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The role of authenticity in design-based learning environments: The case of engineering education

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ABSTRACT

The term *authenticity* is pervasive in the education literature in general and specifically in the design education and engineering education literature; yet, the construct is often used un-reflected and ill defined. The purpose of this paper is (1) to critically examine current conceptualizations of authenticity as principles to design learning modules and environments within engineering education and (2) to propose a systematically derived model of authenticity. The context of the project is toward pre-college engineering education yet findings are applicable across the lifespan of engineering education. A systematic literature review guided by procedures set forth by the Centre for Reviews and Dissemination was conducted in the engineering education literature to synthesize the findings. Based on an initial sample of papers ($n = 36$) a rubric was developed to identify authenticity and authentic experiences in engineering education. Using the developed rubric, a total pool of 1058 references was evaluated using the rubric with 88%–100% inter-rater reliability for each category of authenticity. A frequency analysis of references revealed that the majority of work is seen in undergraduate education, and only 14 instances of authenticity in engineering education appeared at the K-12 level. The proposed model of authenticity includes two additions to existing models introducing impact authenticity and value authenticity. The findings and the model are described. Implications include the use of different types of authenticity to provide more appropriate and promising principles for better design of engineering curricula and standards for curriculum developers and professional development providers, including more use of authenticity in the K-12 classroom.

1. Preamble

An underlying theme of David Jonassen's work, who is honored by this special issue, is what we would call the "quest for authenticity" in education. His work on ill-structured problem solving, the design of problem solving environments, the use of computers as cognitive tools, cognitive flexibility hypertexts and research on workplace practice are indicative of several different presumptions and passions: (1) The opening of the classroom to the complexity of the "real-world"; (2) The theoretical and evidence-based support for countering the effect of oversimplification on the schooling system, (3) The strong belief that bringing reality from outside of academic and schooling systems back into classrooms is truly transformative in addressing shortcomings of education. The context of the paper – engineering education – additionally reflects the many contributions by David Jonassen to introducing the Learning Sciences and Instructional Design into the newly forming discipline of engineering education research.

2. Introduction

With the infusion of engineering into K-12, the field uses existing paradigms and develops new models and frameworks. Within the NAE (2009) report on K-12 Engineering Education, engineering is strongly connected with "posing authentic problems" (p. 99) and introducing

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students to “authentic engineering practice” (p. 129). The term authenticity, however, is often used without reflection or clear definition as “the term of authenticity and its synonyms lull us into the belief that we do not need to explain ourselves” (Petraglia, 1998, p. 13). The ubiquitous use of the term makes it difficult to not only operationalize the term for the development of learning environments (Herrington & Herrington, 2008) but for empirical research into the effectiveness or role of different dimensions and different constructs. Due to the lack of specificity about what authenticity entails, Radinsky, Bouillion, Lento, and Gomez (2001) question even its usefulness as a principle to design curricula. Robust empirically derived models of authenticity are necessary to enhance the value of pursuing the design of authentic learning environments.

Research on Science, Technology, Engineering and Mathematics (STEM) education and underrepresented minorities and women may serve as an example for the significance and impact of authentic learning experiences and the need for more reflection: data show that STEM fields are not as attractive to underrepresented minorities and girls. While reasons differ, girls are turning away from science/math as early as third and fourth grade and for the ones persisting, the current climate provided by STEM curricula produces a high level of anxiety and low self-efficacy (American Association of University Women, 2010; Zeldin, Britner, & Pajares, 2008). Similarly, engineering is considered more object-oriented than people-oriented (Malcom, 2008). As a result, many students who are interested in careers related to helping people may not pursue engineering-related or technology-related fields, but instead go into a field that is thought to be more people-oriented (e.g. medical fields) (Borrego, Padilla, Guili, Ohland, & Anderson, 2005). Rahm (2002), Buxton (2006) and Basu and Barton (2007) highlight in their research on science education, that underrepresented minorities and women are more engaged and learn more in authentic learning activities as compared to simple experiments and simple inquiry projects (for the distinction see Chinn & Malhotra, 2002). Yet as Preston (2009) points out, it is not clear what forms of authentic engagement are contributing to these effects, highlighting the need to provide robust models and operational definitions for authentic practices. In addition, while research on authenticity and authentic practices is fully developed in science education, similar work in engineering is rudimentary.

3. Literature review

3.1. Conceptualization and embodiments of authenticity

The quest for authenticity is pervasive in society (Kreber, 2010) be it in the context of “authentic tourism” (Kim & Jamal, 2007) or in identity questions such as “finding the real me” (Gardner, Avolio, Luthans, May, & Walumbwa, 2005). Equally, the quest for authenticity became the “desideratum of the American educational system” (Petraglia, 1998, p. 10). The search for authenticity in society and education is grounded in a state of perceived inauthenticity (Barnett, 2007) on notions that educational systems are contrived and oversimplifying (Jonassen, Strobel, & Lee, 2006; Spiro, Feltovich, Jacobson, & Coulson, 1992) and the traditional classroom providing learning opportunities mostly consisting of lecture (Nicaise, Gibney, & Crane, 2000). In contrast, the constructivist learning environment is one in which students are actively constructing their knowledge based on integrating their current experiences with their prior experiences to understand novel ideas or situations (Duffy & Jonassen, 1992; Jonassen, 1991). Authentic learning experiences often take place in this type of classroom. Maor (1999) described a constructivist-oriented learning program, of which “simulated authentic learning environments” (p. 46) was a design principle.

Barab, Squire, and Dueber (2000) described authenticity as taking place “in the learner-perceived relations between the practices they are carrying out and the use value of these practices” (p. 38). However, in the paradigm of constructivism, critique grew that classrooms are not “authentic” enough: activities are only relevant within the walls of the classroom; the products are not relevant or well-connected to problems outside of schools, so school work is not contributing to an outside world; the audience is only the teacher (or some students); what is considered authentic to the teacher is not necessarily authentic to the student (Barab et al., 2000); separation from learning and authentic use leads to fail of transfer; and the prior knowledge and experience of students is perceived and treated as irrelevant or something to overcome (misconceptions, naïve conceptions, low critical thinking skills).

The concept of authenticity was introduced simultaneously with a strong call for student centered learning and is seen as hallmark for best-practice development for different learning environments including elearning environments (Herrington & Herrington, 2008; Herrington & Kervin, 2007). Providing students with “real-world” experiences resulted in many project and problem-oriented curricular components (e.g. students’ contributions to newspapers or local pond projects). Major theories and design models were developed to increase authenticity including the use of simulations, cognitive apprenticeship, and problem-based learning frameworks, for instance, the use of simulations or reifications to “create as accurate a facsimile of real objects or events as possible” (Winn, 2002, p. 336). Another example is problem-based learning, which focuses on engaging students in expert-like activities (designing, scientific inquiry) and providing “real-world” cases and problems (Savery & Duffy, 1995).

Authenticity contains several of these external dimensions – implemented in many student-centered learning environments: (a) context authenticity – context resembles real-world context (e.g. patient data in medical school), (b) task authenticity (including process/procedural) – activities of students resemble real-world activities (e.g. scientific inquiry or chemical analysis), and (c) impact authenticity – products of students are utilized in out-of school situations (e.g. collected data are utilized in NASA projects) (Barab et al., 2000).

These three dimensions of authenticity are conceptualized as bringing the learner closer to the realities of the workplace, providing features derived from external, social and environmental constructs, such as the corporate world or cultural norms (Billet, 1994); in other words these dimensions represent the view of the *Canonical Science Perspective (CSP)* (Buxton, 2006). CSP positions authentic science learning as a pedagogical tool that engages learners in science practices that reflect the epistemic and shared practices of scientists in their community.

This paper makes the case that other, less developed, dimensions of authenticity are promising supplements to the existing landscape and so reduce the shortcomings of existing STEM activities: (a) personal authenticity – projects are close to students’ own life (i.e. life-stories of their neighborhood, biodiversity in the forest nearby) and (b) value authenticity – personal questions get answered or projects satisfy personal or community needs. These new dimensions are derived from an Applicative or Sociocultural Perspective (ASP), which recognizes that authentic learning acknowledges the importance of the cultural practices of science, “everyday-life” problems or experiences (Anderson, Holland, & Palincsar, 1997) and the identity of the scientists carrying out these tasks (Brown, 2004).