Interpretation Makes the Difference

Perceived Differences in University Students' Technology and User Interface Environments

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Abstract: Users' technology relationships, i.e., perceptions and understanding of technologies, affect how technologies are accepted and used. Thus, it is important to understand the technology relationships of potential users when new information and communication systems are designed. This paper describes the results of a research project in which university students' perceptions of their technical study environments were studied with methods of user-centered design. Based on the results of the research project, an analysis framework that recognizes three different abstraction levels people use when thinking about technologies is suggested. The abstraction levels are user interfaces, usage practices and interaction logic, and product philosophy and values. The analysis framework can be used to gather insights about users' technology relationships and to support or inspire design.

Key words: User-technology relationship, technology perceptions, user-centered design.

1. Introduction

Perceived usefulness and ease of use have a strong impact on the acceptance of information and communication technologies (ICT) [1]. In addition, more complex perceived properties and features such as how many others are also adopting the new ICT system affect the acceptance of the system [e.g., 2]. Since different people might have very different relationships with technologies, people can also perceive new technologies and solutions differently. In the case of ICT systems, the differences can be even more dramatic than with other technologies because of the nature of ICT. A common factor with the ICT is their enabling nature [3]. ICT systems and solutions enable information sharing and storing and communication between people but do not commit to specific communication partners or styles or even to specific information. Selecting for what to use the tools is left to the users.

On the other hand, the vagueness of ICT is also its strength. New uses for systems can emerge, and users can utilize the functions most useful to them and forget the others. However, this also means that users need to configure and adjust the ICT tools and knowingly or unknowingly define the meaning of the tools for themselves. This can result in situations in which the seemingly same devices and systems can have very different meanings and perceived functionalities for different people, and as a result, people operate in seemingly different technological environments. For example, Mannonen [4] reported a study in which IT maintenance employees with similar knowledge and expertise of the company's ICT solutions had different and partly contradictory opinions and feelings about the solutions. Different perceptions of ICT systems and devices can also cause problems when people are using the systems. For example, a study reported different opinions and understandings of ICT tools as one of the key factors leading to problems when distributed and mobile knowledge workers utilized the tools in online meetings [5].

Since people's perceptions of technologies impact both the acceptance of the systems and their actual usability, it is important to understand users' technology relationships when the systems are designed and developed. Understanding the users and their motivations, their tasks, and their needs is the basis for user-centered design (UCD) (e.g., [6, 7]). Thus, the UCD approach was selected for this study. This article reports the results of a study conducted from January through April 2009. In the study, a combination of a usability evaluation of and contextual interviews about a study and teaching portal of a Finnish university was conducted with 53 students. The study focused on understanding in what kind of actual and perceived technological environment students operate when managing their studies and how this understanding could be utilized when designing new systems and services for the students. Based on the results, a framework for analyzing users' perceived technology environments is suggested.

2. User-centered design and users' technology relationships

UCD emerged as a response to system-centric design traditions [8]. The aim of the UCD approach is to produce a holistic understanding of potential users of future designed services and products and to utilize the gathered knowledge in design (e.g., [6]). UCD activities should help to ensure that the needs, context of use, and users' other insights are taken into consideration and result in products and services that are easy, learnable, efficient, effective, and satisfactory to use, i.e., usable [9,10]. As user-centered design is based on gathering a holistic understanding of the users, a variety of methods and analysis frameworks have been developed to study the motivations, goals, tasks, and characteristics of the users. However, the role of technical devices and the overall relationships the users have with different technologies is not as well studied. One reason for this might be the historical burden of user-centered design of being the opposite force of technology- and system-centric design traditions. Users' technology relationship is touched on here and there in the field of user-centered design. The most relevant themes related to users' technology relationship are user classifications according to technological expertise, use of metaphors, acknowledgment and utilization of perceived affordances, and understanding of appropriation and adoption of new technical solutions. In addition to these research areas, the importance of users' technology relationships is also visible in usability evaluation and user research methods.

2.1 Technical skill levels of users

One traditional classification of potential users is based on their expertise. This classification separates novice, intermediate, and expert users. Depending on the case, the classification has been applied to general technical expertise or to more application- or system-specific expertise. Smith summarizes this skill-level-based categorizing by identifying three dimensions for skills, namely IT literacy, application knowledge, and system knowledge [7]. Though the classification describes the knowledge levels of users, the classification does not say anything about the perception that the users have of the technologies. Naturally, IT literacy can be seen as a skill to understand what the designers have meant with different user interface components and designs. However, as mentioned earlier, ICT products and services are characteristically vaguely defined. There is no one and only meaning for the product's user interfaces. In practice, this means that in many cases some parts of the user interface can be designed, for example, to help professional users to be very efficient in doing certain tasks and some parts keep in mind novice users and some other tasks. Thus, there might not be any correct or even realistic way to utilize the whole product and its user interface. Taking this into account means that the meaning of user interface literacy or expertise needs to be changed from understanding the designers' intentions to the ability to utilize ICT systems and solutions according to one's needs and tasks. A skilled ICT user is able to utilize the available ICT systems and solutions effectively to complete his or her tasks and goals. Thus, being skilled in using ICT systems does not require similar opinions and viewpoints about the systems with other skilled ICT users. In addition, from this viewpoint, the skills of the users are important information when new solutions are developed. However, categorizing users as skilled and unskilled does not necessarily produce the information needed for the design.

2.2 Metaphors and perceived affordances

Whenever metaphors and computers are discussed, the term "desktop metaphor" is mentioned. It has even been named as the most important reason for the success of the graphical user interface. Nowadays, the metaphor is, however, quite a contradictory concept in UCD. While many books and design guidelines still recommend utilizing metaphors when possible, some consider them over-rated and even harmful [11].

Metaphors mean describing and understanding one kind of thing or phenomenon in terms of another [12]. When discussing metaphors, Blackwell [11] defined (computer) user interface as "a representation created to help the user understand the abstract operation and capabilities of the computer." Thus, using metaphors in user interfaces means helping the user to understand the operations and capabilities of the technical system with terms and concepts from the field the users are familiar with. Put in other words, metaphors are a special design tool to guide users to perceive the designed system in the same way they perceive some other things (the source of the metaphor). The contradictory opinions about user interface metaphors as well as the success stories (e.g., desktop metaphor) and failures (e.g., Magic Cap[1] by General Magic), indicate the potential and problems relating to guiding users to perceive ICT systems in certain ways.

Affordance, or perceived affordance as it is currently called, is a kind of counterpart for the metaphor discussions. Norman [13, 14] borrowed the concept from perceptual psychologist Gibson [15] and introduced it to the human-computer interaction community. Affordances are relationships between the environment and the actor. At the user interface level, by affordances people usually mean mostly visual feedback that advertises the properties and possibilities of the system. The concept of affordance has raised a lot of criticism related to the generality of the definition, and to the possibilities of actually utilizing the concept in design work (e.g., [16]).

Perceived affordances and metaphors both link closely to how people understand technical systems. The terms also have the same problem of controlling people's perceptions. With metaphors, designers can try to explain certain aspects of the system to the users, and with perceived affordances, the properties and possibilities of the

[1] http://en.wikipedia.org/wiki/Magic_Cap

system become visible to the user. However, utilizing the concepts effectively is difficult unless one understands how potential users currently perceive the technologies they live with.

2.3 Adoption and appropriation of ICT systems

The ways new ICT solutions are adopted for use are complex and not easily predictable. Several different tools for managers and decision makers to predict the adoption of certain technologies in markets exist (e.g., Gartner's Technology Hype Curve and Moore's Technology Adoption Life Cycle Model). There are also more academic studies about the factors affecting the success of a company or organization in adopting new ICT solutions (e.g., [1, 2]).

The market acceptance of a product is not often in the hands of the designer. The ways the products are utilized are much closer to the design tasks. Quite a few analyses and models of the relationship of designers' intentions and users' actions and experiences exist [17]. In many cases, the design has been viewed as a communication between the designer and the user. At the practical level, the communication viewpoint is reduced to, for example, metaphor and affordance discussions. The communication models do, however, acknowledge the fact that the users might or might not interpret the designs as designers intended, and that the interpretations cannot be reliably controlled [17]. Since the interpretations are often made during the usage of the systems and solutions, in many cases of "misinterpretation," the users are in fact creating new purposes and uses for products.

Appropriation means taking something for one's own use, typically without the owner's permission. Dourish [18] has defined appropriation as "the way in which technologies are adopted, adapted and incorporated into working practice." Appropriation can include customizing technologies and using technologies in a way not intended by the designers. Appropriation is in a way a very concrete expression of the users' perception of the technology. Though appropriation happens during the use and separately from the design, appropriation can be incorporated into designs by, for example, restricting the users' possibilities of misusing or customizing the product or encouraging users to find new uses for the solutions.

2.3 User-centered methods for studying technology relationships

Users' technology relationships are usually analyzed in direct relation to the designed product or service. In UCD, the most focused analysis and research method of this kind is usability evaluation. At the general level, usability evaluations aim to improve the usability of the designed product by providing feedback from and about the users and usage context [9].

Usability evaluation methods can be classified in two dimensions: user involvement and implementation level of the evaluated system. The implementation level classification relates to prototyping discussions, e.g., high fidelity vs. low-fidelity prototypes. User involvement, as the name suggests, separates the methods that include genuine users from the methods that are based on some sort of expertise of the designers (e.g., heuristic evaluation and cognitive walkthrough). The methods involving users are of most interest when users' actual technology relationships are considered. Usability testing is perhaps the most widely accepted usability evaluation method involving real users. In usability tests, recruited users are asked to complete previously designed tasks and explain their thinking while performing the tasks. Usability tests focus on key tasks of the users and parts of the product that correspond to the tasks. The aim is to recognize the areas of the product that are difficult for the users as well as the areas that work well. Usability tests provide excellent information on whether the users understand the designers' intentions or not. However, the reasons for misunderstandings are more difficult to understand, and not all of the users' perceptions of the product are revealed.

In addition to usability evaluations, the users' technology relationships are also touched on during the user research phase of user-centered design. User research is an early phase of product development in which the user, organizational, and environmental requirements of the future designed product are determined. The need to take the technological context of the users into account during design and product development is widely recognized in UCD literature (e.g., [19]). However, the handling of technology is superficial. The tools and technologies of the users are often seen from an outsider's perspective, not from the user's. To understand the users' technology relationships, one needs to preserve the users' viewpoints during the information gathering and analysis phase.

3. The study: University students' technology environments

The study aimed to understand how university students perceive the different systems and solutions available to them to organize and carry out their studies. The university provides web-based tools for students to familiarize themselves with course selection, to enroll in courses, and to submit exercises and course reports as well as give feedback on courses and follow their overall study situation by monitoring their credits and grades. Traditional printed study programs were abandoned a few years ago in favor of electronic systems.

The study support systems consist of three main portals: a course enrollment system, a study and teaching portal, and a web-based learning environment. The course enrollment system allows students to create and maintain personal study plans, enroll in courses, and order transcripts of completed courses. The study and teaching portal is designed to be a communications medium from teachers to students. Teachers can, in addition to filling in the basic information about the courses, create events such as assignment deadlines and examinations and publish assignments, grading results, and other announcements. Students can select their courses and thus subscribe to course announcements, export course events to the students' own calendars, and of course have access to all course information in the system. The learning environment allows teachers to create workspaces for the courses. The workspaces enable dynamic information sharing and communication between the teachers and the students. For example, assignment reports can be submitted and discussion forums created.

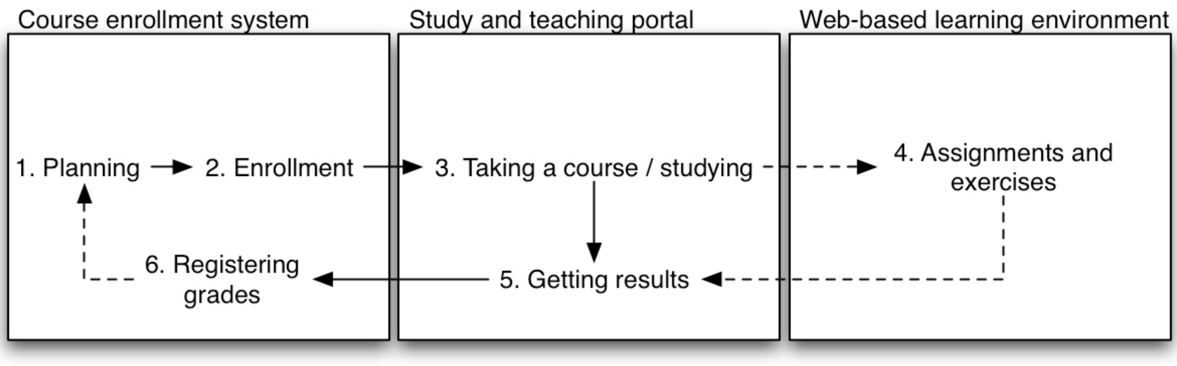

Figure.1 General studying process and its system support.

At the general level, the systems depict a process view of studying. The systems support a study process that starts with course enrollment and continues to carry out the course and to register grades and receive credits (see figure 1). The systems also follow this process in information distribution. The basic course information is gathered from the teachers and entered in the course enrollment system. From there, the relevant parts are automatically distributed to the study and teaching portal.

3.1. Research method

Since the aim of the research was to understand the students' viewpoints and perceptions of the study support systems, a combination of contextual inquiry and usability testing was selected as the research method. The research focused on the study and teaching portal, but the reasons for using the portal as well as the other systems linked to it were also studied.

Contextual inquiry is part of the contextual design method toolbox [20]. Contextual inquiry aims to gather deep insights of the studied users through observations and interviews that happen in the users' actual work context. During the interviews, the aim is to develop a master-apprentice model instead of interviewee-interviewer. On the other hand, usability testing can be conducted either in a real context or in laboratory settings that mimic the planned context of use. In usability tests, participants are asked to carry out certain tasks with the tested product or service while in contextual inquiry the studied users carry out their normal work and duties. Combining these approaches meant arranging a usability-test-like situation where the users were asked to perform their normal tasks. Therefore, the observed tasks and themes of the interviews varied, but the real usages and use contexts were better covered than in the traditional usability test. On the other hand, since especially planning studies is a somewhat irregular task, it would have been very difficult to arrange observations or conduct a contextual inquiry that focuses on those tasks. In a way, the method combination utilized Dix et al's [21] observation that focusing on users' tools and devices can be a good user research strategy if the tasks and working times are not easily predictable. The research was conducted at two sites: the usability laboratory and a normal workroom at the university. The artificial setting lost some of the contextual factors, but since almost all the information that the students utilize in planning their studies and participating in the courses is available online, the context of the interviews was not that different from the real usage context.

During the interviews, the students were asked to tell and show how they planned their studies and kept up with the courses they had decided to take. The students used their own user names and profiles when explaining their study habits. The interviews were videotaped for analysis purposes, but since the students shared personal information, strict confidentiality was promised.

3.1. Results

A total number of 53 students participated in the research. The students were participants in an undergraduate-level user-centered design course, and the participation was part of the course homework. Participation was not mandatory but one of six possible assignments of which the students had to select four to pass the course. The majority of the students were computer science or electrical engineering students, but some students were from other disciplines. As the university is a technical university, most of the students were males (72% of the participants), and since the course was an undergraduate-level course, the students were quite young (89% were under 25 years old) and in the early stages of their studies (mainly first- and second-year students).

At the general level, the majority of the students had a quite similar perception of the university's study-related web-services. The study and teaching portal was seen as the central component, and the enrollment system as an add-on that provided a communication channel with the university administration. The learning environment was seen as one example of computer supported co-operative work (CSCW) systems that could be utilized in courses. The students' view (figure 2) differs radically from the procedural view the systems seem to support (figure 1). In addition to the differences in the emphasis of the systems, the role of the learning environment is different in the students' viewpoint and in the goal stated by the learning environment system itself.

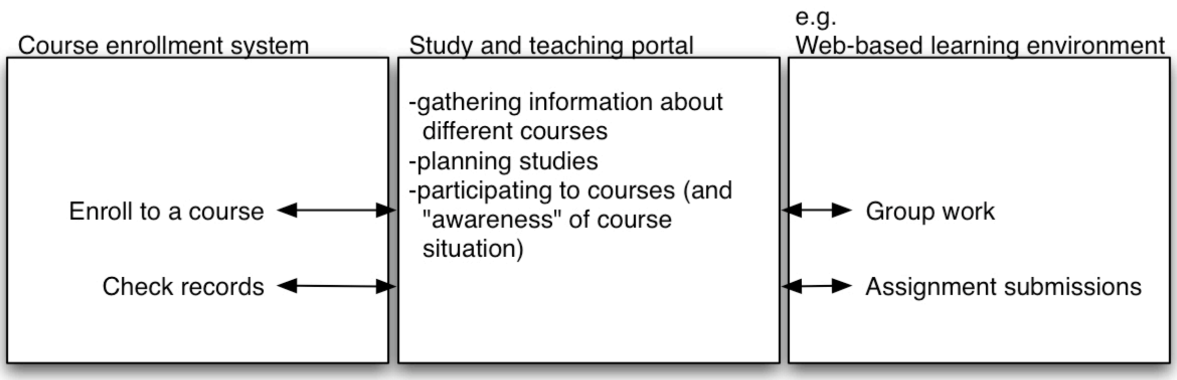

Figure.2 Students' perception of the university's study-related web-services.

Though the general view of the systems was quite homogenous, there were many different opinions and interpretations of the more detailed roles, goals, and intended usages of the systems. In addition, the usage practices differed significantly. For example, some, although a minority, of the students did not usually log in to the study and teaching portal. They had put links to the course home pages in their browser's bookmark lists or on their homepages, and some were not even aware of some of the services that the system provided for its registered users such as a homepage that combines the announcements of the courses students had enrolled in.

At the user interface level, there were some skill and knowledge differences among the students. These differences were mainly indications of differences in IT skills in general and of familiarity with the systems. For example, there were differences in how effectively the students were able to utilize the search engine of the system. In addition, there were some indications of differences in the students' technical knowledge. For example, only those students who had used RSS technologies beforehand recognized the possibility of subscribing to the course announcements as RSS feeds.

All in all, the students had both similar and diverse relationships with the technical systems provided to support their studies. The opinions and perceptions of the students seemed to touch the technologies and systems at different levels. Some opinions and perceptions related to the very concrete user interface level while others reflected the students' views of the university's motivations for providing such as system. Three distinct layers of technology toward which the students' opinions are directed were identified in the research: user interfaces, usage practices and interaction logic, and product philosophy and values. The next section explains these three themes in more detail and outlines an analysis framework for studying users' perceived technology environments.

4. Framework for analyzing users' perceived technology environments

Arguably, user interfaces are the only part of the products and services the users see and experience. However, the perceptions users have about technologies and technical products are not limited to the user interfaces. The university students had strong opinions about the reasons for the existence of some of the systems the students were expected to use during their studies. In addition, the students also had different opinions about the role of the systems and about the ways the systems should be used. As mentioned earlier, three distinct themes were identified from the students' opinions about the systems available for students to organize and carry out their studies. The themes depict different layers of the technologies. The layer viewpoint is similar to traditional technological viewpoints of information and communication technologies, e.g., to software architecture views. However, the identified themes or layers do not seem to follow the technical structures of the products and services.

In a way, the three themes (user interfaces, usage practices and interaction logic, philosophy and values of the product) depict different abstraction levels of the technologies from the users' viewpoint. The user interface level includes mainly visual parts of the product or service. In addition, there were some comments and viewpoints about other aspects of the products, e.g., help and documentation and support services such as training and maintenance. Usage practices and interaction logic include the ways the user interprets the designer's intentions on how and for what the product should be used. In addition, users have interpretations of the role of the product or system and how are the tasks divided between the system and the users. Product philosophy and values level means the users' interpretations of the values the product provides, the goals and the motivations of the product and its designers, and the philosophy the product promotes. Examples of the value interpretations are students' own definitions of the study support systems, e.g., "the study and teaching portal is the main system that provides a comprehensive view toward the course portfolio as well as the personalized view of the most relevant courses in one place."

Table 1 shows the identified technology relationship themes as one framework. All students had perceptions and interpretations of the systems used belonging to all themes. However, the perceptions differed from each other, and similar perceptions in one theme or level did not always mean similar perceptions regarding other themes. The technology relationship framework enables much more detailed technology skill and viewpoint-related user profiling than profiling just based on ICT skill level, application, and domain knowledge such as Smith's [7] classification. More holistic and deeper insights can guide the designs of new products and services in, e.g., metaphor selection, and help forecast the adoption and appropriation of designed products.

Table 1. Technology relationship framework.

Abstraction level	Examples of opinions and perceptions	Examples of design implications
User interfaces	"The structure of the information is the same everywhere. It helps a lot." "The search works well after you learn to use it."	Normal user interface design guidelines, e.g., be consistent, use the users' language, etc. In addition, all of the products surfaces, user interface, marketing material, shared user experiences/product reviews should be thought about during the design.
Usage practices and interaction logic	"I think that you can do this in many ways. I do it like this since it works well enough." "I never log in to the portal. I don't know what's the benefit."	Work division between the system, other systems, and users and how it is communicated to the users should be designed carefully.
Product philosophy and values	"The study and teaching portal is no. 1, others are just extensions."	The mission of the system or product should be comprehensible and fit to the users' ways of acting and thinking.

5. Conclusions

People's relationships with current technologies and technical development have a huge influence on how new technologies are understood and used. The acceptance, adoption, and appropriation of new technologies as well as the perceptional characteristics of humans, and, for example, the potential of metaphors in user interface design have been studied a lot. However, a more holistic viewpoint of users' technology relationship is currently missing and greatly needed.

A study of university students' perceptions of their technical studying environments and especially of the study support services revealed that students have varying opinions and interpretations of the technologies. The opinions and interpretations cover different abstraction levels of the technologies in question. Three abstraction levels were identified: user interfaces, usage practices and interaction logic, and product philosophy and values. Based on this, an initial technology relationship framework consisting of these abstraction levels is suggested. The suggested framework provides more detailed and comprehensive analysis possibilities for studying people's technology relationships than the traditional skill-based categorizations.

Since the framework is a draft based on just one study, the framework should be further developed and tested with additional studies. It would be especially interesting to try and test the explanatory and guiding power of the framework, i.e., how well the framework explains different phenomena related to users' technology relationships and what kind of insights and inspiration the framework provides for designers.

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