On Explaining Intuitiveness of Software Engineering Techniques with User eXperience Concepts

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Abstract

This paper attempts to explain intuitiveness of software engineering techniques with user experience (UX) concepts. It describes a model of relationships between intuitiveness of software techniques and refined understanding of UX for software technology.

It covers both intuitiveness at the starting point and the dynamics of transforming episodic UX to cumulative UX and perception of intuitiveness. Then, it discusses potential application of this model. Finally, it presents examples of explanations resulting from the model.

Author Keywords

Intuitiveness; user experience; UX for software engineering; software engineering techniques

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

K.6.3 Software Management: Software process.

General Terms

Human Factors
Management

Introduction

The term *intuitiveness* of software engineering techniques is used to describe a quality feature of the techniques which are expected to be easier and more useful than similar techniques. Related concepts include: naturalness, fit to cognitive processes, usability of software technology, features such as neat, easy-to-learn and easy-to-apply as well as effective and efficient. Software engineering (SE) techniques are used for a purpose (not just for fun). Furthermore, as SE tasks deal with analysis, problem solving and decision making, they require some intellectual effort and they seldom are easy. Intuitive techniques can better support performing these tasks than those which are not intuitive. The problem is that there is no precise definition of intuitiveness. Thus, claims about intuitiveness can be realistically viewed as good wishes of techniques designers, statement of the intuitively made efforts in this area or promotion tricks.

The goal of this research is to explain intuitiveness of software engineering techniques with concepts from user experience area. This idea is based on the observation that intuitiveness is based on associations which people make in their minds. The associations must be made to something they "have". And most of the concepts, which people have, are based on several kinds of their experience.

This work started with analysis of intuitiveness of software models, especially domain-specific models (DSM)[3]. DSMs are designed by DSM designers for a given domain in a given company. They are influenced by several technical constraints related to automatic generation of code and other artifacts, but DSM designers have a certain level of freedom when defining them. The issue of intuitiveness comes into play when they want to make their DSM easy to use by software developers who might have experience with other models, but they must learn the DSM as a new type of models. Later, we have realized that the results are universal to other software engineering techniques as well. We can observe an evolution of software engineering techniques which adjust to changes in context including the need to develop new types of applications, increasing size of software systems and emerging new technologies.

This paper is structured as follows. In the second section we present UX concepts which constitute the background of this research. In the following section we describe a model of relationships between intuitiveness and experience both at the starting point and during the time of dynamic changes of experience. Then, we discuss issues related to application of this model. After that, we present examples of explanations of selected phenomena given by this model. In the last section we draw conclusions.

Background

Unfortunately, the term *user experience* hasn't got yet one clear definition. There have been collected twenty-seven definitions of UX [5] which are based on different assumptions or backgrounds. Some of them extend the area of interests of usability engineering, others are based on designing customer experience with products or services, yet others focus on emotions, motivations and values. The following characteristics appear in several definitions:

- Focus on general feelings and overall perception rather than specific aspect of experience;

- Motivations, emotions, feelings, satisfaction rather than efficiency and cognitive processes;
- Total fit of products to users in context including expectations, internal state and environment (relationship between user and product);
- Dynamic changes of UX over time;
- Multimodal specifics which needs to be handled with integration of services of multiple disciplines.

The lack of agreement on the concept underlying the term UX was demonstrated also during the workshop which was trying to work out UX Manifesto [2]. Assuming the following dimensions, UX can be viewed: both individual and social, both reductive and holistic, both quantitative and qualitative, both for evaluation and for development, and both work-based and leisure-based.

Another differentiator of experience reality is related to time [6]. One can focus on anticipated UX (before usage), momentary UX (during usage), episodic UX (reflecting on an experience after usage) and cumulative UX (recollecting multiple periods of use).

In this situation, a practical approach has been proposed by researchers who work on the edge of UX-SE [4]. They suggest the following actions: defining UX, modeling UX, selecting UX evaluation methods and describing the interplay between SE-UX methods.

This short overview can be summarized as the need to distinguish between several kinds of UX and the need to refine UX for precision in a specific research.

Model of Intuitiveness Based on Experience

This model refines UX understanding and describes relationships between experience and intuitiveness. It is made on the bases of the following assumptions:

- Intuitiveness of a software engineering technique at the starting point is based on general experience with similar methods, general knowledge, domain knowledge and overall personal attitude;
- Intuitiveness changes dynamically;
- Intuitiveness is influenced by experience related to this technique;
- While experience may be positive or negative, the term intuitiveness is defined as positive;
- The model of relationships between intuitiveness and experience should keep a compromise between the power of explanation and practical usefulness (we cannot monitor and control all aspects of individual human experience and thus we need to make reduction to the most important factors.)

The model consists of the following parts:

- structural components of the model;
- dynamics of change when gaining a new experience.

The structural components of the model are presented in Figure 1.

Experience (user experience) is a kind of generalization of experience in its sub-components of cognitive processes, emotions, motivations and actions. A single event or action generates episodic experience

with diversified intensiveness in the dimensions of its sub-components. The sub-components might even contribute in a contradictory way (positive impact vs. negative impact.) The sub-components are similar to forces which shape final experience of this event or action. In fact, individuals might have different experience from the same event or action depending on their personality.
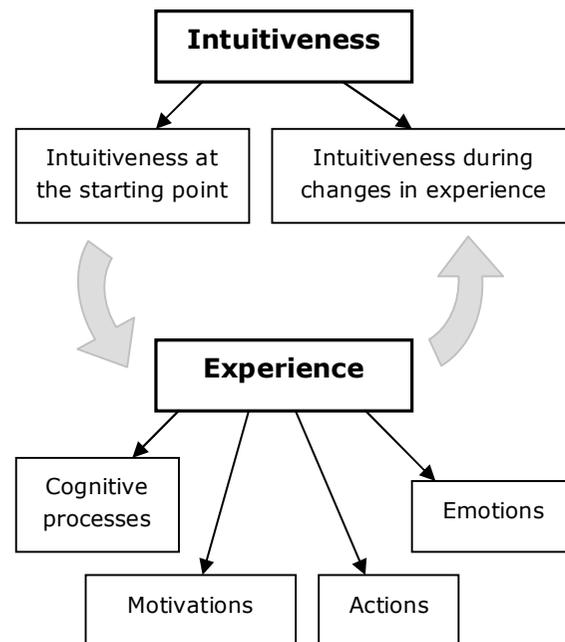

Figure 1. Components of the model

The experience in this structural view covers all kinds of experience in time. However, during the dynamic analysis there is a need to distinguish between:

- pre-experience – experience with similar products or phenomena at the starting point of using a given technique;
- episodic experience – a piece of experience related to an action with a given technique (related to momentary and episodic experience in [6])
- cumulative experience – generalization of pre-experience and all pieces of episodic experience (similar to cumulative experience in [6]).

Cognitive processes are related to knowledge and information processing. The phrases which are related to this perspective are 'I know it, I understand it, I know how to do it'. It covers learning, thinking, reflecting after action, explaining how something works, understanding patterns of action, etc.

Emotions are related to positive or negative attitude when gaining some knowledge or making an action related to work with a given technique. The phrase which expresses it best is 'I like it'.

Motivations cover positive expectations related to a given technique and beliefs that the expected benefits will be achieved. The following phrases express it well 'I want to make it' or 'It's good to make it'.

Actions deal with experience of work with a given technique and the results which are achieved. The phrases which give feeling of this perspective are 'I have made it', 'It's useful', 'Brilliant. Well done.'

Cambridge dictionary defines the term of *intuitive* as *based on feelings rather than facts or proof*. Intuition has a special role to play when someone is exposed to a new situation, especially when the facts are missing and some kind of action is required. **Intuitiveness** of a technique deals with the perception of the technique in novel situation, e.g. using a new technique, modeling a new system, solving a new kind of problem. It assumes the circumstances in which users do not know details of action or solution and they must use their intuition to guide the work (which is a common characteristic of circumstances in software projects). Intuitiveness can viewed as:

- **Intuitiveness at the starting point**, which is related to the first attempt to use a given technique. This kind of intuitiveness results from both affect (first glance appearance) and pre-experience;
- **Intuitiveness during changes of experience,** which is related to dynamic changes of experience caused by actions or external events. It can be traced with the impact of episodic experience on cumulative experience.

The model of **dynamic changes** works as follows. Pre-experience has impact on intuitiveness at the starting point. The intuitiveness at the starting point has impact on motivation for learning, attitude to a given technique (emotions), results of learning (cognitive process) and results of actions (action). Positive experience makes a subjective increase of intuitiveness while negative experience causes subjective decrease of intuitiveness. Although this experience is overall, we ought to explain the impact of

sub-components of experience on intuitiveness. When users are familiar with a technique and they know how to use it (cognitive processes) they feel the technique is intuitive. On contrary, unknown and subjectively difficult techniques make impression of unintuitive. When a user has positive attitude to using a given technique (emotions), the work goes easier comparing to another user with similar knowledge and negative attitude. It makes a difference in subjective feeling of intuitiveness. In similar way, the level of motivation differentiates the attitude to work, especially when trying to solve difficult problems and overcoming obstacles on the way to successful solution. Finally, easy and successful actions with brilliant results increase belief that a given technique brings expected results (motivations), positive attitude (emotions) and knowledge of this technique (cognitive processes) which makes a positive impact on subjective feeling of intuitiveness. On the other hand, actions which were not completed, caused many problems and gave poor results contribute negatively to both cumulative experience and intuitiveness.

Application of the model
When attempting to apply this model several additional issues arise. What are areas of application and how can we describe the context of use? How can we operationalize intuitiveness in terms of variables and methods?

Analysis of applications of intuitiveness can be framed in the typical-to-management actions:

- Planning the actions which allow for achievement of goals (and related benefits) - analysis of potential

benefits which can be achieved with monitoring and controlling intuitiveness,

- Monitoring - assessment of intuitiveness with appropriate variables and methods,
- Control - impact on software engineering techniques during their design or impact on user experience in terms of training, support for action, emotions and motivations etc.

The most popular goal related to the application of intuitiveness is the design of intuitive software techniques, e.g. intuitive DSM. It requires knowledge of inter-subjective perception of the technique and the changes of intuitiveness over time, thus it is not an easy-to-fulfillment goal. Another goal can be related to the proper selection and configuration of the software process with the techniques described in literature. It is worth to mention that the same technique can be intuitive in one process and unintuitive in another. Thus, intuitiveness depends on circumstances of use of a given technique. Focus on developer experience and intuitiveness of action can supplement the practice of defining software process. Next benefit can be achieved when having defined software process one wants to provide right experience to software developers in terms of training, support and challenges. This goal deals with subjective intuitiveness framed in the pattern of inter-subjective process. The model of intuitiveness and experience can be applied also in a very subjective context. Having a new team with diversified pre-experience, it allows for analysis of reasons of misunderstandings and actions towards better understanding. In case of problems with the use of a technique, which is based on previous, similar techniques, it allows for planning a corrective action, e.g. extra training and explanations.

Monitoring intuitiveness and experience requires both quantitative and qualitative methods. In the most simple case, one can ask for subjective assessment of intuitiveness in percentage scale (0 stands for unintuitive technique and 100% - for maximum of intuitiveness). It is a great measure to trace intuitiveness over time, but it has a little value to drive actions. In this situation probably the most intuitive complementary question is *why* someone has given this value in assessment. (An example of answer could be the statement that some elements of a notation are easy and neat while others are strange or useless. We use abstract term of the technique which, in fact, consist of several elements and rules how to use them.) This simple qualitative method of collecting opinions and reasons brings a very important benefit. It allows to discover main factors that need further analysis. Then, these factors can be analyzed in perspective of the sub-components, including enhancement with more precise models. The final goal could be quantitative modeling of the variables related to the experience and intuitiveness with formulas which allow for calculating intuitiveness on the basis of values of selected indicators. It could allow for predictions of intuitiveness. In my opinion, the regression model is not sufficient to describe precisely this phenomenon.

One might notice that when we have analyzed the dynamics of changes we have spoken in terms of personal experience and subjective feeling of intuitiveness. The question is whether we can generalize it to overall intuitiveness of a given technique? In general, this is the issue of transforming individual (subjective) to social (inter-subjective) intuitiveness and experience. Having noticed the differences in pieces of experience among individuals

with regard to specific sub-components, we can predict that the overall experience of persons in similar context (goals, tasks, pre-experience) will be similar.

One could ask about relationship of this approach to research on intuition in software development [1]. Both of them tackle phenomena related to mental (often subconscious) processes called intuition, which are outside of methodological procedures and guidelines. Both deal with issues of immediacy, evolution over time and inter-subjectivity. The difference is in focus. The work on intuition in software development deals with intuition understood as immediate apprehension by mind without reasoning, immediate insights, constructivist approach or phenomena related to guesswork and trial-and-error actions in software development. On the other hand, intuitiveness is related to perception of a given software technique based on experience of software developer. It is easier to capture in frame of time and context (goals, software technique, related experience). In my opinion, these approaches are complementary. The work on intuitiveness of software techniques suggests the source of intuition in experience and explains the changes of intuitive process (or intuitiveness) over time with the idea of gaining new experience. On the other hand, research on intuition can provide means of analysis of intuitiveness in the perspective of kinds of intuitive actions in software development.

This analysis of application confirms that the topic of intuitiveness based on experience includes issues which are both quantitative and qualitative, both individual and social, both reductive and holistic. Additionally, it shows that the context of application cannot be ignored.

Examples of Explanations

As a reflection on the value of this approach, let us discuss examples of explanations which can be inferred from the model of intuitiveness based on experience.

The impact of pre-experience on the intuitiveness of a given technique can be analyzed in the dimension of all sub-components. The following examples illustrate this phenomenon. First, release of an immature technique with related tools and their good promotion might cause the perception of low intuitiveness of this technology in future. Second, the analysis of the impact of similarity between the rules or artifacts in a newly defined model (DSM) and the rules and artifacts developers are familiar with, can be extended to design of nice, aesthetic, motivating experience when modeling.

Overall nature of human experience means that external factors may have impact on intuitiveness of software techniques. The following examples illustrate this phenomenon. First, the quality of training including emotions has impact on the perception of intuitiveness. Second, overall morale in software project team has impact on perception of intuitiveness of a given techniques. Third, missing usability features during actions, e.g. difficulties, obstacles, misfit with the users goals, defects etc., cause negative overall experience and decrease of intuitiveness.

To sum up, while the impact of previous cognitive experience is not a surprise for the designers of software engineering techniques, the suggestions resulting from the overall perception of experience are not explored in the literature so far.

Conclusions

In this paper we have made the attempt to explain intuitiveness of software engineering techniques with user experience concepts. We proposed a model which defines relationship between intuitiveness and refined understanding of user experience as well as dynamic changes of intuitiveness with the changes of experience. We have also discussed its application.

The value of this approach is in the integration of the sub-components of experience (cognitive processes, emotions, motivations and actions) although for the reason of necessary reduction they separately are not very detailed. For example, we use abstraction of emotions as strength and direction (positive vs. negative) while in reality there are a few basic emotions and a few dozens of shades of emotional states with the rules of their dynamic changes which in general analysis are additionally influenced by culture. We speak about cognitive processes in general while these processes can be of several kinds, e.g. descriptive or operational knowledge, beliefs based on opinions or reflections upon the experience of use. This approach sets up a framework where simplified components can be replaced with more precise sub-models when needed. The analysis of application shows that we need to deal with issues which are both quantitative and qualitative, both individual and social, both reductive and holistic.

This framework would definitely benefit from underpinning the evidence from psychological theories and defining more precise ways of operationalization in terms of both quantitative and qualitative methods. It is worth to check which UX methods are suitable for collecting and processing data about experience related to intuitiveness. Transformation between individual (subjective) and social (inter-subjective) experience and intuitiveness is the next dimension which might be the subject of further work.

This research provides a way of understanding intuitiveness of software engineering techniques which contributes definitely to the state of the art in which intuitiveness has been an equivalent of good wishes or intuitive efforts of the designers of software engineering techniques. This model can constitute the basis for more advanced research as well as trials of more mature design of software techniques in practice.

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