Acquiring Mastery

B. Krisler, R. Alterman, Brandeis University, Computer Science, Waltham, MA 02454
Email: bkrisler@cs.brandeis.edu, alterman@cs.brandeis.edu

Abstract: Many opportunities for attaining mastery exist within a typical workflow. By leveraging focus-shifts and providing the user with complete control over the learning process, both critical elements of any "as-you-go" learning method, the HotKeyCoach learning model demonstrates that the production paradox can be overcome by experienced computer users.

Training For Mastery

After formal training, a professional's education continues during on-the-job activities. Expertise is achieved by learning case-by-case how to apply a professional framework to a problem. Learning to use efficiently the appropriate technologies requires mastery.

Mastery, a state of "knowing" how to productively work through the technology, is a problem of skill acquisition. To achieve it requires an understanding of the conceptual model that underlies an application, i.e. learning the operations and methods that best apply to different kinds of situations. As the user becomes more efficient and knowledgeable about the articulation work it takes to use the application, she can remain within the flow of the activity for longer periods of interrupted time. By developing a deep conceptual model of the system, the amount of work required to accomplish goals diminishes, resulting in a more efficient utilization of the system.

Learning to master work-mediated technology, however, is complicated by the production paradox (Carroll & Rosson, 1987): learning more effective and efficient methods for using technology results in mastery in the long-term; however, spending time to acquire mastery in the short-term interferes with productivity. To preserve the flow of activity, the user must be able to concentrate on her activity with minimal interruption (Bederson, 2004).

The tool we present, HotKeyCoach (HKC) develops a model for the incremental attainment of mastery that is integrated into the work activity of the user and minimizes task interruption. HKC provides the individual with an opportunity to gradually acquire mastery of technology during the course of her normal work activity, while ensuring she maintains complete control of the learning process. In support of the attainment of mastery, the HKC model turns user interface actions into learning events (VanLehn, 1996), leveraging the many learning opportunities for attaining mastery of the work-mediated technology. The learning events either introduce new material or provide the learner with the capability to practice previously introduced material.

Minimal Task Interruption & Control

Bødker, (Bødker, 1995), defines two types of interruptions that redirect the user's attention: *breakdowns* and *focus-shifts*. The key difference between a breakdown and a focus-shift is the affect upon the flow of the central activity. A breakdown occurs when something unexpected happens and redirects the focus of attention towards a newly created activity, whereas a focus-shift, a less severe interruption, usually occurs when a subconscious operation becomes a conscious activity, such as the articulation of a point or procedure. The HKC model of learning introduces learning events during focus-shifts. Upon the introduction of a learning event, the user has the option to ignore the introduced event, or she can selectively learn a new concept at its moment of relevancy, preserving the flow of the activity.

For example, in attempting to change the indentation for a paragraph, the user must perform multiple steps. To satisfy the formatting goal, she selects via the mouse the menu operation for formatting a paragraph, causing a focus-shift. The focus-shift creates an opportunity for a learning event by introducing the keyboard shortcut for the executed activity. There are numerous learning events of this sort available in a typical workflow. If every time the user selects an operation from a menu, she had the option to learn an alternate, more efficient method for achieving the same goal, over time she will develop mastery at using the application. Leveraging these learning opportunities has multiple benefits. The more the user performs an operation, the more opportunity she has to achieve mastery of that operation leading to a reduction of future work. And, her learning is highly contextualized: learning is directly associated with the current activity.

To preserve the occurrence of learning events as focus-shifts and not as breakdowns, the user should have complete control over the system at all times. There should be no surprising actions or unexpected behaviors. The HKC model does not usurp the user as the locus of control. Once the user is presented with a new concept (see **Figure 1**), she has a choice of either practicing the concept at its moment of introduction or to ignore it and continue with her work. When the user chooses to practice the new concept, HKC will validate the sequence, dismissing the display if it was executed correctly. Practice of a skill leads to speedup (Anderson, 1993) in the acquisition of that skill. If the user mistyped the sequence, a notification indicating the sequence was invalid is displayed. If the user decides to ignore learning the concept for this instance, she can either click anywhere on the screen or tap the return key to dismiss the display. In an effort to provide complete control, she also has the option of ignoring all future occurrences of the concept by selecting a checkbox in the display window.

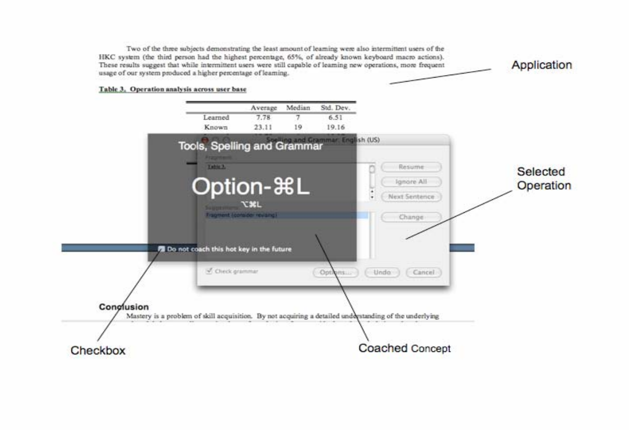

Figure 1. Example of an introduced learning event.

Evaluation

To test our model of learning, we developed HKC and made it available to the Brandeis University population. Nine anonymous participants used the software for an average of 52 days. To determine the usage frequency of HKC, we calculated the percentage of time our software was used as a ratio of the total days installed to actual days of usage, and divided the results into three usage levels: used daily (>90%), used regularly (50-90%), and used intermittently (<50%). Based on this metric, we determined that 67% of our subjects were regular users of HKC, evidence that our model did not interfere with the subjects' main work tasks. That more than half of the subjects continued to use and learn on a regular basis throughout the study is evidence that the subjects had not exhausted the learning benefits of HKC, demonstrating both its viability as a learning model and its effectiveness in overcoming the production paradox.

To produce evidence of learning, we computed the ratio of mouse to keyboard usage for all operations per subject, and divided the data into quarters. A mouse-performed operation during the first quarter that resulted in a keyboard-executed operation in the last quarter signifies learning. If by the fourth quarter of our study the subjects were using the shortcut for a given interface operation more than 50% of the time, we considered that an example of learning. During our analysis period, the subjects acquired an average of 8 new operations; one user acquired 21 new operations. Across all subjects there where 25 operations at an intermediate stage of learning; the users had some success at using the keyboard shortcut, but their use of the keyboard had not reached the 50% threshold. For a more detailed analysis of our study, refer to (Krisler & Alterman, 2007).

The production paradox explains why users frequently fail to achieve mastery of the technology that mediates their work. The learning method presented in this paper attempts to circumvent that paradox. Our results demonstrate that by leveraging focus-shifts and providing the user with complete control over the learning process, incremental attainment of mastery can be achieved. The results of our study show that the HKC model of learning facilitates the learner in transitioning from an intermediate skill level to an expert level via the acquisition of keyboard shortcuts. This observation was consistent across all subjects in our study.

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