively considered, dealt with, and represented through either the design's decisions/constraints or the system's functionalities. The *Culturally Aware Requirements Framework* supports designers in this task. The artifact's basic assumptions are: values are culturally developed according to the building blocks (or areas) of culture (Hall, 1959). Depending on the way the innovation is designed, it will affect different aspects of these areas, promoting or inhibiting the different stakeholders' values. For instance, the innovation my cause negative impact on aspects of stakeholders' subsistence, requiring them to learn a new technology and affecting their autonomy. The designers' task is to identify requirements related to the values of the different stakeholders according to the 10 areas, defining priorities among these requirements, and dealing with potential conflicts. The artifact's inputs are: the 10 areas of culture, the stakeholders identified through the Stakeholder Identification Diagram, the values mapped for each stakeholder through the Value Identification Frame, and any documentation designers may have produced (e.g., problem description, solution proposal, and interviews with stakeholders). The output is a

ranked list of requirements related to the stakeholders and their cultural values. See Fig. 6 for details.

Practical steps for using the Culturally Aware Requirements Framework:

1. Select the most important stakeholders, creating a column for each one.
2. Insert each value from each selected stakeholder as a new line in its corresponding column.
3. Identify requirements related to each value, writing them in their corresponding column.
   - What features should the solution have to promote or respect this value?
   - What actions are required?
   - Is there any design constraint?
   - Can it influence in any design decision?
4. Identify requirements for each area of culture, writing them in their corresponding column.
   - Read the descriptions and explanations.
   - What requirements are related to this area?
   - Are the requirements related to any value? What values?
   - How will the problem and its solution affect the stakeholders regarding this area?
5. Think about possible conflicts.
   - Can the requirement affect or influence other stakeholders' values? How?
   - Does it require new decisions or actions? Which?
   - Does it generate new requirements? Which?
6. Define priorities.
   - How critical is the satisfaction of the requirement?
   - How important is that value for the stakeholder?
   - What is the importance of this requirement when compared to others?

The key point when using the artifact is not to find and relate the requirements and values to the correct area of culture, but to think about requirements that will allow designers to identify and specify features, restrictions, and quality attributes for the solution being designed, recognizing the importance of these requirements, and thinking about the possible impact on the stakeholders. These requirements will complement other existing requirements (which can also be mapped into the artifact), guiding designers in the prototyping and implementation of their solution.

Once requirements have been identified, designers may use their preferred techniques and tools to create the first prototypes for the solution being designed. Then, in the *Evaluation* stage, the eValue artifact supports designers as they evaluate whether the prototypes or the final solution was designed accordingly, i.e., whether design decisions reflect the understanding of the different stakeholders' values and culture (see Fig. 9 for details).

With the eValue artifact, the designers' task is to explore the designed solution, questioning and analyzing the way the design communicates values and affects users' cultural aspects, and compare it to the documentation produced (e.g., values in the Value Identification Frame, requirements in the Culturally Aware Requirements Framework), taking notes and proposing design alternatives. The artifact's inputs are the areas of culture, the list of values from the Value Identification Frame (and other values designers may find important to consider), and the solution to be evaluated. The output is a mapping of what values are being reflected by/on/through the analyzed solution, and the way it is done. It also presents evaluators' reasoning about each value, identifying pending questions, critical issues, ideas, and possible improvements that may guide a redesign activity, or, minimally, serve as a list for future reflection.

Practical steps for using the eValue:

1. Read the documentation available for the solution (e.g., description of the problem, proposal of solution, requirements, design rationale).
2. Explore the solution and its features.
3. For each value, analyze whether there is any feature or attribute of the solution that is reflecting/representing the value.
4. If the value was identified:
   - Discuss whether the application was properly designed to support the value accordingly, and leave comments, suggestions, and highlights.
5. If the value was not identified:
   - Verify whether it does not apply or it is being neglected/forgotten in the project.

   If neglected/forgotten:
   - Think about the possible impacts of not considering the value.
   - Suggest means of supporting the value in the solution.

All the artifacts presented in this section have been experienced and evaluated in different design contexts, e.g., social applications for Interactive Digital Television (Pereira et al., 2013b); applications for supporting cross-cultural collaboration (Pereira and Baranauskas, 2012); and inclusive social network (Pereira et al., 2011, 2013a). Templates for all the artifacts are available for download[3] and a web-based case tool is being designed to support their usage.

4. Putting VCIA into practice: A case study

In this section, we instantiate VCIA in the context of the design of a social network for Brazilian teachers in the Special Education field—teachers who work with students that have some kind of disability.

Over the last few years, Brazilian public policies that promoted the inclusion of students with disabilities in mainstream schools resulted in the creation of the Specialized Educational Services area (MEC, 2009). In order to qualify professionals in this field, teachers from all over the country started specialization courses through e-learning environments. These courses were limited in duration and lacked follow up, leaving teachers on their own to apply these new ideas in the classroom.

Aiming to create lifelong learning support for these teachers, researchers in the Education and Computer Science fields are working together on a research project intended to investigate and design a social network system for connecting and supporting teachers from all over the country in their day-to-day work. The system is named "Todos Nós em Rede", TNR, (*All of Us Networked*). It values the expertise (authority) of its members and has as premises the teacher's autonomy and self-regulation. It aims for the construction of knowledge about issues related to specialized services through the discussion of problems (cases) teachers encounter in their professional practice with students.

Designing a social network for connecting teachers across the country that supports the socialization of their practices and their collaboration is a challenging task. It requires that designers consider the different stakeholders and the values they are bringing to the design context, dealing explicitly with them. Inclusive

[3] ⟨http://www.nied.unicamp.br/ecoweb/products/artifacts⟩.

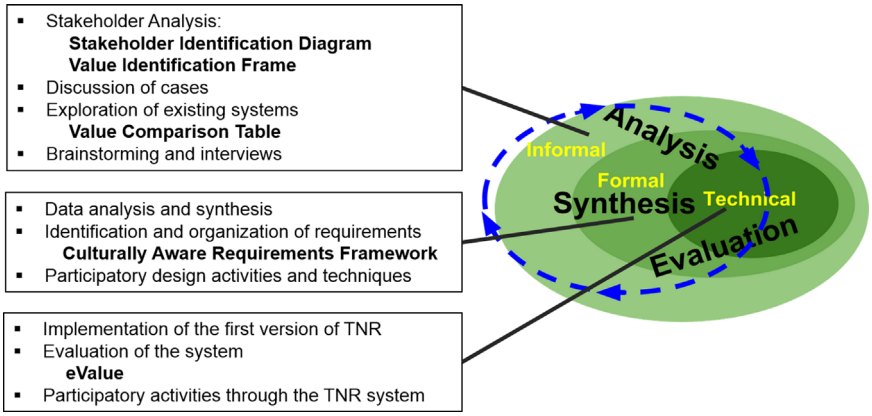

Fig. 4. Activities and artifacts used for TNR design.

education in Brazil is a recent achievement that is still being consolidated and has been marked by political, pedagogical, and economic conflicts. Brazil is the fifth largest country in territory and population, having a very heterogeneous population in terms of ethnicity, and social and economic conditions (IBGE, 2012); habits, behaviors, and needs vary profoundly according to the region of the country. Usually, teachers are not used to computer technologies, and may have an impairment themselves (e.g., visual). They also have their personal customs, preferences, procedures, values, etc., that must be taken into account. Teachers and professionals working in schools are not often open to engage in research projects because of a shared feeling that their collaboration will not be retributed as benefits to them or their schools. Moreover, researchers, funding institutions, and the community also have their particular interests, expectations, and values that must be considered.

4.1. Method

This case study presents results from practical activities conducted from September 2010 to September 2012: from problem clarification activities to the design of TNR's first version. The participants in this case study were 28 teachers, 3 researchers in Education, and 4 researchers in Computer Science and HCI. The 28 teachers, from different regions of the country (named Specialized Education Services "sowers" as a reference for their role in multiplying the project ideas), were invited by email and took part in participatory activities that aligned design activities with social practices.

Fig. 4 summarizes the main activities conducted for designing the first version of the TNR system, and the artifacts that were used in the first interaction of VCIA (in bold). Although there were overlapping activities, the top-down order they appear in the Figure indicates the sequence in which they were conducted in the case study. The 28 teachers participated in both distance and face-to-face activities. Teachers explored and evaluated existing systems for the way in which the system could support their day-to-day activities; participated in brainstorming sessions and interviews; drew prototypes for the system; explored the first version of the designed system giving their feedback and participating in online activities; participated in the definition of the system's terms of use and conditions, created a letter of principles to guide the users' ethical behavior in the system, and so on. The researchers also took part in the activities, supporting teachers, analyzing the activities' results, and socializing them with the teachers.

During the stage of Analysis, the Stakeholder Identification Diagram supported researchers in their role as designers in the identification of the different stakeholders involved in the project, and the Value Comparison Table supported the comparison of four different systems explored by the teachers. During the stage of Synthesis, the Value Identification Frame and the Culturally Aware Requirements Framework supported researchers in making the stakeholders' values explicit, identifying requirements associated to each value and related to cultural aspects, and defining a priority for each requirement. The generated information was used during a participatory workshop with six teacher representatives in order to create the first prototypes of the system. The first version of the system was guided by the prototypes, and the eValue supported three researchers in the process of evaluating the system from the perspective of values and culture. Additionally, a set of values identified in the context of social software (Pereira et al., 2013c) was used to support online activities with the teachers through the TNR system.

Currently, the TNR system has more than 650 registered users, and the registration of new users occurs by invitation from someone already registered. More than 500 contents (articles, documents, questions, pictures) were shared by teachers and received more than 3000 comments[4]. A key-tool for the system, named "Our Cases", was designed to support cooperative discussion about specific cases through the TNR system. By the end of 2015, the system is expected to double its number of users, and the "Our Cases" tool is being considered for adoption to support the aforementioned specialization course offered to teachers by a Brazilian public university.

Following, we present and discuss some results of the activities supported by the different VCIA's artifacts and their methods. These results identify contributions of the VCIA to the understanding and consideration of values and culture throughout the design process, and exemplify how the artifacts were articulated with design activities in order to produce the first increment of the TNR system.

4.2. Results on VCIA instantiation

One of the first activities conducted in the project by the researchers was the analysis of stakeholders supported by the Stakeholder Identification Diagram—see Fig. 5. It is interesting to note that three special classes of stakeholders are representing the three layers of the Semiotic Onion: Specialized Education teachers (represented by the "Sowers") in the informal layer, the Researchers in Education representing the formal layer, and Researchers in Computer Science representing the technical layer. Teachers bring the knowledge about the problem domain, the way things occur in practice, their habits, preferences, etc. Researchers in Education

[4] This information is from January 16th, 2015.

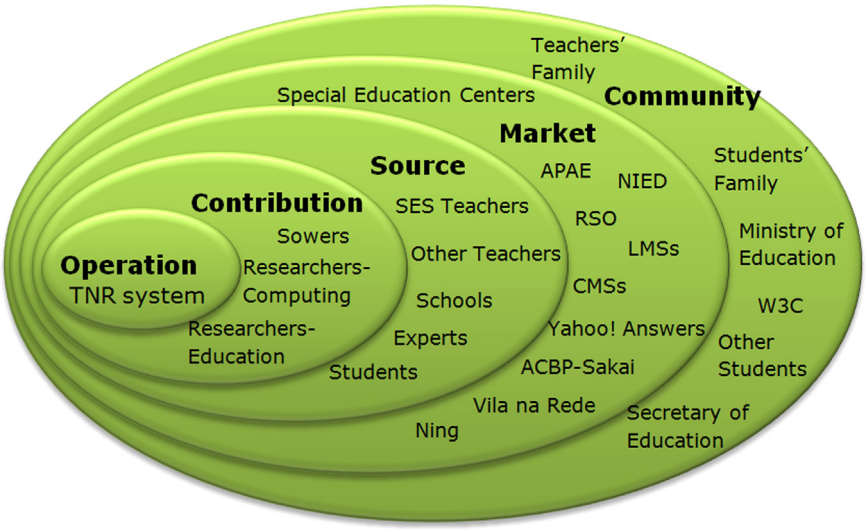

Fig. 5. Stakeholders identified through the Stakeholder Identification Diagram.

bring the knowledge about the rules, laws, and methodologies defined by the Ministry of Education. Researchers in Computer Science bring the technical knowledge necessary to understand and design a computer system to support teachers. Other stakeholders are the students, their families, the school principal, teachers in mainstream education, other professionals that work with the children at school, and so on.

Some stakeholders are easily identified, such as the teachers themselves, the students with special needs, and the researchers working on the project. Without the Stakeholder Identification Diagram, other stakeholders could have remained unnoticed, possibly being identified when, and if, a problem arises. For instance, the "other teachers": teachers that do not work in the Specialized Education Services but teach the students in mainstream classes, and who are key to improving the results expected from the special education interventions. The "Ministry of Education" who is important because it is responsible for defining and managing the rules and policies for the entire education system in Brazil. The teachers' family is another important stakeholder, because teachers that are not used to computer technologies usually ask their family for help, and so on.

Once stakeholders were identified, the Value Identification Frame was used to make their values explicit. For instance, teachers have autonomy, reputation, and security as values; researchers have accessibility, privacy, and usability. Similarly, students and their families have privacy, learning, and autonomy as important values. Thinking about the different stakeholders' values is critical for designing solutions that are universal, and for preventing negative side effects. Whatever the values identified, by making them explicit, they could be questionable throughout the design process.

Participatory activities were conducted with 28 SES teachers in order to know the prospective users, understand their values, needs, expectations, and what are (if any) the existing solutions that could already support them. For instance, teachers explored four different systems: *Yahoo! Answers*® (S1), *ACBP-Sakai*® (S2), *LeMill*® (S3) and *Vila na Rede*® (S4) for at least one month each and gave their feedback by: (i) interacting with the systems in order to solve fictitious cases (i.e., problem situations); (ii) answering evaluation questionnaires, identifying features they liked, disliked, missed, etc.; and (iii) participating in semi-structured interviews. These systems were selected because they offer different features and implement different types of conversation for a collaborative work.

The information provided by teachers were used as input for the Value Comparison Table, which supported the comparison of the four systems and led to the finding that the existing systems would not be able to support the development of a social network for the teachers, and that a new system should be designed. On the one hand, the artifact showed points that were negative from teachers' point of view and that should be avoided in the system to be designed. For instance, limited amount of messages in discussions, features for highlighting the best contribution, absence of authorship information, lack of structure for formal conversations, etc. On the other hand, the artifact showed points that were approved by teachers, providing interesting examples for inspiring the design of the new system. For instance, using both free and structured forms of conversation to guide and promote discussions, accessibility features, privacy control mechanisms, etc.

In the Synthesis stage, the Culturally Aware Requirements Framework was used by the researchers to identify and organize requirements for the system to be designed. Fig. 6 shows the artifact filled with at least one requirement for each area of culture, its priority, and the values and the stakeholders related to each requirement. At least the most representative stakeholder from each layer of the Stakeholder Identification Diagram was selected, including the three stakeholders from the contribution layer (teachers, researchers in education, researchers in computer science) because they represent informal, formal, and technical perspectives to the problem, respectively. The information in the brackets indicates whether the requirement was identified in the participatory activity where teachers explored four existing systems [S1,S2,S3,S4] or whether it is a goal of the project [Project]. The column "AREAS (PMS)" presents the building blocks of culture; and the column "P" indicates the priority for each requirement (e.g., "3"—High, "2"—Average; "1"—Low).

Several requirements were identified and clarified according to their cultural aspects and related values. If these requirements are seen in isolation, they only specify functionalities, restrictions, or quality attributes for the system. However, when they are interpreted through the lenses of values and culture, they reveal important issues that are usually too subtle to be identified, such as what is (not) desirable and important, and why. These issues make a difference in the design rationale, supporting designers in their choices.

For instance, teachers did not show an explicit concern for the value of privacy—they thought it was good to share their opinions and information, and did not see a problem in making them

AREAS (PMS)	P	REQUIREMENTS	VALUES	STAKEHOLDER					
				A	B	C	D	E	F
Interaction	3	User profile with personal information (e.g., picture, about, professional activity). [S1,S2,S3,S4]	Identity	x	x				
	3	The system must allow a user to invite other users to contribute to her or his discussions. [S1,S2]		x			x		
Association	3	The system should provide features for synchronous and asynchronous conversation. [S1,S2,S3,S4]	Conversation	x		x			
	1	The system should allow users to indicate other users s/he wants to receive information from. [S1,S2,S3,S4]	Relationship	x	x	x	x		
Learning	2	The system must offer additional information/explanation about how to use its features. [S1,S2,S4]	Meta-communication	x		x			
Play	2	The system must have a minimalist design. [S1,S2,S3,S4]	Aesthetic	x	x	x	x		
Protection	3	Only registered users will have the right to see the materials available in the system. [S1,S3,S4]	Security	x	x		x	x	x
	3	The system must guide users regarding privacy and security issues. [S1]	Informed Consent	x	x				x
Exploitation	3	All content produced and shared into the system will have its author (owner), who is responsible for all actions on the given material. [S1,S2,S3,S4]	Property (ownership)	x			x		
	3	The system must be accessible. [Project]	Accessibility	x	x	x	x		
Temporality	3	The sections must not have a time limit and expire after the elapsed time. [S2]	Availability	x			x		
Territoriality	2	It is necessary to provide features for searching and filtering information and users. [S3]	Object	x			x		
Classification	1	The user must be able to adapt the order in which contents are presented. [S3,S4]	Adaptability	x	x				
	3	The system must offer non-negative reputation features, such as liking comments and making contents as favorite. [S1, S3]	Reputation	x			x		
Subsistence	3	The system must favor the users' autonomy [Project]	Autonomy		x	x			
	2	It must be possible for the user to upload materials that support the discussion of the cases (e.g., pictures, articles, links). [S1,S2,S3]	Sharing	x			x	x	x

Fig. 6. Requirements organized through the Culturally Aware Requirements Framework. Stakeholders: (A) Teachers, (B) Researchers in Education, (C) Researchers in Computer Science, (D) Experts, (E) Special Education Centers, (F) Students' family.

available to others. However, they were very concerned about security issues, and started to think about privacy only when they became aware of its possible impact on their life, or on their students' or students' families' lives—this usually happens only when problem arises during the system usage. Therefore, the new system must guide users regarding privacy and security issues, informing teachers about the possible consequences of their actions, and instructing them not to share any content that could compromise their privacy or the privacy of others.

In the "Temporality" area, teachers usually take a long time to write and post a message because they are not used to typing in computers, they stop typing to look for information in printed books, they are afraid of doing something wrong, or simply because they like to read the text several times before posting it to be sure it is well written. Therefore, besides the possibility to edit their comments and contributions, a requirement related to the technical value of "Availability" is that the section must not have a pre-defined time to expire while the user is logged into the system.

In the "Classification" area, teachers do not feel comfortable with classification schemes that indicate something as "the best" contribution, that highlight only the best way of doing something, or the best answer for a problem. They believe that every contribution has a value and that different contributions may be combined to produce a better one. Therefore, features that allow them to indicate the contributions they liked the most and to see the contributions that were indicated by other users would be more suitable for them than a reputation feature to choose only the best one.

Another interesting example is related to the way teachers see and understand values such as collaboration, sharing, property (authoring), and identity. Teachers value collaboration during problem-solving situations; they believe that better solutions can be developed from considering the solutions proposed by different people working together, sharing efforts, and exchanging ideas. However, teachers find it important to acknowledge individual contributions. For the participant teachers, no one but the person who created the content (e.g., a post, comment, file) had the right to modify it (e.g., update, delete); e.g., teachers did not accept shared writing (as in *Google Drive*®). Hence, the system must allow users to cooperate during problem-solving situations, preserving their individual participation (edition), and managing users' rights and permissions.

Other values related to teachers were identified based on other stakeholder analysis. For instance, although accessibility affects teachers directly, it was not a concern they manifested; but rather it was identified by researchers in Education and Computer Science. Similarly, autonomy is another value directly related to teachers, but it was a concern manifested by researchers in the

Fig. 7. Prototypes produced in participatory activities.

Education field. Teachers are used to adopt a narrow range of activities and approaches to the different cases they are faced with; researchers hope that by exchanging ideas and experiences, teachers may become more proactive and creative in their day-to-day work, developing and adopting new practices and activities. Furthermore, it is also desired that teachers become more autonomous using computer technology as they gain experience with the designed system.

Once a common understanding about the system and its requirements was achieved, an adapted version of the Brain Draw (Muller et al., 1997) technique was conducted in a participatory workshop with representatives from the teachers. The objective of the workshop was to facilitate the creation of different proposals for implementing the solution. All the material produced during the previous activities was synthesized and discussed by the researchers and the teachers. During this activity, two groups, each one with five participants (three teachers, one researcher from Education and one from Computer Science), created proposals for the system interface. Fig. 7 shows the activity and some examples of the proposals elaborated by the participants.

The discussions and the prototypes produced in the participatory activity were used to inspire and guide the design and implementation of the first increment of the TNR system. In Fig. 8, the detail "I. TNR System" shows the TNR system's homepage in its very first version, while the detail "II. Prototype" illustrates one of the prototypes produced during the participatory activity.

The main structure and the distribution of elements in the layout were based on the prototypes produced (e.g., three columns, tabs, blocks). The labels used in the system were also chosen to make sense to teachers. For instance, the term "Biblioteca" ("Library") is common among teachers, and was used to represent the repository where they can upload content related to different kinds of disabilities—see detail "1" in Fig. 8.

The TNR system is intended to connect teachers from all over Brazil that work in the Specialized Education Services. During the Brain Draw activity, participants used a map to indicate the presence of users in the system according to their geographical location. This idea is representing aspects of time ("Temporality") and space ("Territoriality") by providing a country map where users could visualize aspects of their identity. The idea was well accepted by all the participants and inspired the creation of a feature that supported the first activity in the designed system: a tab named "Sowers" (see detail "2" in Fig. 8) with a map of Brazil indicating the location of teachers and their names was created to support the value of "Identity". Teachers were invited to introduce themselves leaving a comment below the map, and they accepted the invitation as soon as they started using the system.

The detail "3" in Fig. 8 illustrates the information presented to users every time they create new content in the system: "Remember not to share any material protected by copyright, or that may cause any kind of embarrassment, harm your privacy and/or the privacy of other people (e.g., the students)"[5]. This kind of information is intended to support the value of privacy, reminding users of the possible effects of their actions, helping to avoid undesired side effects generated from their behavior.

In the Evaluation stage, the eValue provided researchers in the role of designers ways of inspecting the TNR system regarding the values being identified or neglected—see Fig. 9 for some examples.

The "Values" column indicates the values being considered in the evaluation; the "I" column indicates whether the value was identified in the application (e.g., "I"—Identified, "N"—Neglected); the "Application" column describes the way in which the application is reflecting each value. The fragment illustrated in Fig. 9 shows a designer's reasoning about the way the TNR system was supporting meta-communication and sharing, and the notes/suggestions to be taken into account for the system's next release. Meta-communication and sharing were identified as values in the

[5] Translated by the authors.

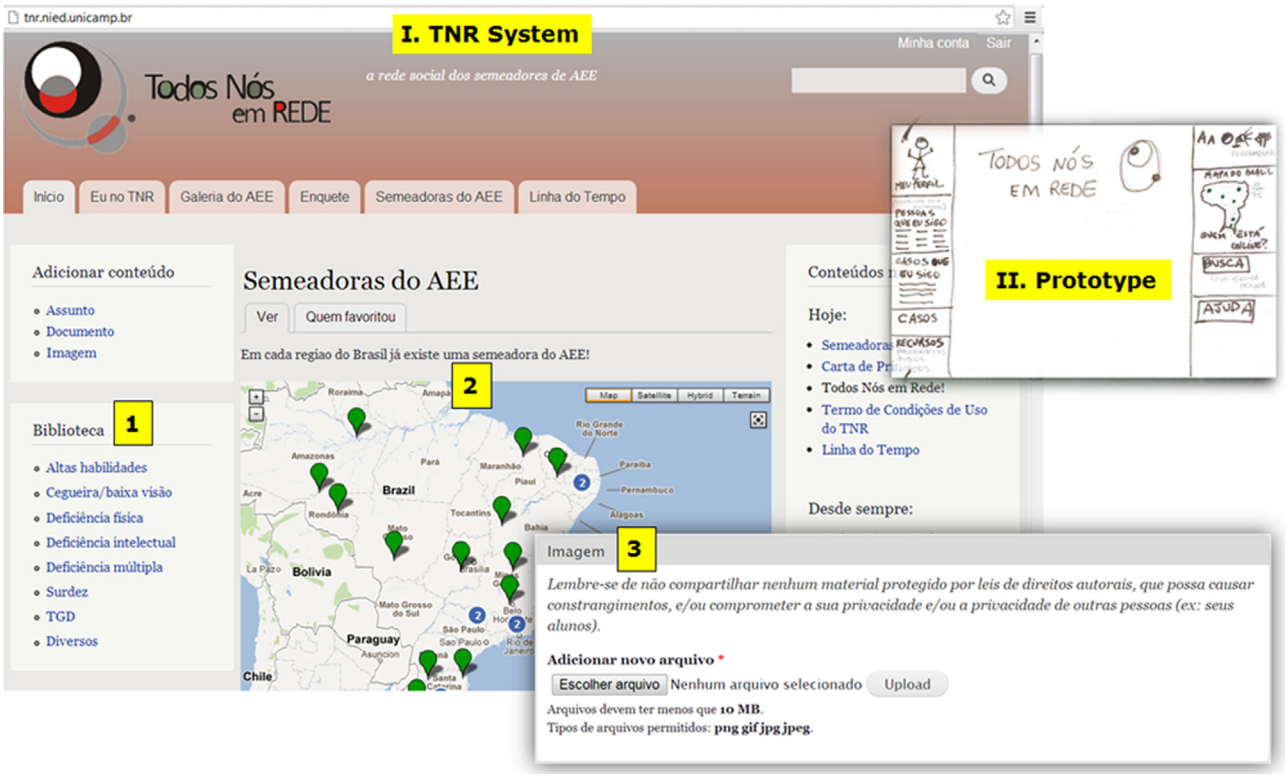

Fig. 8. Screenshot of the TNR Homepage first version.

AREAS (PMS)	VALUES	I	TNR	NOTES
Learning	Meta-communication	I	1. There are tips, explanations and alerts that guide users regarding the possible action to be conducted and their possible consequences. 2. The label "Add content" is not clear. There are different kinds of contents, for different purposes, and visible in different areas (e.g., the "Library"). Besides, there is the "Case", which will serve as a type of content… The user will have difficulty understanding and interacting with the different areas that seem to have a generic purpose.	1. The idea is useful; be sure it is transversal to all the system and its different features. 2. The "Library" is an isolated section, where users can upload content. The "Case" will be another section where users will post their real cases. The "Add content" represents the "other" contents that is neither a case nor a material for the library; it is for informal conversations about unspecified subjects and with unforeseen intentions — similar to a "coffee room" or "teachers' room". Renaming this area may avoid confusions and mistakes.
		(…)	(…)	(…)
Subsistence	Sharing	I	In the "Library", the comments and files are not a practical way of sharing materials. Users are uploading files and leaving comments about other subjects (e.g., a personal conversation). It is not possible to search for the files attached to the comments, which makes it difficult to find the desired material.	This feature must be redesigned. Today, there is no difference between the comment and file sharing functionalities and users get confused. In the "Library", the focus must be on the material being shared instead of the comment created by the user. A search feature that indexes the files uploaded and their comments is mandatory.
(…)		(…)	(…)	(…)

Fig. 9. Detail of the eValue artifact for the TNR system.

design context because they are directly related to teachers' autonomy, confidence, reciprocity, and other emotional and affective aspects.

The TNR is expected to address three different kinds of conversation among users: informal, formal, and technical. In Fig. 9, the eValue allowed designer to reason about the "Add content" label. This label serves to indicate everything the users create in the system and places all content in the same location. However, this is a concept that is different in teachers' cultural context and needs to be redesigned. For instance, there is a specific place ("Territoriality") where informal conversations occur (e.g., the coffee room, teachers' room); there are libraries where materials are organized and stored, and there are formal meetings where teachers exchange information with each other; furthermore, there are multifunctional resources rooms where teachers conduct activities strictly related to the cases they are working on. There is also a specific time and duration ("Temporality") acceptable for each environment, e.g., the break-time is 15 min long in the teachers' social room. In this sense, it must be understood that teachers talk about different subjects in different places at different times. Ignoring these cultural clues may lead to the design of a system that teachers do not identify themselves with, and they will hardly be able to verbally explain why.

Designer's observation of the "sharing" value follows the same reasoning. The "Library" is divided into eight main topics: high abilities, blindness, deafness, intellectual disability, physical disability, multiple disabilities, global development disorders, and miscellaneous. Users may leave comments and attach files to them in order to share resources related to each topic. However, users started to utilize this feature to talk to each other about informal issues, leading to an overload of useless messages that harmed the space. As the designer highlighted in the eValue, in this feature, the focus is on the comments instead of on the files being shared. Therefore, users tend to develop conversations and, eventually, attach a file to them, instead of sharing the file and then beginning a conversation about it. The Library feature was redesigned taking these points into account.

Finally, the artifacts presented in this section also contributed to activities conducted with the teachers through the TNR system. For instance, the values and areas of culture guided participatory discussions regarding the definition of the "Terms of use and Conditions" for the system. As a byproduct, teachers and researchers identified values that were not being considered in the term of usage but that were seen as important for the social network, such as values related to the user's ethical behavior (e.g., team spirit, collaboration, autonomy). Therefore, they created a "Letter of Principles" for the TNR system, which is presented to new users at the system's homepage and is intended to guide users' behavior, inspiring social network values of this group.

A value-oriented definition of the terms of use and conditions, generated and supported by VCIA, represented a differential in the TNR design. The letter of principles reflects the interest in values and culture, and is an indication that the approach was successful at keeping values and culture in the stakeholders' mind (e.g., teachers, researchers, designers) throughout the design process.

5. Discussion

The approach presented in this paper intends to sensitize people involved in technology design to the importance of keeping values and culture in mind when designing computer systems, looking beyond technical issues. Therefore, it is in line and contributes to the literature in HCI that explores the new moment in this field, such as Bannon (2011), Bødker (2006), Harrison et al. (2007) and Sellen et al. (2009).

The ACM defines HCI as "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them"[6]. This definition represents the complexity and comprehensiveness of the area, and attributes to HCI the responsibility of considering factors that go beyond technical issues, such as the formal and informal ones that coexist in society, recognizing that technical issues play only part of the role, and not necessarily the most important one.

VCIA model considers Informal, Formal, and Technical issues according to the Social Anthropologist Hall (1959) and their relationships as expressed by the Semiotic Onion (Stamper, 1996). The model explicitly draws attention the fact that a technical system is only part of a more complex system of norms, rules, laws, and procedures that can be automated. These, in turn, are part of a more complex system that represents people' lives, their customs, culture, values, etc. Therefore, VCIA reinforces that it is not possible to design computer systems that make sense to people and reflect an understanding of, and respect for, users' social world if designers pay attention solely to technical issues. It is important to begin by understanding the informal and formal aspects of the design context as profoundly and broadly as possible.

Similarly to the movement started by Papanek and Fuller (1972) in the field of Product Design, it is critical to challenge the way computer systems are designed, moving to a socially and ecologically responsible design of systems, their infrastructures, and the tools used to build them. Well established concepts and methods in HCI, such as accessibility and user-centered design, can achieve their full potential only if stakeholders are identified, understood, and involved accordingly, and if designers are able to pay attention to the genuine needs of these stakeholders instead of their momentary wants and desires.

Several authors have argued that understanding the design context is the most critical activity in the design process (Winograd, 1997; Bannon, 2011; Sellen et al., 2009). VCIA recognizes the critical importance of understanding the problem before proposing a solution, and suggests that analysis, synthesis, and evaluation are three activities present at any design stage. Although designers will give more emphasis to one of them at time, they co-exist and are intertwined with each other. There is always something to analyze, clarify, and understand; there is always something to synthesize, structure, formalize, and produce; and there is always something to evaluate, inspect, experiment, etc. Therefore, VCIA communicates that a design process does not occur in a straightforward manner, with well-limited boundaries between its stages, but rather progresses incrementally and iteratively. Moreover, it also seeks to address a gap pointed out by Steen and van de Poel (2012), communicating that values and culture must be considered from the very start of a design process.

The three main design stages recognized in VCIA: Analysis, Synthesis, and Evaluation, intentionally represent abstract stages present in any design process, so that VCIA may be understood as a perspective to be adopted and incorporated into existing practices and processes. These stages are able to encompass all the activities present in a design process, with different techniques, artifacts, and tools. The artifacts and methods proposed in order to keep values and culture in mind during the different stages are an answer to the claim that designers with background in Computer Science and Engineering need artifacts and methods to support their activities (Schikhof et al., 2010).

During the analysis stage, thinking of a narrow range of stakeholders and ignoring existing solutions for similar problems are common mistakes that led designers to neglect values in design projects. In fact, Friedman et al. (2006) indicate the identification of stakeholders as one of the first and most important steps when conducting a value sensitive design. However, the common practices in HCI tend to focus on user studies and on the analysis of stakeholders that are clearly linked to the problem and its solution. Satchell and Dourish (2009), in turn, suggest that designers tend to only think about users, ignoring issues related to the "non use" of a solution, which assumes non-users would cause and suffer no impact and influence at all. Therefore, identifying relevant stakeholders would heavily depend on designers' experience and previous knowledge about the problem domain and the solution being designed. The Stakeholder Identification Diagram, the Value Identification Frame, and the Value Comparison Table suggested in VCIA, are artifacts that support designers in problem clarification. They allow designers to think about stakeholders with different levels of involvement and interests, the values they may bring to the design context, and the way existing solutions are considering or neglecting these values.

When reporting a practical experience, Schikhof et al. (2010) highlight difficulties in understanding how to focus on human values, how to identify those that are critical and that must be considered in a design context, and how to actually conduct value-oriented design. In the Synthesis stage, the clarification and

[6] ⟨http://old.sigchi.org/cdg/cdg2.html⟩, last access on January 22th, 2015.

specification of requirements in order to concretize aspects related to stakeholders' values and culture is particularly challenging. The Culturally Aware Requirements Framework helps designers think about requirements related to culture and values, and their priorities. These requirements represent functionalities, quality attributes, or constraints that embody stakeholders' values and culture. However, formalizing requirements, dealing with possible conflicts, and making design decisions that take stakeholders' values and culture into account are challenges that demand further investigations. These studies need to consider the uniqueness of design contexts, the creative nature of the design activity, and the complexity of dealing with social issues, while seeking to support designers without limiting or narrowing their actions.

In the evaluation stage, VCIA offers the eValue artifact to support the evaluation of prototypes and final solutions. This artifact is especially important because it invites designers to look back at their decisions, making explicit the design rationale. It also serves as a milestone between different increments, generating inputs for redesigning activities and further features. The concern with, and attention to, the possible impacts of a solution should not end when it is delivered, but must continue while new increments are designed, the solution is introduced and adopted, as long as it is in use, and even when it is substituted or discarded.

When talking about the third wave in HCI, Bødker (2006) draws attention to cultural issues and highlights that most work has been presented in theoretical isolation and as solitary technical solutions. In addition to making methodological contributions through its design model and artifacts, VCIA brings a theoretical contribution to HCI literature by explicitly articulating the concepts of values and culture. In VCIA, a value is related to a stakeholder's cultural aspects. While a value indicates what is important and must be considered, culture explains why it is important. Thus, a designer can understand how to deal with values and culture, and the possible impacts caused by a designed solution.

VCIA was created based on different theories. The Building Blocks of Culture (Hall, 1959) is a strong and sound framework that has supported researchers in Social Sciences and Information Systems to study and understand cultures. The Organizational Semiotics (Liu, 2000) considers informal, formal, and technical aspects of information systems, supporting the modeling and formalization of solutions. The Socially Aware Computing approach (Baranauskas, 2009, 2014) brings a new perspective to the design of interactive systems, favoring a social responsible design in line with the new moment in HCI. These theories recognize subjective reality influenced by the social context in which individuals live, and understand technology as a powerful social construct that impacts society. This impact is not unidirectional from technology to society, but occurs in both directions. The theoretical and methodological background may be a useful basis for further investigations and discussions (Pereira and Baranauskas, 2014).

While the literature claims the need for guidance, methods, and examples, Isomursu et al. (2011) highlight that existing models and approaches usually restrict the analysis to a set of preconceived global values detached from their cultural context, sometimes preventing the identification of important culturally specific values. VCIA and its artifacts were conceived to support designers who have little or no background in social sciences, and looks for a balance between offering designers guidance while providing them with the liberty to inquire and understand the design context. On the one hand, at first, it may be complex for designers to understand the areas of culture, their scope, which questions to consider, possible related values, etc. On the other hand, because VCIA focuses on basic constructs of cultures through which values are developed, it encourages designers to inquire about values that may appear and that are relevant to the design context, instead of only paying attention to the values they already know, or that stakeholders are able to indicate explicitly. Moreover, although VCIA seeks to facilitate the consideration of both values and culture by Computer Science and Engineering professionals, both are complex concepts that cannot be oversimplified. Therefore, an initial difficulty in understanding VCIA and its artifacts is naturally expected.

The case study presented in this paper helps us to communicate two key ideas about values and culture in design. The first is related to what we mean when we talk about values, and the second is related to VCIA's three principles. Regarding our understanding of values as "core conceptions of the desirable within individuals and society", the case study presents different concepts that were identified and discussed in terms of values (e.g., identity, privacy, accessibility, availability, collaboration). These concepts are quite distinct from one another and have different direct implications on the design context regarding stakeholders' desires, needs, and expectations. These are identified and discussed during design practice. Furthermore, considering these different concepts as values is in line with our claim that thinking about values in interactive systems is more than attempting to consider social aspects of a design context. Values in interactive systems design is also a matter of mindset, requiring a different perspective from the professionals involved.

Regarding VCIA's principles, the examples from the case study also show the importance of understanding the stakeholder's cultural context in its broadest sense. When we approach concepts like reputation or property (authorship) from a value-oriented perspective, the cultural context explains the reason why these concepts are desirable and necessary, in addition to highlighting the importance attributed to these values by different stakeholders. On the one hand, the case study shows examples where the lack of understanding about why such concepts are important to teachers could have led to the design of features that would not make sense to them, or that would trigger a negative impact on their interaction, or on other stakeholders (e.g., students). On the other hand, the case study illustrates VCIA in practice, summarizing examples that show the need for keeping values in mind from the start, throughout the design process.

The artifacts presented in this paper have been explored and evaluated previously in different design contexts, taken in isolation. In this paper, we have shown the integration of all the artifacts in a value-oriented and culturally informed design process experienced in the TNR design context. These experiences indicate that artifacts may be used to support problem clarification, solution proposal, and evaluation, regardless of the problem domain and the design process adopted. In fact, the artifacts may be used to support specific activities and methodologies—e.g., the Stakeholder Identification Diagram for identifying stakeholders in Friedman et al. (2006)'s Value Sensitive Design, the eValue for conducting a value-oriented evaluation, and the Value Comparison Table for comparing different existing applications regarding values. Nevertheless, we understand that the situated character of design naturally demands adapting the artifacts and their method of usage according to the design context considered.

The values mapped through the Value Identification Frame serve as the input to the "Values" column in the Culturally Aware Requirements Framework, Value Comparison Table and eValue. Designers may also use any other list of values they think is important according to the design context as a starting point—e.g., the list of human values with ethical considerations from Friedman et al. (2006). As occurs in any iterative model, the artifacts are not filled in a straightforward manner, but are incrementally modified and updated. Therefore, blank spaces may be left in the "Values" column to be filled as the analysis

progresses. However, it is important to offer designers some suggestions of values to facilitate the consideration of social issues.

For practical purposes, when the number of stakeholders is too high, and listing all the values of all the stakeholders becomes an onerous task during design activities, we suggest consideration of at least the most representative stakeholders from each layer of the Stakeholder Identification Diagram. This assures that the different forces of information are being considered, reducing the risk of neglecting important issues related to values and culture in the project.

The case study presented in this paper was conducted with multidisciplinary teams and involved representatives from the target audience. We understand that this scenario is not always possible due to a wide range of factors. In this case, the artifacts are even more useful in supporting the professionals involved in the design context to see the design problem and envision solutions through the lenses of the different stakeholders.

Finally, although the artifacts have been explored in other contexts and a case study was presented in this paper, further studies with more participants, in different contexts, and that investigate the acceptance and use of the designed solutions as well as their impacts on different stakeholders are welcome. A future study about the constitution of the TNR social network, considering teachers' practices, interactions and shared values, as well as the impact of the system on their activities in the classrooms may contribute in this direction.

Other specific artifacts have been produced to support designers as a supplement to the artifacts presented in this paper: a table with 28 values that may be used as input for the artifacts, with each value containing a description, examples, and references; the Value Pie—an organization scheme presenting these values according to the three levels of the Semiotic Onion and the 10 areas of culture; and a set of questions and examples for each area of culture. Overall, we recommend that designers read the areas of culture and the complementary material, download the templates, and adapt the suggested steps for each artifact, because making sense of VCIA's principles and its artifacts is more important than the "correct way" of using them.

6. Conclusion

Literature on Human–Computer Interaction has indicated that, although there is an increased appeal for considering values and culture in interactive technology design, there is a lack of practical guidance for Computer Science researchers and practitioners as to how to address values and culture in design contexts.

In this paper, we introduced VCIA: a Value-oriented and Culturally Informed Approach to the design of interactive systems, which offers artifacts and methods articulated to support the consideration of values and culture in a design process. More than supporting the explicit consideration of values and culture, the artifacts contribute to design decisions and their representation, promoting reflection, discussions and insights in terms of solutions. This is especially important for professionals who need to bring social issues to their practice of interactive systems design.

Thus, VCIA is intended to disseminate the concern for values and culture in technology design, supporting professional teams in industrial as well as academic settings to conduct socially aware design. The approach has proven to encourage inquiry into emerging cultural values that are relevant to a particular design context.

As future research, there is an open space to experience VCIA in other design contexts, e.g., startups, practical projects in HCI teaching, elaboration of public policies, etc.; to investigate more artifacts and methods in support of designers and their activities; and to investigate issues related to values and culture from a formal perspective, looking for possible forms of organization, formalization and representation.

We expect VCIA could inspire other researchers and practitioners to build on, adapt, create new artifacts and methods, and share new examples produced from its application.

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