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Augmentation in Learning: Supports Which Do Not Fade Away

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In this article we discuss the concept of *augmentation* and how educational technologies can be used to support the learning process. Although the concept of augmentation is not novel, our proposal regarding how augmenting supports can be adopted in the learning process—*in that these supports do not fade away*—is novel. Augmentation in this sense is contrasted with scaffolding (supports which fade away).

There is a significant degree of literature on augmentation, particularly with regard to how virtual reality technologies can be used to augment visual and other sensory processes (Freund & Roβmann, 1999; Oyama, Tsunemoto, Tachi, & Inoue, 1993). Augmentation also has been increasingly adopted in the medical sciences (Hunter *et al.*, 1993). To "augment," in this article, means to complement the learner by supporting thinking, cognition, and learning. These augmenting supports could be physical tools or resources, and also conceptual artifacts. These augmenting supports are provided to the learner to achieve a certain goal. Without these supports, the individual would have difficulties in goal attainment. In this sense, scaffolding and augmentation have many similarities. However, scaffolding supports generally fade away after the learner appropriates the skills and knowledge required. The learner grows out of dependency on these supports (Jonassen, 1999). With augmentation, though, tools (e.g., a computer-aided design package) used in the real world are brought to the classroom to augment the learning environment. These tools do not fade away after students have gone through the initial learning process. Students bring these tools with them and continue to use them when they are entering communities of practice (CoP) in the real world.

Scaffolding provides structures and frameworks to support the learning process and students' performances beyond what is currently possible (Griffin & Cole, 1984; Lave & Wenger, 1991; Vygotsky, 1978). A scaffold adapted to the level of the learner ensures success at a task difficult for the child to achieve on his or her own. In contrast to scaffolding, there are supports which do not necessarily fade away in the learning process, which in this article we term *augmentation* supports.

We propose educational technologies and learning environments in which supports are "superimposed" onto the learning experiences. For example, the learner is engaged in the real, authentic problem case with supporting tools and resources. We see an increasing potential for using simulations (including virtual reality (VR) oriented cognitive tools and information resources) to assist the less experienced to effectively engage themselves in a community of practice (Wenger, 1998).

Another possible strategy of augmentation is that the real practitioners (from CoPs) co-work together with learners on authentic problems and cases. In many cases, it is not possible for the learner to experiment on real cases. An augmented case-scenario will become handy in that the learners could experiment with real practitioners on simulated cases. In organizations, scenario planning is one example where companies create simulated and projected scenarios of the future, and all members think through them. We can augment in terms of supports, such as simulated scenarios, especially when it is expensive, dangerous, and infeasible to learn or practice in the real contexts. Such augmentation supports 'assist' rather than 'instruct.'

In the sections below, we attempt to draw an argument for augmentation supports as bridges between schools and communities of practice (such as in real-world communities of accountants, scientists, mathematicians, etc.). The problem articulated in recent literature is the increasing disparity between school-based learning and what occurs in the real world. The approach proposed here is the adoption of augmentation supports as bridges between schools and CoPs (of the real world).

Augmentation as Bridges Between CoPs

We attempt to situate authentic and purposeful learning experiences from *the learner's perspective* through augmentation. Learning based on the situated perspective needs always to be dynamic and co-evolutionary in terms of interactions between learner and context. In the K–12 context, the school is a community in its own right (for example, how to

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behave as a student, how to follow the school routines, etc.). Students come to school in part in order to learn to become a student. By the time a student graduates from grade six (in an elementary school), this student would have acquired not only the knowledge of how the school (as a community) functions, but the identity of being a "good" student (or otherwise). This kind of knowledge is, of course, acquired in addition to the usual learning of the curriculum content.

The implication for us in adopting the augmentation model is therefore to restructure the school so that there would be a good transitional community (the school as a legitimate community in its own right) for students to interact with, and with a concomitant intention and commitment to further augment students into the real-world CoP. In other words, we are augmenting students from the school community to the community of practice with the relevant supports, which need not fade away. The crucial question is: What are the kinds of augmentation supports that help learners to bridge between school and CoPs?

Instead of fading away, augmentation supports go with the learner as he or she transits from one form of community to another. We make the assumption that learners should progress more easily from schools to CoP-forms of understanding.

Four Kinds of Augmenting Supports

In our conceptualization, augmentation includes four major kinds of supports (that do not fade away): *Tools*, *Artifacts*, *Persons*, and *Conceptual structures* (see Table 1).

Augmenting tools are basically instruments and models that are used by practitioners in communities of practice (CoP), for example, the microscope, various measuring devices, etc. Other kinds of augmenting tools include specific instruments for domain related activities, such as devices that compute data for certain forms of activity. Augmenting tools can also be in the form of supporting personalized knowledge representations in the context of social spaces in online collaboration (Chen & Hung, 2002). Personalized representations can be superimposed/augmented onto social and collective representations. These tools and representations do not necessarily fade away as the learner progresses into real-world practice.

Augmenting artifacts are cases, living stories, accounts, and ideas that have occurred in real CoPs which can be used in schools as illustrations and resources whereby students can refer to examples in their pursuit of understanding. Current knowledge management literature strongly promotes the use of real-case testimonies and stories as situated examples for learning (McDermott, 2000). Learners need access to relevant cases or stories pertinent to them as they engage in context-dependent situations. Researchers and designers believe that instructional materials supporting ill-structured problem-solving skills should incorporate cases that represent (as closely as possible) real-world cases and problems in that particular domain (Jonassen, 1999). The use of stories or cases in problem-solving education increases problem-solving skills, helps address misconceptions, and contributes to the changing of attitudes. Case libraries made available to students while they are learning can scaffold memory by providing representations of experiences that learners have not had (Schank, Berman, & Macpherson, 1999). These cases can represent complexity in learning situations by providing multiple perspectives, themes, or interpretations to the problems being addressed or examined by the learners. Similar to augmenting tools, these artifacts need not fade away and can become the practitioners' aids to memory in practice.

Augmenting persons are practitioners who can go into schools and communicate with students. These augmenting persons act as consultants and experts, mentoring the learners by modeling expert-thinking and behaviors. Augmenting persons also help to bridge the gap between schools and CoPs as the learners move into the context of practice and real work communities. The augmenting persons do not fade away and continue to be a strong influence to the learners from schools to CoPs. By introducing a continuous flow of

Table 1. Four kinds of augmenting supports.

	Think and Work	Augmentation
Tools	with	Actual job aids or tools used in the CoPs; could be in a simplified form when the learner is in school.
Artifacts	upon	These are mainly past examples of accounts, stories, cases, and problems which are encountered and solved by practitioners.
Persons	alongside	Learners work with practitioners throughout the learning process. However, the complexity of augmentation increases as learners approach CoPs.
Conceptual structures	through	Transferable concepts which enable the learner to apply meaning and epistemic structures across domains of knowledge.

augmenting persons into schools, the linkage between schools and CoPs would be tightened.

Augmenting conceptual structures are "common denominators" and ways of seeing (or lenses) that can be transferred from one domain, such as mathematics, to other real-world applications. For example, many mathematical concepts, such as matrixes and dimensions (e.g., 'x' and 'y' axis dimensions), can be used as reasoning tools and structures for other concepts, such as understanding the complexities that are contradictory (because they must be seen from more than one perspective or dimension). Such concepts may seem to be very abstract for learners, but their usefulness in different contexts may convince them that the effort to master certain concepts is worthwhile.

Conclusion

The idea of augmented reality is that technology generates some sort of virtual world, which is superimposed onto the real world. *The spirit is not to replace but to augment the reality.* In the same vein, we make the conjecture that as technologies (and the design of artifacts) become more advanced, the 'superimposing' of authentic augmenting supports between schools and CoPs would become increasingly possible and intensified. We have emphasized in this article that augmentation supports could be both physical and psychological (or conceptual)—*tools, artifacts, persons,* and *conceptual structures.* □

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Suggested Resources

Barfield, W., & Caudell, T. (Eds.). (2001). *Fundamentals of wearable computers and augmented reality.* Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

This book mainly focuses on technical aspects of augmented reality (AR). In addition, it introduces how AR can be applied to different fields, such as medicine, architecture, and education (e.g., for the visually impaired).

http://www.hitlabnz.org/

HIT lab is the flagship Human-Interface Technology research center in New Zealand. Many current projects, such as "The MagicBook," the "eyeMagic: the Future of Reading," and "AR Volcano," are directly related to education. For example, when readers look at the pages of "The MagicBook" wearing lightweight head-mounted displays (HMD), the pictures pop off the page and come alive as three-dimensional animated virtual objects.

www.augmented-reality.org/

This is an augmented reality "portal" that provides an extensive collection of links to AR technology, research, events, projects, and resources. From this Website, the reader will be able to recognize the applications of augmented reality to various disciplines and how this technology is applied to design, human-computer interaction, ubiquitous communications, and visualization.