deconstructing technological literacy:

OPENING A WINDOW TO PROBLEM SOLVING

BY BRANDT WARD

"What constitutes being technologically literate? Perhaps it is the ability to problem solve.

INTRODUCTION

In an environment of rapid and unpredictable change determined and directed by technologies that are constantly changing, the assumption that being technologically literate is the key to being a sustained, contributing life-long learner is well founded. However, technological literacy is seldom referred to or considered in academic arguments as a stand-alone learning domain alongside the conventional domains of language literacy and numerical literacy. Although there have been significant educational, economic, and political efforts to formulate and promote a common understanding and definition of technological literacy, the goal still remains elusive (Rose, 2007).

Much has been written about the importance of technological literacy as part of a progressive school's curriculum and its vital contribution to national sustainability in a world dominated by globalisation. Technological literacy, the technologically literate student, and the contemporary technologically equipped school have all been well defined. The International Technology and Engineering Educators Association (ITEEA) defines technological literacy as "the ability to use, manage, assess, and understand technology" (ITEA/ITEEA, 2000/2002/2007).

In 2006, ITEA refined its definition by stating: "Technological literacy is much more than just knowledge about computers and their applications. It involves a vision where each citizen has a degree of knowledge about nature, behaviour, power, and consequences of technology from a broader perspective. Inherently, [technological literacy] involves educational programs where learners become engaged in critical thinking as they design and develop products, systems, and environments to solve practical problems" (ITEA/ITEEA, 2006). The notable aspect of this definition is that it places technological literacy as a consequence of problem solving.

If technology education and the Key Learning Area (KLA) of Technology are to be representative of the pedagogy primarily responsible for the development of technologically literate students, then a definitive foundation of delivery that reflects the uniqueness of this learning domain needs to be established. "It is not possible to define technological literacy, or measure it, in the absence of an agreed-upon intellectual domain for technology literacy." (Waetjen, 1993)

In recognising language literacy and numerical literacy as the fundamental learning domains, this paper attempts to deconstruct these domains in order to:

1. Identify common core elements that constitute a transformation from illiterate to literate.
2. Provide substance to the notion that all literacies are based on an ability to problem solve.
3. Recognise and allocate similar elements to the learning domain of technological literacy and thus construct a model similar to that of language and numerical literacy that facilitates a transition from the technologically illiterate to the technologically literate.

ENCODING AND DECODING: DECONSTRUCTING LITERACIES

In understanding the learning domain of technological literacy, parallels need to be made with the learning domains of language literacy and numerical literacy. In classifying both learning domains, Waetjen (1993) and Csikszentmihalyi (1990) define literacy as the ability to encode and decode a message. If one encodes and decodes letters and implied messages well, then he or she may be regarded as literate. Waetjen further articulates the connection between symbols and literacy domains by suggesting, “A shared symbol system is simply one that has common meanings and communicates the same information to a group of people.” The same may be said about one who encodes and decodes numbers and messages utilising agreed-upon standards and rules; then they may be regarded as being numerically literate, the degree of literacy being determined by the standards and agreed levels of outcomes of those delivering the curriculum. Very little has been proffered with regard to the process of acquiring technological literacy.

If words represent the spoken and written literacy, and numbers and other abstract symbols figure in mathematical literacy (Waetjen, 1993), can we allocate a system or process that defines technological literacy? If so, what messages, shared symbols, or processes are in need of encoding and decoding that appropriately reflect and characterise the domain of technological literacy? In an attempt to further rationalise this question, Csikszentmihalyi (1990) provokes thought regarding technological literacy by stating: "Literacy presupposes the existence of a shared symbol system that mediates information between the individual's mind and external events."

A suggested model that is both reflective of and supportive of Csikszentmihalyi’s shared symbol system notion as applied to the learning domain of technological literacy, is that of the ***Technological Problem-Solving Process***. A generic composition of this cyclic process is often represented as “investigation, ideation, production, and evaluation” (QSA, 2003), and it is this process that continues to mediate information between the individual’s mind and external events when considering and appropriating technological scenarios.

In consolidation of this notion, and when applied to learner development within the domain of technological literacy, the encoding (gathering of information related to the problem) can be represented within the realms of the technological problem-solving process, i.e., ***investigation***, ***ideation***, and the decoding of this acquired information reflected in ***production and evaluation***. Figure 1 illustrates the commonalities between the three learning domains.

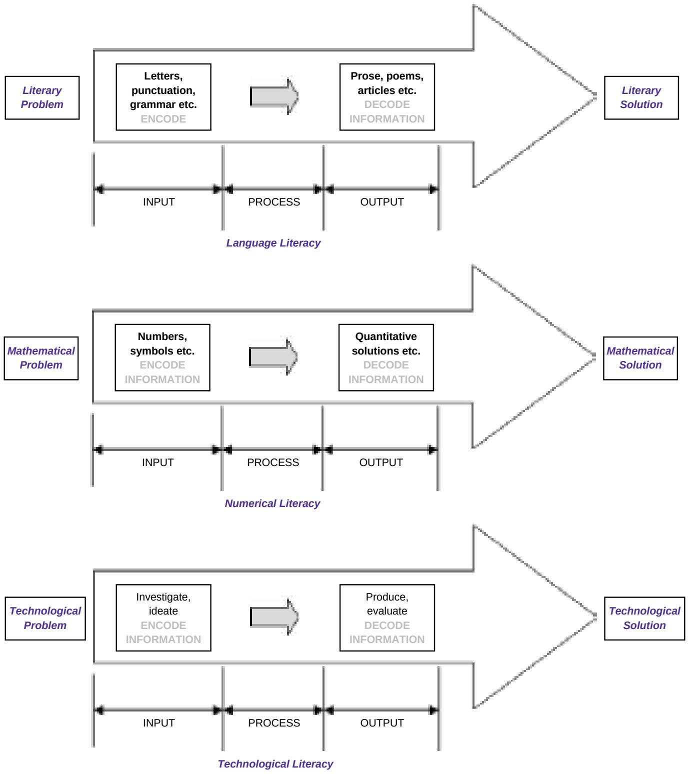

Figure 1. Illustrates the commonalities between the domains of language and numerical literacy when compared to technological literacy.

If this argument is accepted, then the acquisition of technological literacy can be viewed as the end result of **recognising a technological problem and ENCODING information** (investigating relevant data, generating possible solutions), then **DECODING this information to produce a solution** (production and evaluation of a solution). To teach technological literacy, the technological problem-solving process needs to be applied. To be technologically literate, one needs to be aware of the problem-solving process and how to apply it to a given scenario or situation. One needs to “learn how to learn.”

IMPLICATIONS FOR TECHNOLOGY AND ENGINEERING CLASSROOM PRACTICE

If technological literacy is to be credentialed as a recognised learning domain, and a unique shared system of symbols and processes lie within the technological problem-solving process, then the technology teacher needs to acknowledge that techno-

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logical literacy and technological competency are separate, and this separation needs to be reflected when considering educational outcomes. Within this mindset it also needs to be acknowledged that all learning domains, (i.e., language, numerical, and technological), are symbiotic in relation to each other and together provide a platform for a holistic program of education.

Much of the literature on technological literacy seems to place a strong emphasis on the conceptual aspects of technology, such as understanding, decision making, ideation, and evaluation, and much less emphasis on skill acquisition, shaping materials, modelling, and construction. As a technology teacher, this places the assessment of technological literacy on the "journey" or process of solving a problem, as opposed to assessing the final solution or artefact. Continuing this line of rationale, it seems functional as educators to link technological literacy to one's ability to recognise the shared symbol system of this domain as being the process of technological problem solving and the ability to encode and decode aspects of this process to achieve a desired solution. Savage and Sterry (1990) claim that the "technological method" of problem solving is the system of symbols "indigenous to technology."

If technological literacy is to be regarded as an integral part of a holistic curriculum, then stakeholders in the KLA of Technology Education need to consider the following:

- Technological literacy is a learning domain of such importance that its development needs to be introduced at the earliest stages of education (i.e., technological problem-solving in pre-prep. and kindergarten).
- The technological problem-solving process needs to be recognised by teachers and curriculum designers as the primary pedagogy for achieving technological literacy.
- Assessment of a learner's level of technological literacy should focus on the problem-solving journey rather than the solution (the ability to encode and decode).
- The acquisition of technical competencies is a consequence of becoming more technologically literate. Each problem may require the investigation and implementation of skills new to the learner; therefore, teachers should teach the process—skill development will be incidental and unique to the problem.

TECHNOLOGICAL PROBLEM–SOLVING PROCESS: MEDIATING INFORMATION BETWEEN THE MIND AND THE SOLUTION

The technological problem-solving process involves a pedagogical approach that provides students with the opportunity to experience and apply the higher-order learning elements of application, analysis, synthesis, and evaluation. The acquisition of technological literacy builds upon these recognised cognitive hierarchies of Bloom's Taxonomy. Lorin Anderson (2001), a former student of Bloom, published a revised edition of the taxonomy that Andrew Churches (2008) aptly labelled Bloom's Digital Taxonomy. Churches' adaptation of Bloom's Taxonomy to the digital world better aligns the commonalities between the higher-order levels of thinking and the domain of technological literacy. The simplicity of this transition is the conversion of the taxonomy's descriptors to verbs, hence reflecting technological literacy's process of "doing" when problem solving.

Further outcomes emerging from this learner approach are the development of technical skills and competencies, the discovery of new knowledge, the development of critical thinking skills, and the opportunity to manage their own learning. The technological problem-solving process also lays a foundation for incorporating all the Key Learning Areas (KLAs). A well-designed scenario can engage students in all areas of learning well outside the boundaries of the technology classroom.

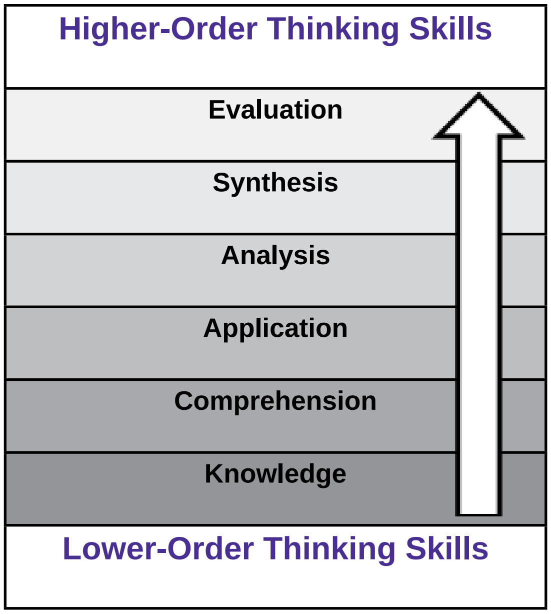

Figure 2. Bloom's taxonomy of thinking skills.

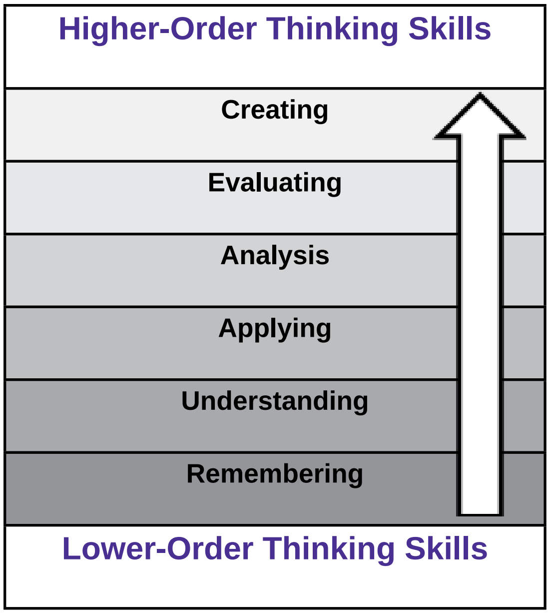

Figure 3. Bloom's revised taxonomy of thinking skills utilising the use of verbs.

TECHNOLOGICAL LITERACY, DIGITAL TECHNOLOGIES, AND THE TEACHER

As new tools enter the educational environment, the term technological literacy is becoming increasingly aligned with digital literacy. It is no longer sufficient to teach students how to decode information they find in a book and then write a paper using pen/paper. Students need to learn how to *problem solve* within a digital world. They need to learn how to research and communicate, using existing and as-yet-unimagined digital technology, which means they need to learn more than "how to use this application"—they need to *learn how to learn* new applications (Baker 2008).

The ongoing development of digital technologies and global networks is increasing at such a rate that existing educational pedagogies need to remain fluid and flexible so as to ensure maximum and appropriate impact when delivered. To be an effective teacher, he or she must embrace the latest and most readily available technologies to ensure that the mode of delivery in the classroom reflects one of the core outcomes of contemporary education; *to prepare students for a rapidly changing and unpredictable future*. To be effective, the teacher (ideally supported by a like-minded school culture) must possess a level of technological competency in the software and hardware at his or her disposal, be willing and capable of innovative utilization of such, and be prepared to develop as an educator at a rate that parallels the developmental rate of educational software and hardware.

Surpassing the introduction of computers and access to Internet sites, schools now have available technologies such as interactive iPads, smart boards, robotics, integrated data analysis and recall systems, wireless laptop access, intranet communication facilities such as *Blackboard*, multimedia applications, and integrated CAD/CAM milling machines. Therefore, it is not unreasonable to assume that a competent teacher ten years ago is not necessarily a competent teacher today if he or she has failed to "up skill" in order to move with technological times. In the same vein, students we equip to be *literate life-long learners* today may lose that competency in a very short time span simply as a result of rapid technological progress inherent in today's society. Therefore, it can be further argued that being able to problem solve (i.e., investigate, ideate, produce, and evaluate) is the key to being a sustained life-long learner in a world characterised by rapid technological change.

CONCLUSION

Defining technological literacy and articulating the parameters by which technological literacy can be achieved has been somewhat of a "grey area" amongst modern-day educators. To be literate in the use of language and numeracy, one needs to have the ability to encode information, process that information, and then decode to achieve a suitable solution. What about technological literacy? The notion presented in this paper suggests


Creating mechanisms and toys.


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that, to be technologically literate, a similar process of encoding and decoding information needs to be engaged. In light of this, technological literacy needs to be viewed as the end result of recognizing a technological problem and encoding information (investigating relevant data and generating possible solutions), then decoding this information to produce a solution (production and evaluation of a solution). This does two things:

1. It aligns the domain of technological literacy with those of language and numerical literacy where shared symbols and processes are encoded and decoded.
2. It suggests that technological literacy is a consequence of the problem-solving process.

Being technologically literate—that is, having the ability to problem solve—is the key to sustainable life-long learning. As teachers of technology, it is imperative that a pedagogical approach based on enquiry and problem solving be employed, sustained, and modified to ensure not only that the continued development of our students meets the needs of a rapidly changing and diverse world, but also that the domain of technological literacy is seen as a core component of an holistic educational program.

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