Towards a Situated Model of Sustainable Software Appropriation

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ABSTRACT

This paper describes HCI research conducted at Interaction Design Lab of Institute of Informatics, Tallinn University towards a situated model of sustainable software appropriation. The overall question of the proposed research is how to cater for software sustainability by designing for software appropriation? In this study we are interested to know if and how interaction design can ensure the sustainability of software solutions by introducing appropriation signifiers in them that allow users to adapt the software according to their needs. In the proposed model, users engage in appropriative behavior that allows the proposed software solutions to evolve through time while meeting the changing needs of the users. Our paper describes a study aimed at developing and validating this model situated in the public schools of Estonia.

Author Keywords

Sustainable interaction design; software sustainability, interaction models; appropriation; appropriation support.

ACM Classification Keywords

H.5.m. Information interfaces and presentation: User-centered design.

General Terms

Human Factors; Design.

INTRODUCTION

Pervasive technological advance of the last decades has created a world where computing artifacts are produced, consumed and obsolete at a rapid pace [14]. Thus, reduced and prolonged resource usage and disposal concerns are central issues that are addressed today by the wider scientific computing community, including HCI. In their review of Sustainable HCI, DiSalvo at al. have outlined several sustainability genres with the claim that there is replication of effort in the approaches to sustainability in HCI and that research needs to tackle on expanding and building on the achievements of the past, establishing connections between Sustainable HCI and other technical fields and fostering discussions and debate among different approaches within the field [8].

One of the genres of Sustainable HCI, Sustainable Interaction Design (SID) addresses sustainability from the perspective of designing interactive artifacts [3, 4, 5, 6]. As such, SID can be understood as a critical lens for analysis of existing technology known as "design criticism" and as a set of guidelines to inform the creation of new technological artifice, including digital artifice, known as "critical design" [3]. For both approaches, SID proposes a set of sustainable design considerations, which include understanding of the effects of introducing new solutions on existing artifacts, considering the possibilities of renewal/reuse of existing solutions, and considering quality as a construct of longevity [4].

This paper suggests addressing SID considerations from a sustainable software design perspective. We believe that software sustainability, although discussed briefly in the seminal work of the SID discourse [4], has not been addressed by the Sustainable HCI community in depth. Meanwhile, software sustainability has been in the radar of software engineering [19]. Academic work on software sustainability in software engineering, however, lacks an exploration of how interfaces and signifiers can be designed to contribute to the sustainability of software (an HCI agenda). Thus, sustainability of software solutions has not been addressed from the software interface design perspective with the value based notions of SID. We aim at addressing this gap by a research study with an appropriation-enabling design approach [1] for educational settings, namely public schools of Estonia.

PROBLEM STATEMENT

As government expenditures are planned to increase the number of e-textbook solutions in Estonia, the sustainability effects of the supporting software and their impact on target populations (students, teachers) remain underexplored. Without addressing the sustainability dimension, the proposed solutions may soon become outdated and obsolete, with the need of costly software maintenance and increased procurement costs. The general problem described above is admittedly too broad to tackle with this research thrust. However, our research goals have a narrow focus in that they aim to provide contributions towards the solution of this general research problem from an HCI

perspective. Specifically, we aim to tackle the sustainability of the e-textbook solutions for public schools of Estonia from the perspective of interaction possibilities of the solutions. Thus, a narrower research problem for this proposal is the non-sustainability of e-textbooks to be used in educational settings of Estonia, specifically as related to interaction possibilities enabled by the interfaces of the solutions.

RELATED WORK

Among other questions, SID research aims to answer how interaction designers can promote prolonged use by motivating "long term use of physical materials by a single owner", creating "artifice of long-lived appeal that motivates preservation such that transfer of ownership preserves quality of experience" and "achieving heirloom status" [4]. Research in this direction has tried to understand how people make decisions on keeping vs. discarding artifacts. This discourse aims to study psychological ownership and the process of relationship-building with artifacts, to inform or inspire sustainable interaction design for prolonged use.

Research in the SID discourse has tried to understand the factors that create attachment to technological artifice to design for such characteristics that strengthen the attachment by incorporating the desired attributes in the solutions.

For example, phone ownership and replacement decisions were studied through a web survey followed by in-depth interviews with some of the respondents [11]. Another study in SID used a repertory grid to explore dimensions of attachment to digital and non-digital artifacts [18]. Adoption practices of previously used personal digital assistants (PDAs) were studied through phone interviews with targeted respondents [12]. Relationships with artifacts were explored through in-situ in-depth interviews in households [16] and in home contextual interviews exploring attachment to artifacts [17]. Further, Gegenbauer and Huang (building on Odam at al.'s framework of attachment categories [15]) conducted a personal inventories study and analyzed the influence of their framework on the design process of new technologies [10].

Thus, the SID discourse has employed mainly qualitative studies, including contextual inquiry and has evolved around ownership attitudes and the notion of attachment to artifice. The qualitative research approach is natural given the largely exploratory stage of research in SID and the need for an in-depth understanding of user actions, choices and attitudes related to sustainable use and reuse. However, we propose that the understanding of ownership and attachment are not sufficient for SID and that other, more pragmatic and situated solutions are necessary to achieve sustainability gains.

Further, explorations of attachment to digital artifacts mainly included the physical artifacts, not focusing on the

software that runs on them. The papers discussed above that aimed to study the attributes which promote attachment to artifacts have also established relationships with the notion of appropriation. Moreoever, prior research has already discussed how appropriation as an ongoing practice can be leveraged for SID [13]. However, the main focus of these explorations has been the design for appropriation and re-use of physical artifacts.

PROPOSED APPROACH

Before we start a description of our proposed study, we need to convey a clear and unambiguous understanding of sustainable software appropriation. To this end we will now define software appropriation and then add the notion of sustainability to that definition.

Software appropriation is the overall process by which users incorporate software into their everyday activities, including tailoring or repurposing it to suit their unique needs. Thus our definition of software appropriations builds on a widely adopted definition of appropriation in HCI [9], but constraints it to the adoption and repurposing of software artifacts.
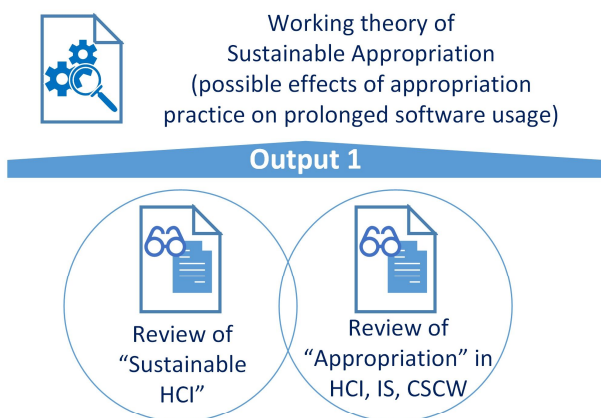
Further, we currently define *Sustainable Software Appropriation* (SSA) as the practice of software appropriation which results (either purposefully or indirectly) in prolonging the useful life of software solutions.

Research goals

The two main goals of our study are to develop (goal 1) and validate (goal 2) a model of sustainable software appropriation in basic and secondary schools to inform the development of e-textbook solutions in Estonia. To meet these two consecutive goals we plan to undertake a two-stage study.

During the first stage we propose to develop a situated model of SSA in Estonian basic and secondary schools. This situated model will be comprised of two working theories. The first working theory will be based on a literature review and will concern practices of appropriative behavior that end-users engage in and which may result in prolonged software use (see Figure 1). The second working theory will be based on a contextual inquiry study and will identify possible factors that influence prolonged e-textbook use in Estonian basic and secondary schools (see Figure 2).

During the second stage we plan to validate the SSA model by exploring the relationships of appropriation-enabling attributes of interfaces to perceived software sustainability. This will be achieved by incorporating the recommendations of the situated SSA model into the e-textbook solutions and validating the model by exploring its perceived benefits for sustainability gains (see Figure 3).

Working theory of
Sustainable Appropriation
(possible effects of appropriation
practice on prolonged software usage)

Output 1

Review of
"Sustainable
HCI"

Review of
"Appropriation" in
HCI, IS, CSCW

Q1. What are the relationships of appropriation enabling features to prolonged software usage in the context of Human-computer interaction?

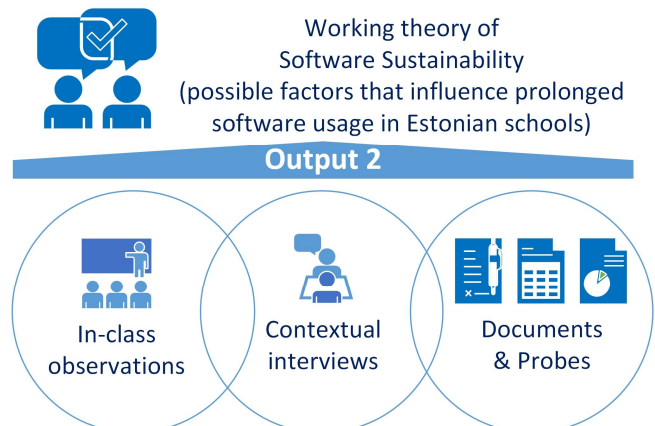**Figure 1. Research question and activities for output 1**

We propose that practice of digital appropriation occurs during a process we call appropriative interaction, which is the actual process during which the users engage with software in ways that build their own understanding and practice of possible uses of the software, including its tailoring, customization and reconfiguration for current and evolving needs.

With our first research question (Figure 1), we are interested to understand how academic knowledge about the practice of appropriation can help us design interactive systems and services that promote appropriative interaction for sustainability gains. To tackle this issue, we will resort to literature on appropriation (which has addressed challenges for creating appropriation enabling technology) and to Sustainable HCI literature (which has addressed how HCI can be involved in solving sustainability).

The second research question is related to understanding of the settings and the needs for the proposed solutions, specifically the general phenomena that might promote or hinder prolonged e-textbook use in basic and secondary schools of Estonia (see figure 2).

In trying to ensure the prolonged use of e-textbook solutions in Estonian public schools, one important aspect is to understand and be able to explain what perceived factors may have an impact on e-textbook sustainability, for which a contextual inquiry approach has been chosen.
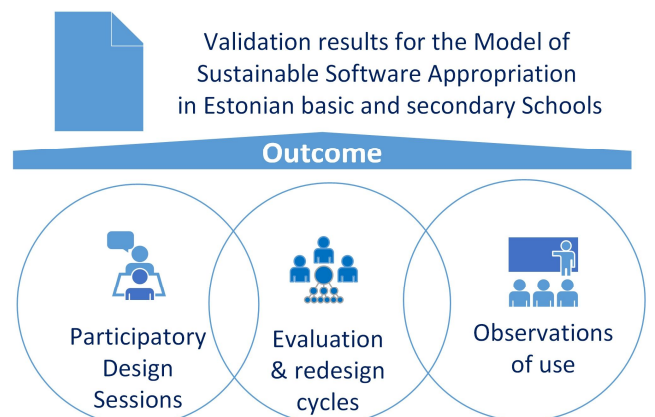
Thus, the distinct data sources to be collected and analyzed throughout the study. are a) observations of classes where technology is to be used, b)contextual interviews with educational specialists on possible uses of the e-textbooks in their work and c) current samples of artifacts including the documents and probes already used in the foreseen interaction settings.

Working theory of
Software Sustainability
(possible factors that influence prolonged
software usage in Estonian schools)

Output 2

In-class
observations

Contextual
interviews

Documents
& Probes

Q2. What phenomena might promote and hinder prolonged e-textbook use in basic and secondary schools of Estonia?

Figure 2. Research question and activities for output 2

We plan to research the two working theories discussed above independently and then merge them in a model of sustainable software appropriations. From stage of the study, we plan to derive a set of proposed appropriation-enabling attributes of interfaces that may be beneficial to software sustainability. Further, these appropriation-enabling attributes will be tested in evaluation and re-design cycles of the e-textbook solutions aiming at the validation of our proposed model (see Figure 3).

Validation results for the Model of
Sustainable Software Appropriation
in Estonian basic and secondary Schools

Outcome

Participatory
Design
Sessions

Evaluation
& redesign
cycles

Observations
of use

Q3. What is the relationship of appropriation-enabling attributes of interfaces to (perceived) software sustainability in Estonian schools?

Figure 3. Research question and activities for Outcome

Our approach thus incorporates both *design for* and *design from* appropriations proposed by Carroll [7].

DISCUSSION

To tackle the problem of software sustainability, we propose the introduction of appropriation-enabling features

that may contribute to the continued use and reuse of educational software. By proposing this solution, we assume that software interfaces are related to the sustainability of the technologies used in education and that they can have an impact on their longevity. Our approach to developing and communicating an understanding of the studied phenomena is largely pragmatic. The study involves components of theoretical research (literature review on sustainability and appropriation), empirical research (contextual inquiry on software sustainability) and action research (participatory design, evaluation and redesign of software interfaces). Further, by conducting an in-situ contextual inquiry study in the first stage, we pursue a socially constructed knowledge claim to understanding the studied phenomena [2], rooted in the views and approaches of the target populations and our interpretation of them.

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