

# Affordances and Form: Applying Lessons from Informal Learning to Formal Learning on the Web

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## INTRODUCTION

For most of us, learning online is performed with a web browser and a search engine. With experience, we develop and hone skills at finding, filtering, and assessing resources made available on the World Wide Web. This kind of informal learning is entirely self-directed. We regulate our goals and time allotted in reaction to what we find as our inquiries proceed. New scaffolds, such as rating and recommendation systems, increasingly aim to improve our effectiveness. But we are simultaneously confronted by many obstacles and distractions. Our searches return overwhelming hits with rankings reflecting many influences. Site and page designs present myriad organizational strategies and user experiences. The information we find varies widely in its motivation, targeted audience, reliability, and currency. Advertising vies endlessly for our attention in subtle or intrusive ways. Yet, despite its efficiency, we persist in this daily pattern of searching and browsing simply because the web is the most extensive and accessible source of information in history, servicing a lifelong need for learning.

Since its inception, attempts to employ the web as a medium for formal learning have also been pursued. Perhaps not surprisingly, many of these attempts have strongly reflected what existed before the web. In the academic community, we find simple “ports” of the classroom experience, with pod-casted lectures supplemented by notes, slides, and discussion forums. In the computer-based training community, we find click-through “tell and test” modules rooted in the CD-ROM era. More promising are newer constructivist and adaptive learning environments, with their foundations in hypermedia and intelligent tutoring systems. While the latter present more indigenous user experiences, especially in terms of user navigability, they make only limited appeals to our everyday experience using the web for learning.

In designing a new corpus of online instruction, one that addresses information security for adult learners, we have attempted to use what is best about the web as a guide, while contending with its liabilities to gain back efficiency and effectiveness. We have introduced familiar web affordances, such as assisted searching and recommendations, with features adapting to the learner’s situation. Foremost, we have emphasized freedom of action and the ability of learners to adapt the training to better suit their individual learning styles. This freedom is counterpoised by explicit activity structures that facilitate action with intention exercised through familiar interfaces and interactions.

We begin the paper by discussing advantages and disadvantages of informal learning on the web through the lens of modern constructivist and adult learning theories. We then describe the use of an explicit macro-structure of learning activities as a means of addressing efficiency and adaptability. Since this design stratagem is a refinement of prior work principally addressing classroom learning, we present and discuss modifications we have made to address online learning. We continue by describing the use of familiar web affordances in our learning designs to leverage the pervasive experience using the web for informal learning. We conclude with a discussion of future work.

## INFORMAL LEARNING ON THE WEB

A predominant characteristic of informal learning using the World Wide Web is that it is self-directed. The primary use elements of the web, searching and browsing, are well suited to learning experiences in which, as Malcolm Knowles describes it, “...individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes.” [1] In his views on andragogy [2], Knowles further recognizes in adult learners the influence of existing knowledge and experience on future learning, a process attribute shared more basically with constructivist learning theories. [3]

Consider an everyday web inquiry. A learner enters some search phrase into a search engine and is promptly presented with a list of links and citations pertaining to those terms. The learner then scans this list attempting to make a connection between some of these choices and his or her objectives. Links are followed and the learner must quickly discern if the material presented will be useful, prioritizing and filtering these choices. How long should he linger in a single resource? How far down the list of resources should he venture? Is a given resource truly accurate, reliable, and unbiased? Is the current search phrase leading in the right direction and when should changes be made? How will he know when the original learning objectives are met and if they were the right objectives?

An obvious problem with learning in this way is reliance on metacognitive skills to efficiently and effectively realize learning objectives. For individuals lacking such skills, the freedom the web offers can become something of a tar-pit. As sociologist C. Wright Mills wrote, when examining the role of intellectuals in a Post-WWII society, "Freedom is not merely the opportunity to do as one pleases; neither is it merely the opportunity to choose between set alternatives. Freedom is, first of all, the chance to formulate the available choices, to argue over them—and then, the opportunity to choose [4]."

We see dual challenges in designing formal learning experiences for the web as (1) to compensate for individuals with poor skills as self-directed learners and (2) to help cultivate those skills. In addressing these challenges for an adult training regime on information system security, we have employed modules that utilize a common macro-structure based on a paradigm for technology-based learning called *anchored instruction* [5]. This design pattern is an inquiry cycle, called *STAR Legacy*, consisting of a set of complementary learning activities overarched by a challenge providing the context for the inquiry [6]. For adult learning, we have simplified this cycle based on an earlier approach taken for adult continuing education [7]. The following sections present and discuss this learning cycle and our adaptations.

#### STAR LEGACY

In an ideal scenario, all of the freedom afforded by the web would be a powerful tool in the hands of the learner. It could be considered the ultimate adaptive learning environment where individuals select resources that best suit their learning style. The process would be efficient and effective, but as we have mentioned earlier, this is most often not the case.

A major goal of the Star (Software Technology for Action and Reflection) Legacy cycle developed by Daniel Schwartz and others in the Cognition and Technology Group at Vanderbilt was to help teachers and learners see where they are in a complex sequence of learning [6]. In an online setting, where the instructor is not part of the environment, we employ the explicit structure of Star Legacy to show the users all of the learning activities that are available to them with no enforced order. Learners are invited to adapt the structure to suit their individual needs, using the activities in an order that best suits them and selecting only those activities that they need to solve the proposed problem. This explicit structure adds the scaffolding necessary for even the most inexperienced online learner to begin constructing his personalized training immediately.



Fig. 1: The Star Legacy Cycle

Presented with five learning activities and the freedom to move in and out of them as he pleases, the first time user often visits each activity in order, as they are presented in the model. A new user will most likely begin by visiting the *Challenge* activity to gain context for the other phases. This challenge is drawn from real-world situations or cases related to the subject being taught. He will then move on to the *Thoughts* phase for problem setting. Here learners are presented with a set of probing questions that serve to lead them into the *Resources* phase. After studying the thought questions, students see the problem from multiple perspectives and identify what they need to know to solve the problems posed in the challenge.

These first two phases in essence provide the framework necessary to preserve efficiency as the user is faced with a list of unfamiliar learning activities. Unlike the common web experience, where the lack of scaffolding or any other trusted guidance can lead to aimless and uninformed "clicking", here the student is

empowered. He has been given a motivating problem to solve and support in examining this problem to account for the applicability of current knowledge and needs for new learning.

Continuing on in the cycle, the *Resources* phase contains the bulk of the learning activities used for problem solving. In keeping with the principles of anchored instruction [5], learners are free to move throughout these resources which address various aspects of the challenge. Ideally, several resources will cover the same material using different instructional methods. This multiplicity is particularly important in areas where learners have greater difficulties and alternative treatments can accommodate learners with differences in individual learning styles. To support reflection on progress towards learning goals, no-stakes self-assessment resources are provided in the *Assessment* phase. Finally, the *Wrap Up* phase supports reviewing what he has learned and presents an opportunity to relate it to a similar challenge.

As the learner gains knowledge about the subject presented, she is also gaining an understanding of the underlying structure of the learning experience. Each new module will be laid out in exactly the same way; Challenge, Thought questions, Resources, Assessment and Wrap Up. Some learners will continue to follow a sequential path through each module; others will experiment with new paths as they find which learning activities afford them the best learning opportunities and possibly, which activities are unnecessary or not useful to their learning experience at all.

In the next section, we examine some modifications we have made in phases of the Legacy Cycle presented in [6] in an effort to construct an online environment suited to adult learners. We will then examine a set of web affordances we have incorporated into the learning platform as a whole.

#### OUR ADAPTATIONS TO STAR LEGACY

Our first departure from the classical six-phase Star Legacy Cycle can be found in the Thoughts phase. In a traditional learning environment where an instructor is present, students are presented with a challenge and then proceed to a phase called Generate Ideas. Here students work alone or in collaboration to list issues and possible answers pertaining to the challenge. Once an initial list of questions has been created, they tackle the Multiple Perspectives phase which helps students to further define issues about the challenge based on the perspectives of relevant stakeholders. The purpose of these learning activities is to help students make their own thinking explicit rather than allow it to remain vague and tacit. The multiple perspectives provide a way to introduce students to vocabulary and perspectives that are quite different from their own and that often characterize expert approaches to the topic.

In our modules, students are presented with the Thoughts phase. Here, the relevant questions have been posed for them, with no answers provided. As mentioned previously, these questions can be used as a general guide for students to assess what they do and don't already know about the challenge. Some questions and their answers may be obvious to the learner and require no further study. Others may bring a fresh new perspective to the problem and can serve as a catalyst for learning. The questions are typically posed from different perspectives, allowing the user to see the challenge in a much broader context. Many of our learners are themselves professionals. They will most likely find their own perspective among the questions posed, but it may be the first time they have seen the challenge from a different point of view. This can be critical to enlarging the learner's understanding of the challenge beyond their current scope.

The freedom of movement afforded by the Star Legacy Model encourages students to revisit the Thoughts phase periodically throughout the training. George Polya, writing in his book "How to Solve It", clearly defines the course that students take as they are grappling with a new skill. "Trying to find the solution, we may repeatedly change our point of view, our way of looking at the problem... Our conception of the problem is likely to be rather incomplete when we start the work; our outlook is different when we have made some progress; it is again different when we have almost obtained the solution." [8] Returning to this phase throughout the training affords the learner a chance to rethink his initial impressions; to challenge his current beliefs concerning the problem; to construct and reconstruct a model for his solution.

The Assessment phase of our modules provides a no-stakes formative assessment similar to those found in the "Test Your Mettle" phase of the classic STAR Legacy Cycle. Everything about these self-assessments is a departure from the typical online exam. Here, we introduce progressive remediation—the notion that assistance provided to a learner attempting to answer questions or solve problems should initially be limited and become increasingly stronger [9]. The goal is to help learners recognize their own mistakes and misconceptions, rather than simply "hinting" about the correct response.

Students decide when they are ready to attempt the self-assessment. They can take it as often as they like; their score and the number of attempts will have no bearing on their course qualifying exam. CAPE (Courseware Authoring and Packaging Environment), the authoring tool that supports our current online development efforts, makes it possible for us to use a rich variety of question forms to include fill in the blank and short answer [10][11]. A learner attempts to answer a question and the response is evaluated immediately. If the answer is incorrect, the first stage in the feedback loop clarifies the question for the learner to be sure that he understood what was being asked. If he answers incorrectly again, a second remediation stage provides a brief explanation of what is wrong with his answer. Here, the user not only recognizes that he may not yet fully understand the concepts being examined, but his misconceptions are addressed and corrected. Finally, if he fails to answer correctly on his third attempt, feedback is given in the form of a list of suggested resources found within the module that will help in better understanding the new concept. A learner may take the assessment one question at a time, moving in and out of the other learning activities as needed, or he may take it all at once, as preparation for the summative assessment.

Our final phase, the Wrap Up, is another divergence from the classic Star Legacy Cycle and complements the Thoughts phase. The primary purpose of the phase is to support synthesizing what has been learned *viz.* the module's challenge. Our Wrap Up is divided into two stages. In the first, students revisit the thought questions that were posed in conjunction with the challenge. A discussion of possible solutions is presented which refer to the module resources. Here the learner has a chance to compare his solutions with that of subject matter experts. The second stage is essentially a transfer task, where a related challenge is posed along with another set of thought questions. The aim of this section is to lead the user to extend his newly gained knowledge to a different situation. Here discussions of the thought questions are presented so that the learner can see how his new knowledge and skills can be extended.

Our changes to the classic Star Legacy Model were born out of necessity—the online training environment we are addressing lacks a real time instructor and does not afford collaboration among users. Taking advantage of the technological advances that CAPE has to offer, we have created an online experience that is as adaptive and rich as the web environment, but also contains structure and guidance necessary for efficient training. It is a complete departure from the tell-and-test training still commonly seen in online learning.

As stated in our introduction, the goals for designing online formal learning experiences have been twofold; to contend with the liabilities of the web while still using what is best about it, in each case seeking to increase both efficiency and effectiveness. We now discuss our efforts to capitalize on the strengths of the web—those affordances that make the web a popular environment for informal learning.

#### AFFORDANCES

From basic searching and browsing to newer scaffolds like rating and recommendation systems, the World Wide Web has evolved into an extremely rich and powerful information resource while preserving its usability. When we began designing our formal online learning environment, we wanted to make it as familiar as possible to the user. Little time would be spent learning how to use our courseware and more time would be spent actually using the learning activities. The hallmark of Star Legacy, as we have employed it in this project, is the freedom of movement given to the learner, allowing learners to "drive" the courseware while providing sufficient guidance to promote efficiency and effectiveness. When a user is granted the freedom to adapt and design their own learning sequence, an environment emerges that is personalized with respect to both their existing knowledge base and their unique learning style.

While constructing formal online learning environments as hypermedia is nothing new, the companioning of link-based navigation with the explicit learning activity structures of STAR Legacy addresses an important efficiency concern. The typical use of hyper-linking on the web is subject-based, which is good when the available information is addressed at multiple depths, in multiple contexts, and from multiple perspectives. Within a formal learning experience, the available treatment of subjects is far more constrained, yet the ability to traverse the available activities and resources to find alternative treatments remains an important feature. Within our modules, we have chosen to use hyperlinking principally to address navigation within the Legacy Cycle and among available resources. We support subject-based traversal through the common web affordance of searching.

Strongly influenced by live-search features provided in web browsers such as Mozilla Firefox, the search facility we provide in our courseware is an assisted search, where feedback regarding the presence of a word, fragment, or phase in the search indices is provided continuously in a *Suggestions* area. The scope of

searches can be adjusted from the current module to the entire course. Both the learning resources provided in the *Resources* phase of modules and the reflection resources provided by the *Assessment* phase are indexed. In this way, learners can use searching to freely move back and forth between learning and self-assessing what they have learned by subject.

Glossaries are a common feature of online learning resources that are not typically found in web resources. While valuable additions, glossaries can present usability concerns when presented as distinct resources accessed through hyperlink-based navigation. The inline glossaries we employ in our courseware are small pop-up windows that appear when a user moves the cursor over a term that is double-underlined, an approach widely used on the web for such things as targeted advertising. In this way, a user can easily access word definitions without leaving the resource they are currently studying.

We believe that the affordances we have included in our courseware create an environment that is familiar to the user and embodies the strengths of the web. Users should immediately feel at home with the freedom of navigation, active search, annotated remediation, and inline glossaries featured in every course. These common tools, placed in what may first be viewed as an uncommon environment by the learner, will put him at ease and serve as a guide. Each user should be able to begin work quickly, customizing the environment to facilitate their study.

#### FUTURE WORK

The web continues to evolve and provide increased functionality. Learning theories also mature and evolve. If online learning to grow as a viable alternative or supplement to face-to-face training, it must keep pace with these changes. We are exploring several innovations that have their roots in technological advancements and learning theory developments.

One area of interest is scenario-based assessment. In this style of examination, students are first presented with a scenario, possibly in the same style as the challenge they encountered at the beginning of their training. Questions concerning the problem and its possible solutions are posed, and then the scenario continues to unfold. With each new development in the story, more questions are asked. While the questioning can include traditional multiple choice, fill in the blank and short answers, the difference is that the questions all relate to the real world problem situation posed to the learner. In this way, the student sees relevancy in the questions and begins to appreciate their newly acquired knowledge as a tool to be used in solving new problems. As noted by Anderson and Heck, in the classical style of exam students answer questions that are limited in scope shifting from one concept to another, drawing on their memory more heavily than their problem-solving skills [11]. In opposition, scenario based assessments require the learner to exercise both their newly acquired knowledge as well as their ability to apply that knowledge in the form of relevant skills.

More adaptive approaches to scenario-based assessment are now possible with technological advancements found in authoring tools such as CAPE. Scenarios could unfold based on the responses of the student. For example, if a user chooses to install a host based firewall as his first line of defense against distributed denial of service attacks, questions concerning the configuration of the firewall would be presented. If they chose host-based intrusion detection, questions concerning the deployment of that software package would be the next subject investigated. A well designed test would lead each learner to cover all of the required subjects and several subjects of their choosing. This is reminiscent of classical style exams where a list of questions was posed and some portion of them had to be answered – a subset selected by the student.

Another area of development is the use of multimedia in presenting challenges and other learning activities found in the Star Legacy Cycle. Our interest here is motivated not only by the continued evolution of the web into an interactive visual medium, but because this use of multimedia is supported by sound research-based theories of how students learn [13][14]. Live video, animation, and sound are now commonplace throughout the World Wide Web. Resources that use such presentation techniques are not only eye-catching to the web-savvy user; they also provide dual channels for the learner to process the presented information, offering the potential for deeper understanding of the real-world knowledge and skills.

Finally, in an effort to increase efficiency in the face-to-face classroom, we are continuing to explore so-called *blended learning environments* [15]. Blended learning uses both online training and face-to-face classroom instruction to create a comprehensive training experience that maximizes efficiency and, thus, conserves training dollars. As an example, students preparing to attend a costly face-to-face training course

could first be required to successfully complete an online training component. This training may include a pretest to ensure that the learner possesses the requisite skills and that those skills are up to date. Those needing remediation could be directed to outside training sources, other classes created by the same provider, or included instructional material. In this way, valuable face-to-face training time would not be wasted bringing each individual up to the same training level. The online training could also include a review of material relevant to the upcoming course. In another scenario, online post-tests could be administered after the face-to-face training to test knowledge and skills retention, serve as a recertification test, or provide more study time before the final, certifying exam. Remediation could also be a part of this component. A third setting for blended learning could be the presentation of supplemental training material to be presented along with face-to-face training. After the completion of a traditional lecture or other training activity, students could work with online training modules, applying what they have learned and reinforcing new skills.

#### SUMMARY

At the outset of this project the authors had one goal in mind, to harness the best of what the web had to offer in an effort to create efficient and effective online training. We relied on well studied learning models such as anchored instruction to create a scaffold that would provide the user the guidance needed to navigate the learning activities that we provided. We took full advantage of the technological advances of the CAPE authoring tool to create resources that were rich, assessments that were challenging and tools that were familiar as well as useful. We have succeeded in removing web frustrations, distilling the World Wide Web learning environment to create a new, familiar but more efficient framework. As we continue in our research in the area of online learning, we hope to discover more about today's online learner and to create learning environments that are not only pedagogically sound but also on the cutting edge of what technology has to offer the teaching and learning community.

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