

Information Literacy Skills Application in Engineering:

A Problem of Learning Transfer

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**Abstract**

Students hold their ability to find and use information appropriately for schoolwork in high regard. The librarians and teaching faculty who review and grade the work submitted in assignments tend to find the quality of information sources lacking the expected rigor. In a class setting, students are generally able to answer questions about how to evaluate resources and how and why to cite those resources, and yet that knowledge fails to be reflected in assignments. The paper presents this gap as a learning transfer problem in how the skills are taught and assessed, and in the level of understanding and ability to apply the skills to new situations and needs.

## **Information Literacy Skills Application in Engineering:**

### **A Problem of Learning Transfer**

As a librarian, the author is regularly asked to visit a class and provide the students a one session lecture on the library resources and services. The value of the resources in the library and the ability to find and use those resources efficiently is understood by the teaching faculty, which leads to the invitations to present information literacy skills to the students. Librarians do their best to make sure the information provided during a class session is relevant to the course content, and preferably directly related to an assignment the students have been given and will be working on shortly after the presentation.

Unfortunately, every librarian encounters situations where the students addressed in class are the ones asking questions later about retrieving materials or getting access to specific information, most of which was covered during class. The apparent disconnect between the instruction and application of the information presented raises questions about how the information is taught and the students' ability to assimilate the new information into their existing frameworks of understanding to leverage the benefits of the skills presented.

Additionally, students are able to respond to questions about information evaluation or resources which can be used to find the data or research needed when asked. Why do those students seem to revert to the methods and practices used before the library instruction session, and not apply information and knowledge, which they can clearly state and understand, raises questions of how information and knowledge is transferred from one learning situation into actual use? The lack of application of information literacy skills in situations outside of writing

an English paper, and in particular in science and engineering settings, can be presented as a lack of learning transfer.

### **Information Literacy Skills**

A commonly used definition of information literacy derives from the ALA Presidential Committee on Information Literacy Final Report written in 1989, where it is described as a set of abilities requiring individuals to “recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information” (American Library Association, 1989). While people outside the library profession may not know this definition exists, when presented with the information there is agreement that the skills listed are important for all students and are included in many of the learning outcomes included as part of accreditation goals, such as students who are lifelong learners.

Academic librarians are frequently asked to visit classes and present information to the students which include use of the library resources, criteria for evaluating resources and reasons for citing information used in a project or paper. The author has experienced many occasions where the students are able to list the criteria used to determine the credibility of resources found, both on the Internet or from a print resource. Similarly, students are able to articulate what pieces of information need to be included as part of a complete citation to materials used as resources, and list reasons why information needs to be cited when it is used. Despite these abilities to answer questions, faculty members lament the inability of students to find and use appropriate resources for their assignments.

Since it seems students know how to evaluate sources and how to cite them in their work, the question remains as to why they do not do so. While I propose this is a learning transfer

problem in the rest of this paper, additional explanations for the lack of knowledge application may exist. Motivation of the learner is often seen as intrinsic to the learning process. The more motivated the student is to acquire a particular skill, the more likely it is he will integrate that skill into his into existing models of understanding and functioning (Bransford, Brown, & Cocking, 2000). Since this explanation makes sense to teachers trying to impart knowledge and build skills in the students, many library guest lectures occur at the time an assignment requiring research skills is about to begin, and the instruction often includes resources which contain useful information for the project. While the information is presented in a fashion this is intended to assist the motivation to learn the skills and address immediate needs, students are not motivated to apply the information to the assignment. It is unclear if this is due to lack of accountability on application of the skills or some other factor. Identifying the factors effecting the students' choice to apply the skills to a particular setting or not could be an additional explanation for the apparent lack of application of information literacy skills. If the students truly know the information as well as it seems when they answer direct questions, then what factors are included and effect the decision to not apply those skills? I do not intend to pursue an answer to this question here, but it raises awareness of a possible area for future research.

### **Learning Transfer**

There are two theories about learning transfer which can be traced to the beginning of the 20<sup>th</sup> century and two seminal published papers (Judd, 1908; Thorndike & Woodworth, 1901). The first theory formally presented in the literature supports the specificity of learning functions, the need for similarity of tasks to enable transfer of learning and the lack of specific skill learning to influence other skills or areas of knowledge, even ones closely related (Thorndike & Woodworth, 1901), which was used to develop the ideas of multiple, unique intelligences in

people. The contrary theory supports the more general nature of learning and that learning in one area or skill set can be generally applied in other domains (Judd, 1908).

Thorndike and Woodworth (1901) posit that “improvement in any single mental function rarely brings about equal improvement in any other function, no matter how similar...” (p. 250). Examples of the mental functions Thorndike and Woodworth were including in their research are sense discrimination, attention, memory, observation, accuracy, and quickness. The experiment used different shape pieces of paper representing different areas and asked the subject to guess the area. The results show the ability to properly and consistently identify area for one shape in a particular size range, did not help the ability to estimate the area of another size or shape. The results were used to show that the mind works in great detail, and adapts to special data with which it has experience, and that the skill development is very specific to that environment.

Judd (1908) responded to Thorndike and Woodworth, specifically to address the topic of knowledge and lack of transfer between similar skills and to assert that all learning affects other skills. The experiment asked subjects to place pencils into positions matching the lines in front of them, without being able to see the hand moving the pencils. The subject was then allowed to see one pencil and practice setting it in position to match a particular line. The test was then repeated, with vision again blocked to the hand manipulating all the pencils and changes were observed in all placements which mimicked the adjustments made for the individual case where learning took place. Judd determined that the type of teaching and specificity of the teaching mechanism played a large role in the style of learning and the subsequent ability to apply that information to similar situations. Judd (1908) discusses how early instruction is well received by a learner, as they are in a “habit-forming attitude”, but that after the initial learning and practice

period, any subsequent instruction is less well absorbed, as that attitude of learning has passed (p. 30).

While this conversation may be identified as a starting point for research into learning transfer, questions about how people learn and how what they learn is transferred, or applied to new situations, continue to be investigated. There seems to be a difference in the original two research studies, as one tested mental practice and estimating skills, something without any concrete association in activity (Thorndike & Woodworth, 1901), and the other tested a physical skills exercise (Judd, 1908). Current writings have not reached a consensus about learning transfer, precisely what it is and how it occurs, but there are growing similarities in the descriptions around ways of knowing and learning and how those effect transfer of knowledge.

Issues of testing, training and re-testing to determine the ability of an individual to transfer the learning from a single situation to other, similar situations are discussed in both early papers. These experiments test what is termed *low-road* (Wilhelm, 2008) or *near transfer* (Bransford, et al., 2000) which describes the use of skills learned in one situation in another very similar and highly parallel situation, so the step necessary to apply the skill to a new situation is very small. In contrast, *high-road transfer* (Wilhelm, 2008) or *far transfer* (Bransford, et al., 2000) is the ability for a newly learned skill to be applied in a situation that is different in content or application from the details in which the skill was first learned. Both experiments used a protocol that included a retest shortly after the training exercise was accomplished. The testing was also completed in similar settings with only slightly altered activities. It seems likely that the early experiments were only addressing, or testing for, low-road transfer.

Authors apply different terms to the issues of low-road and high-road transfer, all with similar meanings, which give additional context through the subtlety of language. For example, Schwartz, Bransford & Sears (2005) talk about efficiency and innovation in transfer of knowledge. Efficiency is the knowledge that is readily retrieved and applied in similar situations, thus low-road or near transfer, while innovation takes additional understanding and application of knowledge and skills, thus high-road or far transfer. When thinking of transfer with the language presented by Schwartz et al (2005), a question emerges about the time necessary for a learner to develop more in-depth knowledge and understanding of information and skills, time to engage the meta-cognitive skills that lead to learning being assimilated into an individual framework. If that time is required, the research published to date which tests transfer have included that time in the procedures. Bransford et al (2000) discuss the effect of learning with understanding rather than simply memorizing content on transfer. When the information is truly understood, not just memorized, the information has been assimilated and the transfer of knowledge becomes easier.

Schwartz, et al (2005) and Illeris (2009) have attempted to tie different types of learning to the different modes of transfer and the subsequent ability to apply what has been learned. How we learn different information significantly effects the way we can retrieve and reuse that information, or transfer it, to new learning endeavors. Broudy's "Three Kinds of Knowing" (1977) are referenced by both Schwartz, et al (2005) and Illeris (2009), specifically his discussion of "replicative", "applicative" and "interpretive" ways of knowing. In replicative schooling, any input (skills or information) gets recalled pretty much in the same form as it was learned. Examples of this type of information can include numerical functions such as addition, multiplication and other types of rote learning. Broudy presents a need for these skills as the

“constants of thinking”, pieces of information which enable higher and more complicated mental processes because the student does not need to expend energy on these skills every time he encounters a need to use them. Applicative schooling describes the process of deducing the answer to a problem from facts, rules and known principles. For example, principles of physics can be applied the manufacture of jet airplanes. Unfortunately, without regular rehearsal or intense study, information gathered through replicative learning seldom remains with the learner, and similarly, without clear application to a workplace skill or other situation of recurring use, applicative skills will likewise fail to be retained (Broudy, 1977, p. 10).

Illeris (2009) put the “three kinds of knowing” into a different context and created parallel categories with the terms cumulative learning, which describes repetition oriented gathering of information; assimilative learning, which embodies working toward application of a subject or scheme; and accommodative learning, which embodies the ability to understand and interpret the knowledge and apply it in a flexible manner to new situations (p. 143). The naming used by Illeris (2009) recalls the Piagetian terms of how learning develops and how facts are assimilated into current frameworks until there is sufficient disjuncture to cause accommodation of the new knowledge into a new framework.

### **Learning Transfer and Applied Skills**

Illeris (2009) and Thomas (2007) address the topic of transfer specifically in the situations of youth and adults in a more work focused learning environment. Both present ways in which bridging between academic and vocational settings can assist in the development of learning for transfer. The experiments in these papers entail applied educational methods in a classroom setting, interspersed with periods of application and practice in a work setting. It is

easy to understand and see the possibility for enhanced transfer in such a situation. What becomes more challenging is how to enhance skills, facilitate and measure transfer for younger students who are not in a work situation where they can take in new skills and apply them on a regular basis. Additionally, younger learners do not yet have their own, well-developed, life framework where new learning and knowledge can be situated. Jarvis (2006) speaks in Chapter 7 of his book about learning as an ongoing part of living. The more we live, the larger or base of experience to situate new learning and to make connections and add understanding to new information. One of the factors that separates adult learners from younger students is the wealth of experience they have to draw from when solving problems, and the more robust framework in which to situate new information for future recall and application.

Schwartz, et al (2005) posit that much of the historic problem of testing transfer has more to do with the testing methods used and how they check for the direct reuse of information in a new situation. Much of what is tested when transfer is trying to be measured is what Schwartz, et al (2005) have called “transferring out” of situations, referring to the ability to recall certain pieces of information after a particular type of learning experience. If transfer has occurred has generally be tested with a “sequestered problem-solving” technique which tests only the direct application of knowledge in the replicative and applicative modes. Rather, a more valid test would be to check what thinking derived from previous information and situations, may be going on for a given individual when presented with a new situation. This testing of “preparation for future learning” is presented as a more accurate measure of how previous knowledge and experience is influencing a given problem interpretation and solution process. The point is that not only do people transfer out information, they also “transfer in” from previous situations and knowledge to help frame learning in the new situation. What people transfer in to a given

situation can have profound effect on what is learned in the new situation. As observed by Judd (1908) in a statement on learning new methods, “to break up a bad method is more than double the task of teaching a wholly untrained child” (p. 33).

Ultimately, how a student learns new information has a large effect on how or if she transfers that information to new situations and how much variety between the learning and application situations she can accommodate. It almost seems as if the two original positions are being shown to represent different aspects of the same problem, instead of completely different theories on learning transfer. The specificity presented by Thorndike and Woodworth (1901) seems to indicate the highly efficient recall of facts, but only in situations identical or very similar to the original learning mode. The knowledge is present, but highly specialized to a particular situation and is unable to be applied to new scenarios. This is very much what Broudy calls the “replicative” aspect of knowing. Judd (1908) presents an understanding of learning and its future application to other situations is more “applicative” and may begin moving into the “interpretive” aspects of knowing, which allows an observer to see the transfer of knowledge from one area to another.

### **Applications of Learning Transfer to Information Literacy Learning**

Much of the work on teaching mechanisms which motivate students and support stronger learning, and ultimately the ability to transfer the new skills to novel situations is brought to bear on the teaching of information literacy skills by Schwartz and Svinicki (1988). The application of learning theory presented by Schwartz and Svinicki is systems level approach to the instructional process, built upon Kolb's model (1984).

In the realm of information literacy, students are transferring in a wealth of experience in online living and electronic support of information needs. It could be thought that students also bring preconceived notions or misconceptions on the validity or credibility of materials found online. Unfortunately, as more of our world's information becomes available online it is increasingly difficult to distinguish the quality information from everything else.

For the experiences the students have had, the “transfer in” information (that of using online search engines for research) seems valid and not problematic, despite the teaching regarding credibility of information resources having been absorbed at some point. Students know the criteria for evaluating sources and writing proper citations, and can produce the information when asked in isolation, confirming absorption, and yet do not apply the knowledge.

So what is missing in the connection of knowledge and action? Is the feedback on assignments in school not sufficient to cause dissonance that would bring the methods or the sources themselves into question? Or do students not really understand the reasons and importance behind the ethical use of information and the possible consequences of invalid or incomplete attribution?

### **Transferring out: near transfer or far transfer?**

Information literacy skills would seem to fall within the typical arena of applied skills, and while not bridging school and work settings, there is a need to bridge different disciplines in education. Most information literacy instruction is very situation specific, tied to a particular course and often a particular assignment. The idea many librarians employ to generate motivation in students is to tie the instruction to a particular assignment with direct application of the learning to an immediate need, which reinforces the learning and enhances retention and

future use of the skills. Librarians experience frustration when the information literacy skills being taught do not seem to be retained or used in any noticeable way. Broudy's categories of replicative and applicative learning and lack of regular use of skills may explain the post instruction behaviors seen in students. Students express lack of interest with library instruction that appears always the same, regardless of how far they have progressed in the education sequence, or is divorced from the course content.

Several issues may influence these observed situations of non-transfer of skills. First, the librarian/instructor is likely ignoring any preconceptions of self-efficacy or existing knowledge on the part of the students, which makes any new information less likely to be learned. Frequently what is presented regarding information literacy skills will cause dissonance with a preconception that has been formed through years of a self-developed method that has worked in the past. For today's students that would be the use of Google and the Internet as a primary research tool. As Judd (1908) indicated, the process of unlearning a poor or incorrect method is twice the work of teaching someone who has no existing notions of a skill or process. Next, as observed in the research on novice and expert problem definitions presented by Chi (1981), the students are likely to categorize the information needs they encounter based on surface characteristics and not on deeper structure of the type of information needed. Therefore, skills and information types which are applicable in an English or history class for writing a term paper, could easily be categorized as not applicable to an engineering or science data need for a lab report or design background. On the surface these applications, and even the information type, are very different. To a domain expert (librarian) these needs and the processes to fulfill them are not different, and so the lack of transfer frustrates them.

## **Conclusions**

There are multiple issues involved in the lack of transfer of knowledge and skills from classroom learning into practice of assignment completion on the part of students. The research into learning transfer would suggest a couple of areas for improvement in how we teach information literacy skills, including a need to examine and honestly address preconceptions the students bring into the learning session on information discovery and use. Librarians and classroom faculty need to regularly convey the need for citation patterns and reinforce the use of appropriate citation through grading. Additional reinforcement of the message of ethical information use can be woven into courses by relating instances of faculty and student misconduct, discover and resulting consequences. Making the process real in terms the students will relate to could help build the justification for employing these techniques in the work being submitted for assignments.

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