Learning-in-use: An Experiential Perspective on Learning in Interaction Design Research

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ABSTRACT
Learning-in-use analyzes users' learning experience with interactive artifacts. Learning-in-use is enacted under four conditions, such as through the development of personally meaningful relationships with artifacts, the changing of those relationships, the negotiation of those relationships within use, and the engagement of users with their artifacts. This article describes the theoretical background for learning-in-use and an experiential, longitudinal study. In this study, the authors interviewed and observed users about their learning experiences over the course of five months. This observed data revealed four characteristics of *learning-in-use*: *grasping, situating, perceiving-in-use,* and *making meaning*. Learning-in-use re-conceptualizes learning in interaction design moving beyond knowledge gained in learning to incorporate the learning experience.

Author Keywords
Learning, experience, phenomenology, interactive, artifact

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H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Learning how to use new interactive artifacts is a complex and difficult task for most people. While early efforts in the study of learning to use artifacts led to improvements in usability—for instance, [3] have shown the manner in which a computer system provides help to users influences how effectively those users can learn the system—there are still many other perspectives from which to consider learning to use new artifacts. Another perspective considers the transformation in use of one author's experience with an iPod Nano. Among the many factors the author dealt with, he negotiated with well-defined procedures for ejecting the iPod before unplugging, accessing data on the iPod only through iTunes, interface differences due to a familiarity with Windows products, and learning how to alter unwanted default settings.

These situations forced his interaction to deviate from initial expectations and led to a rather contentious relationship at first. However, he was able to work through these problems and gradually learned how such an artifact might come to fulfill the expectations in different ways. This learning-in-use required a re-orientation. Within his currently stable use of the iPod, his patterns of learning and use crystallized into a habituated style of interaction. This example details that while usability problems may exist with the artifact, there is a rich experience the author went through involving the brand, his expectations, and quirky though not necessarily unusable aspects of the interface and Apple policies.

The work of various authors in interaction design [2, 13, 14] provides a basis for such issues by studying learning as it evolves under its own constraints. We extend this study in learning how to use interactive artifacts by analyzing the learning experience as it evolves during use. Four conditions are necessary for learning-in-use to occur. First, this experience occurs over a lifetime of use. Second, two users in similar situations may experience the same artifact differently due to varied motivations and prior experiences, contributing to different personally meaningful relationship with artifacts. Third, these qualities are not designer-driven, but rather emergent as users negotiate given their own unique circumstances, histories of experience, and motivations to learn the artifact. Finally, users must be actively engaged with an artifact for learning-in-use. Users cannot passively let the experience happen.

In this article, we will identify learning-in-use through the four conditions we described above drawing on theory in phenomenology, embodied interaction, and learning theory to gain new insights on this problem. Next, we will describe the longitudinal study in which we observed users' learning-in-use. We will then describe the findings from the study through a number of codes revealed in the interview data. Next, we will introduce four new characteristics emerging from re-organizing the codes and implications these phenomena have on design. Finally, we will discuss

future research on learning and design of interactive artifacts we see evident in the findings.

IDENTIFYING LEARNING-IN-USE

We identify learning in this article by going beyond the common concept of learning as knowledge gained. There is a great deal more going on as a person learns to use an interactive artifact. One factor is the experience one has in relation to that artifact. Forlizzi & Ford [7] define this experience as a "constant stream that happens during moments of consciousness" [p. 419]. It does not exactly constitute knowledge, although it can assist the development of knowledge about an artifact. Nonetheless, there are uniquely defined experiences unique to the individual user and the particular interactive artifact occurring in use.

We identify the integration of these learning experiences as learning-in-use. Learning-in-use can be understood as the relationship developed by a user over an interactive artifact's lifecycle where how an artifact is perceived, used, and incorporated into one's life changes through different periods of use. The relationship one has with an interactive artifact can be caring, distrustful, engaging, purely functional, or even invisible to the user. These perceptions, while experienced by the user, are co-shaped by both user and artifact. The user may have certain motivations, needs, and expectations about a learning experience, but there is no guarantee the artifact will satisfy all of these. Alternatively, the artifact may surpass all and create a uniquely meaningful experience for the user.

Learning-in-use emphasizes the user's learning experience, which develops 1) in personally meaningful ways, 2) over a lifetime of using interactive artifacts, 3) through negotiation in use with an artifact, and 4) through engaged interaction. These are the four conditions for learning-in-use.

First, these experiences are filled with personal meaning developed through one's use. Users learn how an artifact is directed toward some goal and how it is meaningful for them given those contexts of use. Dewey [5] argued for the peculiarity of experiences, which tied the learning experience to the perspective of the learner. Nagel [11] ties subjective experience to consciousness. According to his argument, to understand what it is like to be something—such as a bat—we can only project our own experiences on what the internal world of a bat must be like. Likewise, each learner goes through their own process of learning that is unique and personally meaningful. When considering this personal meaning for an interactive artifact, it means that artifact takes on different role if the user is upgrading from a previous version of it, has used a similar artifact but not this one, or has never used any artifact like it before. Users' personal histories, prior experience, and general knowledge all affect this relationship.

Second, with respect to the time of use, a longer period of use of an artifact does not guarantee they will learn more about an artifact. Rather, over the course of time, through shifting contexts, individual needs, and styles of use, user experiences will be inherently different. Looking at just one point in time in individuals' use could miss aspects of the bigger experiential picture. While initially a user may be excited to play with various features, they may eventually stop exploring the artifact and use it in essential ways to accomplish everyday tasks. A key component of Husserl's phenomenology was that experience, while occurring moment-to-moment, existed in a series of these connected moments [10]. We are able to make sense of the world around us because it is largely invariant over time. Dewey [4] describes how learning helps one deal with a world that is largely the same, but does have a changing characteristic. Finally, Pohlmeyer, Hecht, and Blessing [15] have devised a model for accounting for shifting contexts and use over time through the User Experience Lifecycle Model ContinUE. It describes aspects such as anticipated experience, experience associated with use, reflective experience, repeated use, and retrospective experience. While artifacts and the environment are largely invariant, use is not.

Third, negotiation is an important element in learning to use interactive artifacts. No matter how user friendly an artifact may be, there will still need to be some effort and active learning by users. This includes learning directed at how the artifact is useful to users, how it fits into their lifestyles, time commitments, what is possible with the artifact, how to work-around problems, and so forth. Norman [12] describes how some of the most historically important artifacts in our culture require some effort on the part of the users to learn them. Verbeek [18] building on Ihde's work on technological intentionality describes how artifacts co-shape experience with us through our negotiation. For example, if a cart at a shopping center has a bad wheel, users of that cart have to account for the artifacts tendency to veer combined with their own intended direction to guide the cart. The resulting intentionality is a blend of the two. Brodersen and Kristensen [1] introduced negotiation in interaction design stating, "[negotiation is] the dynamic development of needs and understandings represented at different stages of a use situation," [p. 259]. Every time a user interacts with an interactive artifact there is the potential for a breakdown, which requires negotiating with the artifact.

Fourth, learning-in-use requires engaged interaction with an interactive artifact. Our previous research [16] looked at how breakdowns during game play occurred in two forms: breakdowns in interaction, which describe when players analyze the situation to learn something new about the game, and breakdowns in illusion, which described a loss of immersion. The first of these two would only be possible through being engaged with the game one was playing and making serious efforts to succeed. Engagement has also been described as an essential component of our embodied interaction with the world. "Embodiment is the property of our engagement with the world that allows us to make it

meaningful," [6 p. 126, italics in original]. Dourish makes an argument that the way humans are embodied in the world does "not simply mean 'physical manifestation," [6, p. 125], but rather embodiment is grounded in everyday experience and engagement. Therefore, learning and meaning making requires the learner to be engaged with what is being learned. In this sense, learning-in-use happens against the backdrop of an engaged experience with an interactive artifact.

Learning-in-use is the relationship users develop with artifacts over time. It describes part of the reason people continue to use older versions of artifacts when newer versions exist. It reveals the possibilities users ascribe to an artifact in terms of what they might do with it. It is what remains of a long-term engaged experience with an artifact. Learning-in-use must be considered an equal and important part of learning how to use interactive artifacts.

This concept of learning-in-use draws inspiration from the concept of learning in use presented by Bødker and Petersen [2]. These two concepts focus on aspects beyond the knowledge and skills gained from learning, appreciate the role of prior experience for shaping a learning situation, and account for the role of time in the study of learning. However, they diverge on issues of usability, the location of meaning in use, and the distinction of novices and experts. For usability, while learning-in-use would support that profound learning experiences could occur even when an interface is difficult to use, learning in use holds usability as important part of the process. For the location of meaning, learning-in-use asserts that meaning is found in intentionality, while learning in use asserts it is found in motivation. For the distinction of novices and experts, while learning in use asserts novices focus on low-level operations and actions and experts do not, learning-in-use asserts that while the underlying structure may change, the meaning-making structure of the learning experience will remain the same for both. Furthermore, transparency of an artifact and social aspects of use take a prominent role in learning in use, while the co-shaping aspects of the artifact and ego-centric aspects of use take a prominent role in learning-in-use.

AN EMPIRICAL STUDY OF LEARNING-IN-USE

Research Study Purpose

We applied this perspective and concept to a longitudinal study of interactive artifacts. We sought the consistent patterns emerging across participants' learning experiences, how these experiences changed over time, and in what ways users needed to negotiate with the artifact to make sense it.

Study Protocol

This longitudinal study was conducted over a period of five months from December 2009 to May 2010. Divided into two phases, participants had access to two different artifacts over the course of the study. The two and one-half months long study was sufficient for the novelty of the artifact to dissipate, but still short enough to be manageable to study. Within each phase, participants were encouraged to incorporate the artifact they were given into their lives and learn to use it in the way most appropriate to them. The three interactive artifacts used in this study were Adobe Photoshop, World of Warcraft (WoW), and the iPod Touch. Participants were given these artifacts based on two seven-point scale questions assessing their interest in learning and the level of their prior experience with each artifact. They were placed into the groups in Table 1 based on responses to these questions.

Table 1. Artifacts received by group members by phase. The groups were divided to account for ordering affects.

Group	Phase 1 Artifact	Phase 2 Artifact
1a	Photoshop	iPod Touch
1b	iPod Touch	Photoshop
2a	Photoshop	World of Warcraft
2b	World of Warcraft	Photoshop
3a	iPod Touch	World of Warcraft
3b	World of Warcraft	iPod Touch

Participants were invited to a series of interviews with a single researcher at the beginning of, one month into, and at the end of each phase. The interview sessions were broken into four parts including 1) an interview of prior experience, motivations, and expectations; 2) a free exploration time; 3) a unique task for each artifact; and 4) a final questions. Audio was recorded for each session and additional notes were taken during observational portions of the session. The second and third interview of each phase had the same structure, but questions in the first part focused more on participants' ongoing learning of the artifact. This structure and the phenomenological approach of this study are based on prior studies explained in [16].

As mentioned above, a task was associated with each artifact. In Photoshop, the task was to recreate an image the researcher provided. In WoW, the task was to collect as much money as possible in twenty minutes, which was used to buy the best piece of armor the user's character could equip. Finally, for the iPod, the user downloaded an application that addressed an identified need.

Participants also were encouraged to learn the artifacts on their own. While the interviews provided contact with participants, this self-guided learning time provided a natural setting in which learning-in-use occurred on its own. We asked participants to keep an online experience diary inquiring about their relationship with the artifact, contexts of use, functionality used, resources used, and any problems they had. We sent participants weekly reminders to write diary entries about learning the artifact.

While this study aims at a natural process of learning, we acknowledge the procedures will not permit for a completely authentic experience. The authors have tried to

create and maintain a research environment as conducive as possible to participant's authentic learning.

Participants

We selected 12 participants randomly from a total of 23 participants who responded to a recruitment email sent out to the Indiana University School of Informatics listeserv. One of the original 12 dropped out before the study and so was replaced by another randomly selected participant from the 23 that responded. The participants included 7 undergrad students, 4 grad students, and 1 staff member divided between 7 males and 5 females. We recruited participants by advertising the interactive artifacts they could learn. Advertising the artifacts gave us access to participants who were already interested in learning WoW, Photoshop, or an iPod. In the interest level question used for grouping, participants reported a mean of 5.8 for artifacts they eventually used, showing a high level of interest. There was one outlier who reported a 2 for WoW because she was unsure she could use it. We also recruited a wide range of prior experience from novice to years of experience. In the level of experience question used for grouping, participants reported a mean of 2.9 for the artifacts they eventually used, showing a relatively low level of experience, but there were several outliers showing some variety in level of experience.

Nine participants completed the entire study. Of the remaining 3, 2 completed 5 of the 6 sessions and 1 completed only 2. One of the five session participants and the two session participants withdrew due to a lack of interest in the iPod Touch and time to learn Photoshop respectively. The other five session participant could not be reached to schedule a final interview session.

Methods for Analysis

Of the collected data, only 1 audio recording session and 1 session's Photoshop images were lost. The total data collected include approximately 64 hours of audio, 74 collected Photoshop images, 72 diary entries, and hundreds of pages of notes taken.

From these data, 85 pages were transcribed based on those repeating patterns in the sessions. Audio was selected based on relevance to learning, capturing the important learning situations for participants, and avoiding repeated statements. A more complete transcription was not possible due to the amount of data collected and limited resources of the researchers. The transcription was taken exclusively from the interview portions only because other portions were captured already in field notes. Furthermore, one narrative for each participant in each phase—a total of 23—were synthesized about participants' learning experiences. Narratives were constructed from field notes and interview sessions. The narratives recorded long-term episodes in development and multi-session themes for participants.

To analyze the data, authors first transcribed recordings and field notes organized by participant and session date. Diary entries were not used directly in analysis. In general, they were not effective for capturing non-session data, though, sometimes details in the diaries were asked about in the sessions. Second, evidence of the meaningful relationships between participants and their artifacts, changes over time, and examples of negotiation were tagged and identified as codes within the data. Codes were formed when at least two events or transcribed interview snippets across participants could be identified as similar. Further events and snippets were then placed within these codes or new ones as data were reviewed. The narratives, then, were used to maintain fidelity between the codes and the original interview and provide structure for multi-session patterns. Third, these emerging codes were then grouped into four characteristics of learning-in-use.

FINDINGS

Each artifact contributed its own unique perspective in this study, yet all revealed similar findings. The data collected were organized around three of the four aspects of learning-in-use: the development of personally meaningful relationships with artifacts, time aspects of use, and negotiation of use. The fourth, engagement, acted as a backdrop against which learning-in-use occurred and was present in all the codes. Several codes may address multiple aspects simultaneously. Regardless, codes were placed in the following subsections to correspond with the aspect they most logically address.

Personally Meaningful Relationships

There were 5 relevant codes corresponding to personally meaningful relationships. These included *anticipating use*, the *social situation* of using an artifact, the *uniqueness of and alternatives to an artifact*, *sharing experiences*, and the *depth of experience*.

Anticipating use centered on instances where a participant mentioned their future use of an artifact as well as whether that future would be positive, neutral, or negative. Positive experiences would reinforce the interest of the participant, whereas a negative experience might prevent a participant from developing any kind of a relationship at all. This code was recorded for participant (P) 1, P6, P7, and P10 using Photoshop; P6 and P12 using WoW; and P11 and P12 using the iPod.

Participants described the social situation of artifact use referencing groups, such as friends, roommates, spouses, children, or other users on the Internet influencing their use. Participants solicited others for help in learning, invited them to use the artifacts with them socially, and learned about their own use from watching others use the artifact. Also, participants' use of these artifacts would mediate the relationships the participants had with these others. These relationships altered the meaning a participant has with for a given artifact. This code was recorded for P2 and P10 using Photoshop; P2, P8, P9, and P12 using WoW; and P5, P8, P11, and P12 using the iPod. The following is an example from the study of such social influence on learning the artifact when that social support is not present.

P8: this is my friends account. That's his, that's his player, not mine. Like it's a joint account and I guess you can triple, or yeah, triple the experience if you play together.

R: Really?

P8: Yeah. It's pretty cool. I told him it's ridiculous. So, basically when I got to level 60, everything like, He played with me until level 60, so everything was triple experience, so it was really easy. And then from 60 to 69, it just killing me.

R: Yeah, it gets worse and worse.

P8: And it's a mage. So I get that.

R: Yeah you gotta be in a group.

P8: I'm not really good at playing on, getting hit, getting away from players, so player against player. So every time someone hits me, I give up.

The uniqueness of a particular artifact was recorded based on a unique experience between the user and a particular artifact. This was coded for P3 using Photoshop and P9 using the iPod. Alternatives to an artifact were closely related to this code, since the presence of alternatives meant the artifact is less unique. Alternatives to an artifact were how a participant would describe other artifacts in their lives already doing what a new artifact does. It reveals overlapping functionality. Frequently, the iPod was described in this way because of participants' laptops, other MP3 players, cell phones, and cameras replicating this functionality. WoW participants also described other games and systems they played. The alternatives code was recorded for P4 and P9 using WoW and P8, P10, and P12 using the iPod.

On a few occasions, participants would share their experiences with others. This experience could be based on specific aspects of an artifact (e.g., some use they made of it, how they made the best use of artifact for some goal, and so forth). Those who could integrate the artifact into some social use could share their experience with others, but other participants could not share the experience in a meaningful way because they did not have any core, shared experience for that artifact. This code was recorded for P2 using Photoshop and P12 using WoW. P2 mentions how the only reason he wanted to learn Photoshop was to "show off" to his girlfriend who also used it.

P2: My girlfriend, for example, knows how to use Photoshop. I want to learn how to touch things up and make things look nicer.

R: Have you ever like done that with her? Or has she mostly just done that by herself?

P2: She has always done things by herself. I don't think I have ever really been there when she's done that stuff. That's basically what I have used it for is to show off to my girlfriend.

Sharing their experiences was different from social situation because the social situation coded changes from the mere presence of others in relation to the artifact, whereas the sharing of experience relied on deeper mutual understandings (or lack of understandings) between the participant and others.

Finally, participants frequently refer to the depth of experience with an artifact or the lack thereof. Increasing depth of experience would reveal more questions about the artifact through exploration. For this code, depth was not overwhelming, but rather, through further learning, a participant could one day explore that depth. Another reason this depth was coded was when participants became increasingly interested in how an artifact works or realized the functionality of an artifact can do more than they once thought. This code was recorded for P4 and P6 using Photoshop and P3 and P8 using WoW. It was also recorded for P8 using WoW, P11 using Photoshop, and P12 using the iPod from the sense of wanting to understand the functionality more deeply. P3 mentions how he envisions this depth:

R: How strongly would you rate your ability to use the software having used it for four weeks on a scale of one being the lowest and five being the highest?

P4: I still want to say three. Because, the more I delve deeper into Photoshop, the more I'm not really I'm feeling I'm knowing the stuff, the power that's under the hood. You know. I probably I will feel like I'm staying at three for a while until I actually get through a whole bunch of different tools.

Time-aspect of Use

The influence of time on participants in the study revealed 3 codes, including an *improved articulation* about an artifact, *changes in an artifact or how it is perceived*, and *surpassed and unmet expectations*.

An improved ability to articulate one's experiences, needs, expectations, and motivations marked several participants learning experiences by becoming more detailed and nuanced. There was a transition when, in the process of describing their learning experiences, statements moved from less clarity and more vagueness to more clarity and less vagueness in descriptions about the artifact. This does not have to do just with increased knowledge, but also an improved relationship and fit of the artifact to the participant's life. P2 using Photoshop demonstrated the clearest example of this code, but arguments could be made to include P5 using the iPod and P8 and P12 using WoW.

Other codes that tracked changes over time were changes with the artifact itself, which indirectly altered the participant's perception about an artifact, or changes in the way the participant perceived an artifact. The first instance in the study happened only with WoW when the game sent out a patch to update the software midway through the first phase—the second of two updates in the phase, though the first went unnoticed. The other instance happened primarily when participants switched between two related interfaces. This was coded for P3 and P6 using Photoshop and P4 and

P9 using WoW. P9 alluded to this code while using WoW as it changed from novel object to tedious and confusing to entertaining due to the changes made to the user interface for completing quests in the patch.

R: What goals do you have for using World of Warcraft and have they changed at all during the course of the study?

P9: Well, about halfway through when I was having trouble with like the missions and stuff, my goal was just to get it over with. But now, that they have made it easier, it's more enjoyable since they basically tell you where to go for the missions. So my goal.

R: So, the latest update has made it easier?

P9: Yeah. A heck of a lot easier. So, yeah, it's more enjoyable and easier to play now.

Finally, participants experienced *met and unmet* expectations in relation to what the artifact could and could not do. The user did not necessarily know how to articulate these expectations at all times. Nonetheless, participants could appraise whether an artifact was meeting, surpassing, or falling short of their expectations. Participants' responses to this issue would vary dramatically depending on when this question was asked as some of the greatest advocates for the artifacts turned into the greatest detractors. The code was recorded for surpassing expectations in the interviews for P4 and P11 using Photoshop, P9 and P12 using WoW, and P5 using the iPod. The code was recorded for failing to meet expectations for P7 using Photoshop, P9 using WoW as well as P8, P10, P11, and P12 using the iPod.

User-Artifact Negotiation

There were 7 codes recorded to address the aspect of negotiation including *leveraging familiarity*, *identification with a particular brand or platform*, *usage management*, *opportunism in use*, the *fit of an artifact*, *perspective taking*, and *control over an artifact*.

Familiarity was the comfort participants had with aspects of an artifact with which they already had experience. When participants leveraged prior experience, they relied on experience with a particular task, other similar artifacts, or a certain way of thinking about a process. Participants would occasionally look for ways prior experience could help make sense of a learning situation. This familiarity was a basis from which new learning could take place. New experiences proceeded gradually from familiar ones. This code was recorded for P1, P4, and P6 using Photoshop; P12 using WoW; and P7 using the iPod. P12 demonstrated how this familiarity actually opened up new possibilities with WoW as he realized the Auction House in the game was much like eBay, which he already uses.

R: What made you re-evaluate your stance not to even sort of interact with the auction house?

P12: Well, from our conversation, that there might be something of value there that I may have overlooked previously. I was really taking the path of least resistance, which early on made sense. But I mean, I'm getting to the point now, where I can't buy stuff at a higher level. I have a lot more coin. And I'm realizing that you have to continue to get creative to improve your, you know, capabilities on equipment and everything. And my guess is, I mean, I don't know if people made this stuff, you said, you know, I've already made some stuff, crafted some things. And I just went and sold it to a merchant. But now I'm realizing that I can go ahead and make it and sell it. And I'm seeing a whole new world of commerce opening up that is, like, not the retail world, but the eBay world of World of Warcraft, which I enjoy doing. I've sold a ton of stuff on eBay.

Closely related to leveraging familiar experience, was participants' identification with particular brands or platforms. This brand identification was usually stated in the first session. Participants would say they were a PC person, and not a Mac person, or a console game player, and not a PC game player. These identifications not only associated the participant with one type of brand—usually the opposite of the artifact they were using—but also shaped the kind of expectations they would experience. In the case where P12 identified with the Apple brand of the iPod, he knew he could trust that product. The brand identification code was recorded for P6 and P9 using WoW as well as P5, P8, P10, and P12 using the iPod.

Usage management addressed how participants dealt with monitoring and managing their usage of an artifact. For example, P6 actively tried to restrict the amount of time spent using or learning an artifact. Others would describe how they felt they had not put enough time into learning the artifact between sessions, which may be an artifact of the study, but may also reveal some regret to learn more about the artifact. Participants recognized to make progress in learning the artifact, they needed to commit themselves and their time to learning the artifact. They need to be actively engaged. Finally, this code was about setting boundaries between the artifact and the individual. If these boundaries were not managed, or not monitored, a user could spend a great deal more or less time than intended using the artifact. This code was recorded for P1, P2, and P11 using Photoshop; P4, P5, P6, P8 using WoW; and P8 and P11 using the iPod.

Complicating the situations recorded under the previous code was that participants were opportunistic in using and learning an artifact. This opportunistic code recorded situations where learning was not well-planned. Participants would learn the artifact when they had time and were interested in furthering their understanding. Participants started by using the artifact and would supplement the experience only when needed with Google, online forums, or friends who used the artifacts. The code was recorded for P1 using Photoshop as well as P3, P5, and P8 using WoW.

The fit of an artifact was recorded to mark when participants mentioned the relationships between their

needs and the roles the artifacts could fill. Often, this fit would only be realized through a process of trial and error discovery with the artifact. Furthermore, contextual issues may also play into whether the fit of an artifact, such as timing, other artifacts, and other life situations. This code was recorded for P11 using Photoshop; P6 and P8 using WoW; and P8, P9, and P10 using the iPod.

Perspective taking had to do with the various point of views participants had with their artifacts. This code signified changes due to anything from making mistakes and misunderstandings to participants finding ways to work around problems, or using trial and error to test different strategies. These different perspectives could be beneficial or detrimental to the progress on learning to use the artifact. Changes in these perspectives often took place in later interview sessions as participants would realize there were different ways to look at their problems. Participants exhibiting this code included P4, P6, P10, and P11 using Photoshop; P4, P6, P8, P9, and P12 using WoW; and P5, P8, P9, P11, and P12 using the iPod. P5 was in such a situation where he unsuccessfully tried to download an app from the iTunes Store on his iPod. He reasoned the only way to download apps on the iTunes Store was to upgrade the firmware, which would cost money he was unwilling to spend for the study.

R: What goals do you have for using the device?
P5: Huh. The number one goal right now is to get software on it so that I can do, so that I can download apps.
R: And how have your goals changed during the study?
P5: Uhm. At first it was, it was just, uh, you know, I want to use it so that I cannot be bored on the way to class and stuff. And then I found out about the whole, uhm, 'it costs money to upgrade software to the new firmwares.' And, until then I can't download apps and stuff. So, I've been looking online at a bunch of different ways to get the software for free.

Later in the session, we asked him to try to download another app and figure out this problem. He started to learn as he explored other apps that he may have been focusing only on apps that could be used with other Apple hardware. While this could be classified exclusively as a mistake, that fails to take into account other factors, such as his expectations, the perceived fit of the artifact, and how he tried to incorporate the artifact into his life.

The final code described participants' responses about the amount of control they had over the relationship with the artifact. Some participants felt they had total control over the artifact. Others felt they had little control. As previously described, the concept of learning-in-use is formed by a co-shaping of experience between both user and artifact [18]. Nonetheless, what was recorded here demonstrated participants' perception of that control. This code was recorded for P1, P3, and P10 using Photoshop; P9 using WoW; and P7 using the iPod.

Changes in Abilities

In relation to this study of learning-in-use, we looked for traditional measures of learning gains using these artifacts. This was accomplished by looking at the tasks participants completed every session. This comparison only includes Photoshop, because while the iPod and WoW tasks were interesting, they provided no standard, consistent measures to compare across participants. For Photoshop, participants were asked to transform Figure 1 into Figure 2.

Figure 1. Starting image.

Figure 2. Goal image.

A sample of participants' work is shown in Figures 3-5. More have not been included due to space restrictions.

Figure 3. P6's attempts. She self-described her level of experience prior to the study as 5.5 out of 7.

Figure 4. P4's attempts. He self-described his level of experience prior to the study as 5 out of 7.

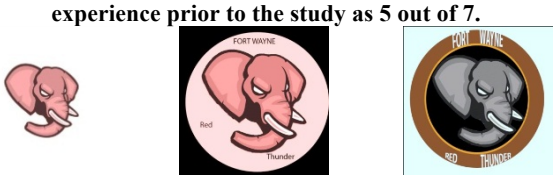


Figure 5. P7's attempts. She self-described her level of experience prior to the study as 5 out of 7.

As you can see, while there appears to be some progression as the study went on, most participants produced largely the same image each time. Either they could do it right the first time as in P6's case, they made the same mistake every time (as P4 noticed and reflected on in the last session), or they were able to focus only on certain elements with the time they had as in P7's case.

Finally, , there were nine tasks to complete this study, including changing the elephant color, creating each of three concentric circles, adding text, curving the text, adding a stroke around text, and placing the text appropriately. When counting up the number of changes required to complete the Photoshop task, the mean number of completed items changed little between sessions. From session 1 to 2, there was only a 16.7% mean improvement. From session 2 to 3, there was only a 9.4% mean improvement.

When participants were asked to comment on the changes in their learning ability for all artifacts, participants reported a 22.8% increase between sessions 1 and 2, but only a 9.3% increase in ability between sessions 2 and 3.

This evidence shows that while over time, there may have been a modest improvement in participants' ability and perceived ability to use and learn the artifact, there were large changes going on in their learning-in-use.

DISCUSSION

This section introduces four phenomena derived from the study. These four describe major phenomenological characteristics of *learning-in-use*, including *grasping*, *situating*, *perceiving-in-use*, and *making meaning*.

Grasping

The characteristic of grasping involved users proceeding through unfamiliar situations while using an artifact. When learning something new, unfamiliar situations can be fairly common. Learning is about how these unfamiliar situations can be made familiar. While this grasping characteristic occurs most frequently when a novice first uses an artifact, even an experienced user can still have this experience. Experienced users may push themselves to learn even more about their experience with an artifact. Users who have a meaningful relationship with the artifact always have more to learn about the artifact. Finally, users experiencing grasping do not always seek to remove all aspects of uncertainty because that may also remove aspects of surprise and enjoyment. Grasping acts as a means for users to map out the possibilities of use of an artifact. It provides an initial impulse for participants to learn more about the artifact.

Grasping is drawn from the codes of anticipation, learning opportunistically, leveraging familiarity, brand or platform, and perspective taking. These codes demonstrate the user perspective when facing a situation that is not immediately obvious. Under the circumstances leading to these codes, participants were challenged to form a coherent relationship in spite of an artifact that was not entirely known, a vague sense about why they wanted to do with the artifact, and a situation that was constantly changing.

Situating

The situating characteristic involved how users would situate artifacts in their lives in terms of when to use the artifact, how to use the artifact in relation to other artifacts, and how the artifact functioned within users' daily routines. When learning about an artifact, participants would often acknowledge obstacles to learning the device besides potential lack of experience or motivation. Frequently, other commitments might get in the way of spending time with the artifact, even when the participant was motivated to learn. This situating involves finding time to use and learn the artifact, the right fit for it, and activities in which to use it.

The codes supporting situating were the social situation, uniqueness of or alternatives to an artifact, surpassed and unmet expectations, managing usage, learning opportunistically, and the fit of an artifact. These codes refer to the use situation whether social, temporal, artifactual, or personal in nature. Assigning meaning is a complex process formed in some part by the relationships and meanings a user has already formed. It is the result of the navigation and negotiation of users, their situations, and the artifact being learned.

Perceiving-in-use

Perceiving-in-use encompassed how engaging with artifacts would affect the way users perceive activities for which they use the artifacts, problems they can solve, and usefulness of certain artifacts over others. As participants used these artifacts, what they saw and how they saw the world were transformed in several cases. The transformative effects of perceiving-in-use affect both perception and action, changing how they perceive the artifact and use it. WoW mediates both actions and perceptions through the fictionalized world the game developers created. Photoshop augments a visual artist's ability to create art and aids in the process of deconstructing an image visually. The iPod transforms the way a user interacts with media and information in the world through mobility and interactivity.

The codes from which perceiving-in-use is derived include changes in an artifact and how it is perceived, surpassed and unmet expectations, perspective taking, and controlling an artifact. All of these related to a user's engagement with an artifact and the activity for which the artifact is used. They also dealt with the realizations participants had about the artifact and the activity. As participants learned-in-use, perception and action subtly changed to account for the way the artifact addressed, or did not address, their needs.

Making Meaning

The characteristic of making meaning is about rationalizing through an experience, relating it to previous experiences, and making new knowledge. Making meaning is not a linear process, as there may be several inconsistent beliefs the user must address in prior knowledge first. Users experiencing this characteristic attempt to interpret and understand the use situation by assigning or enhancing the meaning of an experience. It is about consolidating an on-going experience as it happens.

The recorded codes supporting making meaning were sharing experience, depth of experience, improved articulation, surpassed and unmet expectations, leveraging familiarity, and perspective taking. Each of these codes refers to the internal consolidation and rectification of new experiences in relation to previous experiences. There are also several codes that dealt with the outward expression of new knowledge. This consolidation of new knowledge often occurs in relation to mistakes as demonstrated by the code perspective taking. Those mistakes can lead to new perspectives in addition to new knowledge.

DESIGN CONSIDERATIONS

We believe these characteristics are important contributions for the interaction design research community as theoretical lens towards understanding learning over the course of use of an interactive artifact. However, can we take this concept of learning-in-use and apply it in the process of designing new interactive artifacts? We believe there are some latent points to improve design through learning-in-use to be found in these characteristics.

Grasping

Design for a learning environment, not for learning

For years [3], researchers have urged designers not to rely on front-loaded learning through a tutorial or manual for training purposes. The characteristic of grasping has confirmed the assertion that, when left to their own devices, users of interactive artifacts will jump into hands-on exploration with the device. It demonstrated that mistake making and surprise is very much a part of the learning process and developing a meaningful relationship with the artifact. Even in fault-intolerant systems, e.g., an air-traffic control system, it is in the designers best interest to provide a risk-free, sandbox environment to "play around with" and explore the interface, such as a by using a simulator or serious game version of the real artifact with simulated data. Furthermore, such environments can be conducive for pushing users out of their comfort zones more quickly and experimenting with the artifact given the proper encouragement.

Design training materials for integration in use, not for before or after use

Despite the need for exploration, users still need access to resources such as tutorials, just-in-time help, and especially a community of other users to be applied opportunistically when skill- or knowledge-based learning is required. Users cannot know the questions they will have, until the artifact operates in unfamiliar ways. Nor will they remember all issues with an experience through recollection after the fact of using an artifact. Context-sensitive help, clear labeling, explanatory feedback (e.g., why did the artifact take such an action), and ready access to other users who can help are the most effective approaches to scaffold users to figure out what they are doing, diagnose problems, and find workarounds to accomplish what they mean to accomplish.

Situating

Accept outliers and peculiarity in the user experience

Situating demonstrated that the "fit" of a particular artifact to the user was a central component of the learning experience. Now, there is no certain way to understand the situation facing users in advance. However, by analyzing those cases which deviate from normal usage in the process of designers' user research and especially by highlighting those instances where the use experience deviates from what was expected, designers can help promote a culture of openness in the design of the artifact. [8, 17] have asserted that ambiguity and the play of meaning can encourage this difference in meanings for different users. While such practices are encouraged by interaction design researchers, this approach is far from ubiquitous. More than this though, designers need to accept that the value they find in the artifact now—as designers—will differ greatly from user to user and use to use.

Perceiving-in-use

Make changes in new versions of an artifact a big deal, but provide support for users for these transitions

This study has demonstrated people tend to center their attention on familiar aspects of an interactive artifact. As much as users might prefer not to learn new ways to use an artifact, it is an important part of the user-developer relationship as was evidenced in the perceiving-in-use characteristic. Changing cultural tastes, new competitors, and new technologies force developers to change their artifacts periodically to maintain a competitive advantage. Often these changes benefit users in the long-run. However, this change can be a major disruptive force to the user experience, so there is a great disincentive to hide these changes. Make them open and public. Celebrate these changes. At the same time, users will need support in terms of learning resources, customer support, and a way to distinguish what has changed from that which has not. Given these resources, a user may find new reasons to continue using the artifact not just because of the change, but also because how that change was communicated. Facebook's recent move to the Timeline interface demonstrates that celebration of change while providing support for their user-base to make the transition.

Making meaning

Encourage people to share their experience

An important part of the user experience as evidenced by making meaning and in other studies [9] is sharing or recounting that experience. Any usage experience is always inscribed in a social context, and the learning experience is no different. Whether designers provide the resources for or platform from which to share their experience, users will seek each other out for the purpose of sharing their work and accomplishments, for figuring out workarounds for troubling aspects of the artifact, or even to share meaningful and enjoyable—or not—episodes of their use. In a sense, you are trying to develop not just an artifact, but moreover a community of loyal users.

Challenge your users

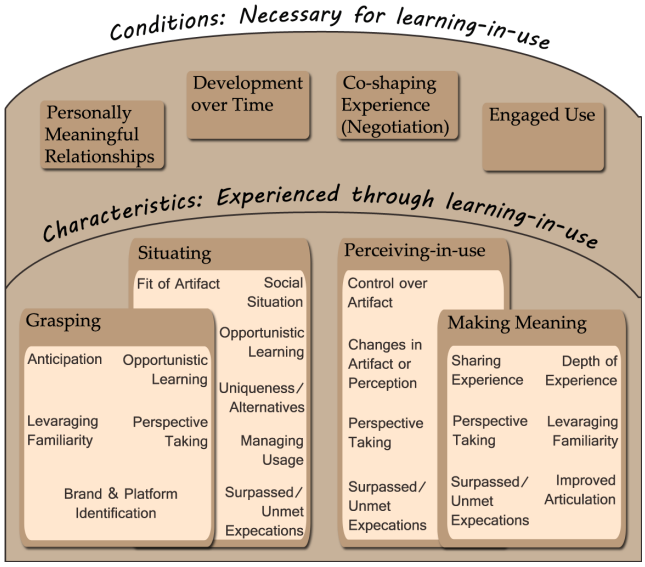
Finally, users are going to explore all an artifact offers opportunistically. Often times a user will go through an entire artifact lifecycle and only use the same few features over and over again. Without "provocation," a user may not have any reason to explore the artifact even though there may be aspects of it that they would use if they knew how to use them. By gently nudging a user to other ways of using the artifact, designers can help users expand beyond what is familiar to start exploring new features. Social media, in general, has been good at this, suggesting that users connect their different accounts together. Careful

balance is required to prevent user frustration, but occasionally such a strategy can be beneficial to helping the user expand their horizons with the artifact.

CONCLUSION

This article described the concept of learning-in-use through a theoretical and empirical study to observe the learning experience for participants over five months. This study has taken a phenomenological and experiential perspective on learning, leading to unique insights about this complex process. This study confirmed the importance of not only gaining new knowledge, but also of establishing a personally meaningful relationship with an artifact, nurturing that relationship over time, and navigating between what an artifact can do and what one's goals are for an artifact. These conditions provide the basis in which learning-in-use can occur. The study also found four characteristics users experience as they learn-in-use: grasping, situating, perceiving-in-use, and meaning making. The conditions and characteristics of learning-in-use are organized in Figure 6.

Figure 6. Conditions and characteristics of *learning-in-use*.



The future of our work into this concept will include looking more deeply at aspects of familiarity in the learning experience, how different resources are utilized throughout the process of learning, and broadening the backgrounds of participants beyond those with more extensive technical knowledge. The concept of learning-in-use represents an alternative to how users learn to use artifacts. Each learning experience is unique, yet each is important for developing a sustainable and meaningful relationship with artifacts.

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REFERENCES

1. Brodersen, C., & Kristensen, J. F. (2004). Interaction through negotiation. *Proc. NordiCHI '04*, 259-268.
2. Bødker, S., & Petersen, M. (2000). Design for learning in use. *Scand. Jour. of IS, 12*, 61-80.
3. Carroll, J. M., Mack, R. L., Lewis, C. H., Grischkowsky, N. L., & Robertson, S. R. (1985). Exploring exploring a word processor. *HCI, 1*, 283-307.
4. Dewey, J. (1938). *Experience & Education*. New York: Touchstone.
5. Dewey, J. (1944). *Democracy and Education: An Introduction to the Philosophy of Education*. New York: The Free Press.
6. Dourish, P. (2001). *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge: MIT Press.
7. Forlizzi, J., Ford, S. (2000). The building blocks of experience: an early framework for interaction designers. In *Proceedings of DIS 2000*, New York, 419-423.
8. Gaver, W. W., Beaver, J., & Benford, S. (2003). Ambiguity as a Resource for Design. *Proc. CHI '03*, 233-240.
9. McCarthy, J., & Wright, P., (2004). *Technology as Experience*. Cambridge: MIT Press.
10. Moustakas, C. (1994). *Phenomenological Research Methods*. Sage Publications. Thousand Oaks, CA.
11. Nagel, T. (1974) What is it like to be a bat? *Philosophical Review, 83*, 435-450.
12. Norman, D. (1999). Affordances, Conventions, and Design. *Interactions, 6*(3), 38-42.
13. Petersen, M. G. (2002). *Designing for Learning in Use of Everyday Artefacts*. Ph.D. Thesis. University of Aarhus, Denmark.
14. Petersen, M. G., Madsen, K. H., Kjær, A. (2002). The usability of everyday technology—emerging and fading opportunities. *TOCHI, 9*(2), 74-105.
15. Pohlmeyer, A.E., Hecht, M., & Blessing, L. (2009). User Experience Lifecycle Model ContinUE [Continuous User Experience]. *Proc. BWMMS 2009*, 314-317.
16. Ryan, W., & Siegel, M. A. (2009). Evaluating interactive entertainment using breakdown: Understanding embodied learning in video games. In *Proc. DiGRA 2009*.
17. Sengers, P., & Gaver, B. (2006). Staying open to multiple interpretations: Engaging multiple meanings in design and evaluation. *Proc. DIS '06*. 99-108.
18. Verbeek, P.-P. (2005). *What Things Do. Philosophical Reflections on Technology, Agency, and Design*. State College, PA: Penn State Press.