Digital badges for deliberate practice: Designing effective badging systems for interactive communication scenarios

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ABSTRACT
This paper investigates the role of digital badging in technical and professional communication for supporting deliberate practice, or practice that is done with intent to improve a skill or ability. The focus is on deliberate practice as it relates to information design and writing within interactive environments. Deliberate practice is deconstructed into its required components with connections established between these components, badges, and best practices in the literature. Relevant theories are discussed and examples are used to demonstrate strategies for implementing badging systems for deliberate practice within technical and professional environments. The takeaway from this paper is that digital badging systems present opportunities to foster deliberate practice. This practice can then improve a variety of skills and abilities within complex environments, both for improving design and better training end users. Our paper synthesizes findings from the literature to suggest a number of best practices for designing opportunities for useful deliberate practice using digital badges.

Categories and Subject Descriptors
H.5.2 [**User Interfaces**]: Interaction styles – *theory and methods, training, help, and documentation.*

General Terms
Performance, Design, Theory

Keywords
User Experience, Interactive Design, Digital Badges, Badges, Deliberate Practice, Reward, Intrinsic Motivation, Feedback, Goal Setting, Goals

1. INTRODUCTION
Designing interactive information systems is challenging because good design must account for not only the readability of textual and visual components within a system, but also the ways in which that system must adapt and respond to user actions and behaviors as audiences engage with interactive content. Salvo and Rosinski [1] suggest that a shift in perspective from authoring texts to architecting virtual spaces is important for understanding the characteristics of interactive design. Like their counterparts designing for physical environments, architects who build digital products must understand how to design both products and experiences. In other words, they must consider the spaces they build, the environments that surround these products, and, most importantly, the ways in which visitors move through and interact with their designs.

When designing products well-suited for productive user experiences, we can often begin by thinking about how content interacts with experience. Here, we must consider information design strategies for aiding in the findability, searchability, and navigability of information stored online or in electronic databases. Then, we must consider how users need to engage with such systems for particular purposes. For example, within employee training or simulation contexts, information designers might wish to know what design features keep users motivated, on task, and performing well. To better understand such human-centered patterns of information seeking and retrieval, an interdisciplinary approach is useful. This allows us to review strategies from other fields such as human-computer interaction, information architecture, and psychology, fields that have also considered issues of user engagement and assessment. Such a review allows us to better understand how designers from other fields have grappled with the complexities of understanding and redirecting user behavior in complex information systems.

In this paper, we describe a theoretical approach, based on relevant multidisciplinary literature, for effectively using a particular type of interactive design intervention: digital badging. We specifically focus on how digital badge systems can be used for the purpose of encouraging deliberate practice within information systems. Deliberate practice is important for a number of reasons within information design. Users need to practice tasks repeatedly before they become proficient in navigating complex information systems, identifying relevant information, and becoming fluent with advanced system features.

Drawing from interdisciplinary literature sources, we review key scholarship regarding motivation and deliberate practice, then assert that digital badging can be used for productive purposes to potentially increase user motivation and build opportunities for deliberate practice. After identifying the importance of badges and framing them within the context of deliberate practice, we propose a series of design guidelines for developing badging interactions within information systems. These guidelines emerge from what the literature tells us about goal setting theory and self-determination theory, major areas of research in psychology, and then translate key theoretical findings to suggested practical

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design heuristics applicable to the domain of communication design.

Additionally, we address ways to maximize the effectiveness of technical communication-based badging implementations. These steps will lead to the ultimate goal of this paper – identifying practical strategies for implementing badges for deliberate practice in interactive communication scenarios. Such strategies can improve users' abilities to engage in deliberate practice in a manner that enhances skill proficiency or knowledge acquisition.

2. DIGITAL BADGES

Digital badges are visible markers of achievement that exist in a virtual space. While research has focused on badging systems for their merits as digital resume enhancers (e.g., [2]), badges can also be considered in other ways that fit within the framework of technical and professional communication. For example, badges can be conceptualized both as interfaces between users and systems and as communication devices to inform about goals and provide feedback. In this sense, badges can send messages useful to a diverse range of audiences in professional and technical environments [3]. Badges are acquiring recognition for their utility in a variety of fields, such as digital media [4], medicine [5], and others. But, we do not yet know very much about the utility of badges in more specific communication contexts. To investigate such matters, we need to first consider how badges relate to communication.

Operationally speaking, badges can be conceptualized as transferrable information vessels. After all, badges are infused with information specified by the designer, are transferred across some medium (e.g., Internet, game, physical space), and are then accepted by the end user. Thus a digital badge "travels" from some system repository to a user's profile page, account directory, or a shared leaderboard somewhere within the system. Such travel transfers ownership of the badge from the system to the user.

When well-designed, the information contained in a badge is assimilated by that end user, bestowing upon the individual some advancement in knowledge or understanding. In other words, the awarding of a badge is essentially a process of information transfer between a sender and a receiver, mediated by some virtual environment. However, like many interactive forms of communication, badges are transferred only after pre-specified criteria have been met. Well-designed badges are thus vessels that can transfer information at the exact moment when it is needed. Despite the surface-level simplicity of badging, badging executes complex communication processes that inform users as they require information. This "just in time" aspect of badging communication is a key strength that is useful in a variety of different situations.

Badges are also potentially useful for engagement and motivation, since users tend to enjoy well-designed badging experiences. For example, in one study, a mobile app was created to supplement the university orientation process for incoming university students [6]. The app included several features to aid the students during their orientation, including a schedule of events, a map, information about university services and phone numbers, and a section to record new contacts. A badging system was incorporated to encourage users to attend events, explore campus, learn about bus routes, and add friends to their contact list. 25 out of 26 participants agreed that the badging system was fun to use and enhanced their orientation experience.

Another study implemented badges in an innovative type of online university course delivery system to promote desirable student behaviors, such as completing tasks in a time-efficient manner [7]. Results revealed a small positive response to the badging initiative. Yet another study examined badges in the mobile application *Foursquare* [8]. The author conducted interviews with frequent users to examine the impact of badges on their experience. Data suggested that participants enjoyed earning badges and frequently engaged in specific behaviors for the sole purpose of obtaining badges. As this research suggests, digital badging is useful for a variety of purposes. In this paper, we will review the relationship between badging and a new type of activity that the literature has not yet addressed: deliberate practice.

3. DELIBERATE PRACTICE

Deliberate practice is practice that is done with intent to improve a particular skill or add to a learner's knowledge. Examples of areas that could be addressed through deliberate practice include writing concisely, using appropriate terminology from a style guide, or using figurative language to vividly describe a technical problem to an audience of non-experts. The technique works by repeatedly engaging a learner in a practice task.

From an end user's perspective, deliberate practice is a process of acquiring, improving, or establishing ability. Students are introduced to deliberate practice at an early age as they learn mathematics and writing skills. For instance, there are many fundamental abilities that are important in good writing. Among other things, one must have a firm grasp of the rules and mechanics of writing for specific genres, a clear sense of the appropriate style for those genres, a knowledge of the communication context, and the ability to analyze and write for particular audiences. Purposeful, directed practice sessions can build competency in each of these areas.

Deliberate practice is useful in a variety of more advanced communication tasks, too. Consider, for example, a technical communicator who is writing software user documentation. In this case, deliberate practice with a new software product, experienced over time, can facilitate the understanding of how to use the features and affordances of software and services, especially when the product involves a degree of complexity. Such focused effort leads a writer through a progression of experience – from a beginner to an expert user. Both extremes are important. The beginning user perspective is necessary to be able to understand the perspective of novice users and write for these audiences using the appropriate degree of complexity and with an adequate amount of supporting contextual information. Similarly, the expert perspective, eventually arrived at through repeated practice, is important because it allows a writer to understand a system well enough to clearly explain its features and functions. In other words, it is useful for the writer to integrate both novice and expert perspectives in order to better fulfill the needs of her audience.

4. LINKING BADGING AND DELIBERATE PRACTICE

Badging and deliberate practice can work hand in hand to improve skills useful for both end users and information designers, particularly those working to develop interactive systems for the training or simulation of complex tasks. However, while the literature we previously discussed demonstrates how badges can be effective in particular communication contexts, we do not yet know the specific parameters in which they are most useful for

specific tasks within specific communication scenarios. This paper establishes design guidelines for using badging to support deliberate practice, a technique which has been shown to have value within writing instruction [9]. In order to justify using badges for such a purpose, the merits of deliberate practice must first be established.

While expert performance was once believed to have spawned through an understanding of basic techniques or knowledge paired with innate talent [10], it is now known that developing expertise is less reliant upon pre-disposed factors. Although genetic factors can play a role in some instances (e.g., taller than average height is useful for basketball players), performance is also mediated by the focused and conscious repetition of task-specific efforts, otherwise known as deliberate practice [11].

One use for deliberate practice within the realm of technical and professional communication is as an activity for supporting both design and writing tasks. For example, in the scenario considered previously, user documentation writers form an understanding of the utility of various features and the connections between them through deliberate practice. On a more basic level, deliberate practice is likely necessary to develop writing ability [12]. Sims-Knight and Upchurch [13] suggest that the most important part of instruction is instilling habits that learners will repeat as they engage in solitary deliberate practice. When considering instructional materials, tutorials, or systems, supporting deliberate practice enhances users' ability to focus on the essential aspects of the technology to be learned.

Linking badges to deliberate practice means developing strategies for using digital badges as mechanisms for guiding user behaviors toward deliberate practice. If we want to use deliberate practice in tandem with badging, we need to have a more precise idea about what this type of practice requires. Deliberate practice involves five factors [9]. An individual must:

1. Be intrinsically motivated to engage in a task
2. Put forth a strong effort to improve performance on the task
3. Engage in carefully designed practice tasks
4. Receive or generate feedback that informs on the results of performance
5. Sustain this effort through repetition

These factors are represented in Figure 1.

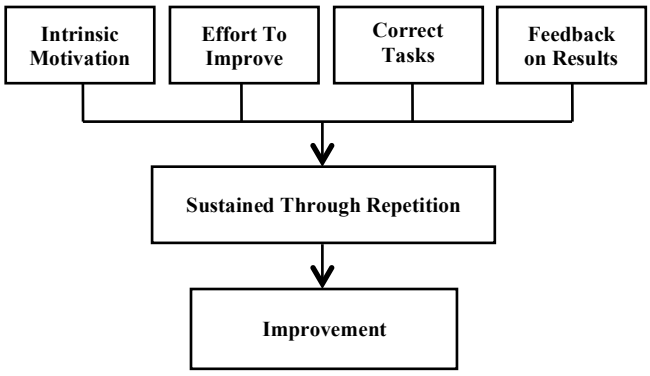

Figure 1. A diagram of deliberate practice.

The present paper considers these points with the aim of better understanding how deliberate practice can be fostered through the use of badging technologies. This paper places less emphasis on condition 5, repetition, and more emphasis on how to create the necessary conditions for the completion of deliberate practice (i.e., conditions 1-4). While a discussion of how repetition can best be executed is useful (e.g., how many times practice attempts should be completed and time interval between them), it is beyond this paper's scope. We can begin by focusing on the first step, which aims to establish motivation in the learner.

4.1 Motivation and Effort

Motivation is an interesting construct due to its widespread applicability. If the goal is to foster completion of any task in any domain, one seeks to foster motivation in addition to other task-specific and general constructs and processes. Aside from being one of the criteria for deliberate practice, motivation is what gets users to adopt software and read documentation. It is what enables students to listen and be receptive to instruction and to test new strategies. In other words, *motivation is powerful and necessary for learning to occur*.

Motivation can come in many forms. It may be achieved through encouragement, the promise or expectation of tangible rewards (e.g., money or prizes), the delivery of verbal praise, the solicitation of additional input in regards to critical issues, and so on. While the processes that support motivation all deliver a similar message – approval – the choice is not trivial. This is because the form in which motivation is delivered does matter. Consider two scenarios. An employee may have to learn how to use a specific piece of software quickly in order to keep his job and continue to obtain paychecks. Meanwhile, a hobbyist may begin to learn HTML because she has always wanted to build a website.

The employee is completing the task so that his supervisor will allow him to keep his job and continue to earn his salary. In other words, the first is *extrinsically motivated*, or motivated to complete an action in order to acquire some reward [14]. The hobbyist, on the other hand, is motivated by an internalized goal to share her work through the Web. This individual is *intrinsically motivated*, or motivated by internal factors [14]. They are both accomplishing their goals, however, so why is one form superior to the other? The answer is *effort*. Intrinsically motivated individuals, like the hobbyist, are more likely to put forth a stronger and longer lasting effort than extrinsically motivated individuals [15]. Here, the employee is more likely to learn the minimum required knowledge in order to do the job to a satisfactory degree, while the hobbyist is likely to learn more, because she is actually interested in the subject matter and spends more time on task. In the latter case, the hobbyist enjoys learning more about the area and practicing the necessary skills to gain expertise.

The above scenario is not meant to argue that extrinsic motivators have no value. When an activity is not intrinsically motivating, for example, extrinsic motivators can be effective [14]. If the employee is unable to find any source of intrinsic motivation to complete his tasks, then the extrinsic awards associated with his duties (namely, financial compensation) are enough to persuade him to continue working until the job is finished. However, if such performance is also linked with intrinsic motivators, such as a sense of self-fulfillment resulting from a high quality of work, then the duties are more likely to be performed with a higher degree of quality.

4.2 Designing Badging Systems that Support Motivation

Several studies examined the impact of badging on motivation, with many showing an increase in motivation [16,17,18]. However, not all have obtained such positive results. For example, Fanfarelli [19] implemented a badging system in a game meant to teach brain structure and function, and compared it to versions of the game without badges. In this study, badges did not significantly affect intrinsic motivation. Participant observation indicated that this was most likely due to the design of the system, a conclusion that has also been reached in other badging studies (e.g., [16]). Luckily, there are some guidelines that can be followed to aid in the badge design process when such badges are included to increase user motivation.

Before advancing, a contradiction should be addressed – *How can badges influence intrinsic motivation when intrinsic motivation concerns internal justification and badges are externally awarded?* The response to this question is why badging design should be undertaken carefully, and with proper understanding of the underlying mechanisms. If one completes an action for the sole reason of acquiring a corresponding badge, the badge will function as an extrinsic motivator. The key is to use badges to inspire intrinsic motivational qualities – curiosity, exploration, thirst for knowledge, improved ability, and so on. The remainder of this section will address how to accomplish this purpose.

First, literature suggests that it is important to *make sure the badge system is visible*. This is important to consider in order to support the motivational effects of badges, and also to support general badging effectiveness. If several non-essential steps are required before a user can access their badges, they may never access them. If badges are not accessed, or are accessed infrequently, they may not provide any motivational benefits [16,19]. After all, how can a system be effective if it is never used? To this end, systems should ensure badges are easily accessible and should incorporate some method for reminding the user of their earned badges. If a visual interface is used, a conspicuous button can be placed in a position that remains constant and allows users to quickly access their badge acquisition history with a single click, meanwhile serving as a constant reminder of their existence. A website may keep such a button just beside the navigation bar with a background color that differentiates it from the navigation. A system with breaks in between content presentation may find opportunities to present recently earned badges during those breaks (e.g., a training game designed to teach new employees how to effectively interact with customers over the phone might show recently earned badges during a break between levels).

Research also suggests that in order to foster intrinsic motivation, badges should be *unexpected*. In other words, the user should not be able to predict when they are going to receive a badge. A meta-analysis examining 96 studies on rewards and their effects found that negative effects were only produced when rewards were expected, tangible, and provided only for task completion [20]. To make badges unexpected, users should not be able to view a list of badges prior to earning them [21]; badges should only be made available as they are earned. When badges are expected, they feel more like typical extrinsic rewards ─ if an employee works, he will receive his paycheck. If a user completes the badge's task, he will receive his badge. If the paycheck is not received, the employee will probably be fairly upset and feel like his effort was for nothing. If the user does not get his badge, he will probably be upset and believe he is working with a poorly functioning system. Also, over time, the user may lose interest in completing tasks that do not provide a reward (i.e., badge), potentially reducing any intrinsic motivation the user originally had [22].

On the other hand, unexpected badges include surprises. Users are not trying to complete the task to obtain the badge, they are completing the task for the sake of completing the task (e.g., completing an examination earlier than the due date because they have several errands later in the week). The badge becomes *a little something extra*. It is not the reason the user completed the task, but it is a nice recognition and reminder of their positive behavior.

These unexpected badges can also inspire curiosity, thereby encouraging exploration [23]. For example, a user might ponder: *If I received a badge for finding this new feature, I wonder if there are other features I am unaware of that have badges attached to them.* By this reasoning, receiving a badge for stumbling upon the track changes feature in MS Word could lead to active seeking of new features and the corresponding discovery of its citations features. In other words, *unexpected badges can motivate users to actively explore and understand new interfaces and other environments*.

Finally, research suggests that badge designers should avoid providing badges awarded only for the completion of required tasks. As mentioned earlier, awarding badges only for task completion can hinder intrinsic motivation [20]. If the user was going to do something anyway (whether because it is a simpler part of a more complex task, or is forced by an outside source such as job requirements), no further motivation is needed. Instead, it is more productive to *design badges that are awarded for exceptional effort*. Taking the time to explore is one example, but others exist as well.

For example, in a technical writing course, deliberate practice is often a necessary condition of student learning. Consider a course in which students are taught to develop good technical presentations. Within this course, a student may design a table, chart, or other visual tool that is designed in a way that is exceptionally well-organized, aesthetically appealing, or clear. A student's strong performance in any one area may be a good candidate for a badge in order to motivate the student to continue iterating through the assignment until all three areas are of high quality. Here, awarding badges serves as approval of the student's competencies, informing the learner of good performance that should be replicated in the future but that also could be improved through additional focused practice.

Above all, when designing badging systems to support deliberate practice, it is important to remember to keep your audience in mind. If you anticipate your readers will be inherently interested in the topic, you may not need to spend much effort fostering motivation through badging. Existing motivation may be sufficiently high to enable deliberate practice. On the other hand, if you expect the receiver of your material will be a bored employee, forced into his or her role, consider implementing these strategies with a focused effort.

4.3 Designing Badging Systems for Goal-Setting

Information designers must also be aware of the role of focus and goal setting in interactive information scenarios. For example, after a user is motivated to engage in a task, he must be sure to practice the *right* task in order for deliberate practice to occur. No matter how much one consciously exerts effort toward a goal, no progress will be made if the effort is exerted in the wrong direction. Choosing an appropriate direction is often difficult

when working in a novel environment or on a complex task. Even if a user is able to effectively contrast her current skillset to the one that is required to complete a task and identify the relevant gaps in her abilities, she must then understand how to address those gaps by training the missing skills in ways which do not promote negative habits.

An intermediate or expert may be able to identify these skills and self-prescribe relevant practice exercises, but it can be difficult for a novice to understand which tasks are valuable in a complex professional environment. Here, trainers, teachers, mentors, or other leaders are useful in helping novices set goals [24]. These individuals, however, may not always be available. If the user is learning to use new software from his home computer, other knowledgeable individuals are unlikely to be present. Even in the workplace, where mentors are more readily found, they often must spend time elsewhere, leaving novices to learn on their own. This condition is unfavorable, as it can lead to insufficient or negative training ─ training which results in the development of skills, knowledge, or behaviors that are incorrect or otherwise do not match the task [25]. At best, this provides no net benefit; at worst, it can be detrimental to a user's understanding or skill development.

When mentors are unavailable or otherwise unable to assist in prescribing useful practice tasks, badging is a useful option. After all, badging systems inherently prescribe tasks that are to be completed, and may be designed or co-designed by subject matter experts. When these tasks are linked to professional goals in a way such that badge completion also signifies goal completion, striving toward badge completion is also striving toward professional improvement. Moreover, badges used as goal-setting devices tend to be positively perceived by users [6].

Goal setting theory [26] provides recommendations for effectively defining these goals. First, goals should be challenging, but achievable. Higher difficulty goals tend to produce higher levels of performance, but only if the user has the skillset necessary to meet the challenge. It is therefore important to carefully predict which skills and abilities the target users will possess. This enables badge requirements to be designed to an appropriate level of difficulty. Goals that are too simple decrease the efficiency of learning and performance within the system. Goals that are too difficult can be frustrating and compromise the learnability of the system.

Consider a web-based simulation of a smartphone, where users have access to on-demand information, instructions, and help as they attempt to learn to use this device. If the users are primarily novices, the first badge probably should not be awarded for downloading an app from the app store. This is a complex task which requires several steps, any of which may be foreign to the user. Instead, simply unlocking the phone may be a good first goal.

While it may be necessary to start with simple goals, user abilities will improve over time as training progresses. Goals should thus have multiple levels of difficulty so that goal difficulty can continuously be matched to user ability [26]. This can be achieved by incorporating incremental badges [21]. These badge sets are provided for the same behavior, but for doing it more times, or to increasingly higher levels of proficiency. Perhaps a quality assurance worker needs to identify defects. In a virtual training system, separate badges may exist for identifying 10%, 25%, 50%, 75%, and 100% of all defects within a training scenario. While the beginner may only be able to spot obvious defects at first, increasing levels of understanding will tune his senses to be able to identify more subtle issues, raising his success rate over time. A similar incremental badge set may require a worker to identify 1, 5, 10, and 25 defects within a scenario. The key is that the user continues to strive for increased proficiency.

However, badges do not need to be designed to only award different levels of the same behavior to support improvements in skill. Like the smartphone example presented previously, they can also reward increasingly complex demonstrations of ability. *Meta-badges* are badges that are earned for completing a series of related badges [21]. To download an app on a smartphone, a user needs to complete a series of steps. He needs to activate the screen by pressing the "On" button, unlock the phone by inputting a password, navigate to the app store app by swiping over a few screens, click the app store icon, and so forth. To develop micro-goals that can support a macro goal at task completion, a meta-badge system can be created. For example, if task completion is constituted by successfully downloading an app from the app store, then micro-level performance objectives can be specified through the design of several *sub-badges*. The sub-badges may reward these individual steps, leading the user through the steps toward achieving the larger goal.

The specificity of badges is also crucial [26]. Vaguely defined goals can inspire a range of performance levels that do or do not meet the goal, depending on the subjective opinion of the rater. Specific goals use concrete specifications that are not ambiguous. Both the designer of the goal and the user attempting to accomplish the goal have a shared mental model of the performance required to be successful, resulting in predictable behaviors, performance, and all associated constructs. In other words, badges that are meant to facilitate goal setting should attempt to set concrete values when possible. While subjective badges can be useful for other purposes (e.g., supporting motivation through reward), specific badges support the formation of specific goals.

It is also important to consider the relationship between motivation and goal setting. We know from the prior discussion regarding motivation that unexpected badges seem to offer the best outcomes, at least according to the literature so far. However, in order for badges to facilitate goal setting, the user must understand the goal, and therefore be able to see the badge requirements prior to earning. This means that badge design guidelines may contradict one another, depending on whether a designer's primary goal is to motivate or direct users toward specific task objectives.

There is, unfortunately, a dearth of research on the interplay between goal-setting and motivation in badging systems, but we can speculate about some strategies for developing a system around one's knowledge of a system's users. For instance, if a user is already sufficiently motivated to complete a task, *unexpected* badges may not be necessary. Similarly, if a user has sufficient expertise to set her own goals, or has goal setting support in some other form, then *expected* badges may be unnecessary. However, if a system needs to provide both motivation and goal direction, the designer may consider two options.

If only minor goal setting support is required, designers may consider using unexpected badges, with hints in the badge text toward the requirements of another badge. "You have successfully recorded a macro in Microsoft Excel, but where can these macros be useful?" In this way, the user can be invited to explore a feature more deeply without explicitly defining a goal, obtaining a hint about obtaining the next badge and a direction in which to

focus her efforts. This is achieved without the system making the next badge expected. The next badges may then be obtained for applying formatting or completing calculations using macros.

The second option involves using a combination of expected and unexpected badge types. This may be the best solution when more explicit goal setting is required. Badges that facilitate goal setting may be expected, while other badges may be unexpected in order to support motivation. As previously stated, more research is needed on ways to properly integrate badges for goal setting and motivation. This is an area of research that has great potential for improving the versatility of badging systems.

Ultimately, goal setting guides the user in the direction of appropriate practice tasks, as required by deliberate practice. As badging becomes more effective in supporting goal setting, so does it become more effective in supporting deliberate practice.

4.4 Designing Badging Systems for Feedback

Once a user is motivated to complete a task, and once that user is exerting effort on useful practice tasks, feedback must then be generated in order for him to understand his current ability and progress. Feedback is the aspect of communication which tells users how well they are doing [27]. It is essential to communication, in general, [28] and to deliberate practice. After all, feedback enables users to adjust course and implement change [29]. One aspect that separates practice from deliberate practice is the emphasis on focused exercises. Good feedback is essential for providing that focus to end users.

A user who is motivated and striving toward a goal will be exerting some level of effort, but it may be unrefined. Consider an employee in a lead role who is designing a PowerPoint presentation to communicate a research agenda to the company's advisory board. The critical information that needs to be communicated is fully present within the presentation, *if* the audience chooses to read the three paragraphs of text on each slide. The overly dense text is likely not the best format for communicating this particular information to this particular audience. More broadly, working toward a goal is useful and necessary, but sometimes a little redirection is necessary. Feedback is the external force that says "Have you considered using figures and tables to supplement the text?" Like feedback in a classroom, there are various forms this communication might take, from a verbal reply by an instructor to an entirely automated assessment within a course management system.

As with goal-setting, feedback can be difficult to obtain in the absence of mentors. In these situations, badges can provide feedback, especially in instructional contexts [7]. Badges excel in this role due to their ability to support timely delivery of feedback. Earning a badge, after all, is feedback. The badges can be tailored to provide specific types of feedback by adjusting the visual look and feel of the badges as well as their textual, visual, or auditory accompaniments. Fortunately, for many learning scenarios, instantaneous feedback tends to be most effective [30]. Badges excel in communicating information on an event-based schedule. They can be designed to release pre-specified information that follows the occurrence of any event that can be detected by the system. In other words, to the extent that user behavior (or a range of possible behaviors) can be forecasted, badge-based feedback can be designed to provide information that is appropriate for the situation.

Moreover, it is known that feedback is most effective when it is layered upon feedback given in previous trials [31]. When simple conditional algorithms are used (i.e. if *this* has occurred, and *that* badge has not been awarded, do *this*), designers not only have more control over exactly which information is released and at which point in time, but can also assess which information has previously been provided so that elaboration can occur. This elaboration is situated with reference to, and understanding of, pre-existing knowledge. This is important and supports feedback's mission to enhance learning when there is a gap between current understanding and desired understanding [32].

The event for which feedback is provided is also influential. While feedback can be provided for incorrect responses or other failures or shortcomings, feedback given for correct responses tends to be more effective [31]. In other words, it is preferential to state "Your decision to include a chart in order to describe this complex topic really helps clarify your argument," instead of "Your description of the topic is unclear. You should have included a chart." Aside from conveying approval of the user's actions, feedback for correct responses also provides a clear route to success. The user has enacted the strategy successfully in the past and is likely to be able to replicate that effort. On the other hand, feedback for incorrect responses helps users understand where they could have done better, and provides some direction.

The amount of feedback delivered at any given moment within an interactive system must also be considered carefully. For complex actions, a student may not know exactly how to implement a corrective strategy until they successfully implement it once. For example, an instructor may suggest using a chart, but the user might wonder what that chart should look like. However, feedback with enough elaboration to explain all of these factors is likely to be overwhelming. So, determining the appropriate amount of feedback to include can be a difficult exercise. When it is necessary to convey a large amount of feedback, badges can help to release information in small chunks rather than all at once.

As an example of how digital badges can mediate feedback that is useful for deliberate practice, consider interactive electronic technical manuals (IETMs). IETMs are manuals that are displayed on an electronic device and allow interactions between the manual and user that may facilitate the subsequent presentation of information [33]. In other words, the information displayed is dependent on the actions of readers and the decisions they make as they interact with content. When well-designed, these interactive manuals have a number of benefits over traditional paper manuals. They do not have to be physically stored, they are easily searchable, and they can interact with the user to facilitate the user experience. However, the openness of the format also presents opportunities for readers to become overloaded with information or for them to lose their places when troubleshooting complex procedures. Feedback provided by badges could be used to direct reader attention toward particular nodes of information or assist with navigation during the display of complex troubleshooting steps.

Consider an IETM designed to assist mechanics with a particular type of aircraft landing gear repair procedure. This hypothetical system is infused with a badging system and uses interactivity to adjust the system based on user expertise and relevant feedback

from recent maintenance calls in a central database. A training tutorial in this IETM leads a maintenance mechanic through the process of removing a wheel from the landing gear by loosening each bolt in a particular order then removing the wheel to perform a visual analysis of wear. Wheels with excessive wear must then be inserted into a special machine for additional analysis. Then, the existing wheel or a new wheel must be added with each bolt tightened with the correct amount of torque. Since this repair involves multiple steps, including the removal of wheels from the landing gear system and their subsequent reinstallation, it is critical that the repair be done correctly. Specifically, the bolts must be removed and reinserted in the correct order, turned so that they are not too tight nor too loose, and so forth. Additionally, the mechanic must log the appropriate notes in the maintenance database following the procedure.

As a user continued through this process, the system could use badges with specific feedback to shape the interactions into opportunities for deliberate practice when additional practice was deemed necessary based on other repair entries in the central database. This would supplement the information relevant to the task at hand with additional training to ensure both the current repair and future repairs were done correctly. When novice mechanics are first learning how to perform this repair, badges could be used to customize feedback within IETMs drawing from both general and personalized maintenance notes in a central database. For example, the following scenarios indicate possibilities within two different critical areas of this maintenance repair process:

Torque: A *right tool for the right job badge* recognizes when a repair is done with the most appropriate tool. While a normal wrench or socket wrench can be useful for applying torque, it forces the user to set torque by feel, an unpredictable method for those who do not have years of expertise. Torque can be applied more consistently through the use of a torque wrench – a wrench that allows the user to set the specific amount of torque that will be applied. Thus, this badge may provide feedback that states: "A common mistake in this repair is applying incorrect amounts of torque to the wheel nuts. Using a torque wrench allows you to consistently apply torque with precision. According to your maintenance log, you have identified the importance of using a torque wrench to ensure you are meeting torqueing specifications." While the badge is rewarding the user in response to desired behavior, it is also providing feedback that tells the mechanic which part of her behavior was desirable. Now, the user knows that she has selected the correct tool, and will be more likely to use the torque wrench for torqueing in future work.

Logging: A *maintenance log I badge* can be used to recognize positive behavior while explicitly describing opportunities for advancement. For example, the badge may include a description that reads: "You sufficiently detailed the type of maintenance performed and the order of your repair steps, but did you include the tools you used?" Meanwhile, the *maintenance log II badge* would be disseminated for all of the conditions required by the first badge in addition to including the tools used. In this way, the combination of badges can provide instant feedback focused on desirable behavior, while also identifying shortcomings, contributing to the creation of a system that harnesses lessons learned from the literature to effectively use feedback. This combines with the repetition, goal setting, and motivation recommendations presented earlier in this paper to form the necessary conditions for deliberate practice to occur.

5. CONCLUSION

In this paper, we described deliberate practice as a useful activity within the realm of technical and professional communication. We then synthesized literature from a variety of fields in order to suggest design guidelines for building badging systems that guide end users toward deliberate practice. Although the concept of repeated practice seems deceptively simple, doing it productively is actually a complex activity which requires sufficient motivation, clearly defined goals, and appropriate sources of feedback. Fortunately, in the absence of human expert mentors or instructors, computer-based interventions such as digital badging systems are now more capable of guiding users through more meaningful practice scenarios. By doing so, practice can lead to the cultivation of important skills and knowledge useful for purposes ranging from training new employees to flying modern aircraft.

More research is needed to identify the best types of badges necessary for encouraging deliberate practice for specific types of individuals and specific types of learning contexts. Such research will tell us not only about the impact of badging in redirecting or guiding user experiences, but also about the deeper possibilities of how we might use computers to shape and guide how humans use technology.

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