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Re-thinking scientific literacy out-of-school: Arguing science issues in a niche Facebook application

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ABSTRACT

Social network sites (SNSs) like Facebook.com, are the dominant technology-mediated leisure activity among teenagers in different countries, prompting researchers to explore their suitability as learning tools, largely in formal higher education settings, and with mixed results. In contrast, this paper examines whether an open-source social networking application implemented outside of the school context engaged young people (ages 16–25) in debating socio-scientific issues. A multi-dimensional approach to analyzing argumentative knowledge construction in a designed Facebook.com application yielded insights about the presence and nature of young people's socio-scientific issue argumentation along four process dimensions (participation, argumentative, epistemic, social co-construction). We discuss the implications of these findings for computer-supported collaborative learning (CSCL) theory and the design of similar applications that attempt to supplement formal learning or bridge formal-informal learning settings.

1. Science literacy and argumentation in social network sites

Improving adolescents' scientific literacy, preparation for the 21st century workplace, and engagement in current affairs are critical problems facing U.S. education (Bureau of Labor Statistics, 2007; Collins & Halverson, 2009; National Center for Education Statistics (NCES), 2005). A 2012 Program for International Student Assessment (PISA) revealed that U.S. students ranked 23rd in science (Kelly et al., 2013), and the U.S. had lower rates of American undergraduates earning STEM degrees compared to other countries despite higher per-pupil spending (National Science Board, 2010). Furthermore, research in the U.S. continues to document young people's disengagement from school (Levin & Arafeh, 2002) and public life (Putnam, 1995): more than one-third of people under age 25 do not get any news on a daily basis (Pew Research Center for the People, 2008).

Within the broad field of science education, conceptualizations of *scientific literacy* or *science literacy* has typically emphasized learners' coming to know science as practicing experts do (e.g., developing content knowledge and authentic inquiry processes). In recent years, the definition of scientific literacy has emphasized reading, writing and communicating about *current* science topics—herein referred to as *socio-scientific issues* (SSIs)—for civic, cultural, and personal understanding as these topics relate to everyday life and policymaking (Polman et al., 2010). Argumentation or negotiation competencies, such as participation, epistemic skills, argument skills, and social co-construction skills (Sadler & Fowler, 2006; Weinberger & Fischer, 2006) are important to engaging in *socio-scientific issues.*

Argumentation of SSIs have been argued to be powerful facilitators for teaching and learning science (Barab, Sadler, Heiselt, Hickey, & Zuiker, 2007; Cavagnetto, 2010; Sadler, Barab, & Scott, 2006), particularly in formal learning settings, such as online (Yeh & She, 2010), offline (Berland & Hammer, 2012; Nussbaum & Edwards, 2011; Yoon, 2011), and in museums (Gutwill & Allen, 2012). Such studies have also identified the challenges of inserting SSIs into already time-strapped classrooms and test-driven curriculum.

Yet, socio-cultural learning theory and theories of computer-supported collaborative learning have suggested that *informal environments* may also be particularly supportive of learning and have argued that a considerable amount of learning occurs through informal interactions with others, reading, and observation (Brown, Collins, & Duguid, 1989; Greeno, 1989; Lave & Wenger, 1991; Vygotsky, 1978). However, little is known about informal learning processes within out-of-school online contexts,

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such as those within online SNS (Lenhart, Purcell, Smith, & Zickuhr, 2010; Rideout, Foehr, & Roberts, 2010). Thus, the focus of the current study was to extend socio-cultural learning theory and computer-supported collaborative learning theory developed in formal learning contexts to informal contexts by (1) examining the nature and extent to which young people engage in a variety of argumentation skills around socio-scientific issues (i.e., climate change issues) within an informal online social networking application (HotDish) in Facebook.com and (2) exploring whether and how argumentation skills are related to each other within this context.

Next, we situate our work within previous research and theory in argumentation and computer-supported collaborative learning. We then introduce the socio-technical features of the social networking application, Hot Dish, before providing an explanation of our methods and subsequent presentation and discussion of results. In the conclusions section we suggest the strengths and limitations of this work and suggest areas for future study.

1.1. Socio-scientific issue argumentation

Sociocultural learning theories have assumed that learning is derived from participation in joint activities, inextricably tied to social practices, and is mediated by artifacts over time (Greeno, 1989; Lave & Wenger, 1991; Vygotsky, 1978). Such theories have helped researchers conceptualize and study learning as participation in communities of practice (Wenger, 1998). Highlighted by science educators and new science standards for its role in science learning (Yeh & She, 2010), researchers have argued that scientific literacy requires *argumentation* of SSIs in formal science classrooms (Barab et al., 2007; Sadler et al., 2006; Zeidler, Walker, Ackett, & Simmons, 2002). Furthermore, some have proposed that argumentation of SSIs in science classrooms and beyond is essential to developing modern scientific literacy, especially during activities that prompt certain types of learning behaviors important for increasing students' use of argumentation skills (Berland & Hammer, 2012; Chin & Osborne, 2010; Nussbaum & Edwards, 2011; Sadler et al., 2006; Yoon, 2011; Zeidler et al., 2002). There are four types of argumentation skills: participation, epistemic skills, argument skills, and social co-construction skills (Sadler et al., 2006; Toulmin; 1958; Weinberger & Fischer, 2006).

1.1.1. Participation

Participation refers to how much someone participates in argumentation (Weinberger & Fischer, 2006). Scholars have noted that participation is important in constructing knowledge and initiating collaboration and cooperation. For example, Cohen and Lotan (1995) argued that elementary school classroom contexts that have high interaction among students are more likely to have higher levels of participation at the individual level compared to classrooms with less interaction among students. It has also been speculated that engaging in content with others is associated with academic success and learning.

1.1.2. Epistemic skills

Another form of argumentation is epistemic skills, such as *complexity*, *skepticism*, and *inquiry* (Sadler et al., 2006). Complexity refers to the ability to use multiple sources of information and perspectives during problem-solving discussions; using multiple sources and perspectives may complicate the picture regarding the socio-scientific issue and the solution to the issue. For example, when discussing whether using solar and wind power is better than using nuclear or fossil power, the advantages and disadvantages of using one strategy or another may become more complex as additional sources and perspectives are included in the discussion. Sadler et al. (2006) defined skepticism as the ability to question the validity or reliability of information based on the source (Kolsto, 2000). Inquiry referred to being able to question or gather information in order to begin finding a solution or compromise. Learners who use sophisticated epistemic skills are more successful at understanding theoretical concepts and complex problems and issues (Fischer, Bruhn, Gräsel, & Mandl, 2002; Hogan, Nastasi, & Pressley, 1999; Salomon & Perkins, 1998). Often SSIs are complex problems that do not have clear-cut solutions. Thus the ability to think about multiple perspectives, to be skeptical about multiple views or perspectives based on the source of evidence, and to ask questions that dig deeper into socio-scientific issues would be associated with learning (Sadler et al., 2006).

1.1.3. Argument skills

Argument skills refer to the ability to construct a case for potential solutions or perspectives (Toulmin; 1958; Weinberger & Fischer, 2006), though these reasons need not be persuasive or justified. Argument construction can comprise claims, grounds with warrant, and qualifiers. Claims refer to simple statements that present an argument. Qualified claims or qualifiers refer to claims that also provide limitations to the claim. Grounds with warrant refers to claims that do not include a qualifier but do provide supporting evidence for the argument; this type of skill is the most salient form of arguments that learners use.

In addition to being able to construct an argument, argument competence also includes the ability to carry out a dyadic or group debate with others, through the following steps: (1) arguments, (2) counterarguments, and (3) integrated replies (Clark & Sampson, 2008; Leitão, 2000; Weinberger & Fischer, 2006). In other words, first an argument or case must be presented, then, a challenge or counterargument to the initial argument is presented. Following this challenge, integrated replies are presented, which synthesize the arguments and counterarguments in order to advance or move forward the discussion. In each of these processes, scholars have argued that learners explore the material and build their argument; other learners may challenge the first learner's position by bringing thoughtful insight to the interpretation of the material or bringing in prior knowledge; and lastly, both learners work together to reach a consensus (Weinberger & Fischer, 2006). Importantly, argument skills have been shown to be conducive to learning (Andriessen, Baker, & Suthers, 2003), and the ability to engage in debate has been shown to foster perspective-taking skills (Spiro, Feltovich, Jacobson, & Coulson, 1991), which are important for modern notions of scientific literacy.

1.1.4. Social co-construction skills

The fourth and final form of argumentation skills is social modes of co-construction, which refers to whether learners collectively acknowledge and draw on the contributions of their learning partners (Brown et al., 1989) through the use of externalization; elicitation; and consensus-building moves (Weinberger & Fischer, 2006). Externalization is defined as statements that describe basic thoughts, or one's personal feelings or reactions to a group (e.g., this makes me angry). Elicitation is defined as when learners request other sources of information or knowledge by questioning or trying to get another learner to expand on his or her initial statements.

For co-construction tasks, learners can use three types of consensus-building techniques to compromise on a course of action or an idea (Weinberger & Fischer, 2006). Researchers have defined quick-consensus building as accepting arguments from other learners, regardless of whether or not he or she agrees or disagrees with the argument (Clark & Brennan, 1991; Fischer et al., 2002; Weinberger & Fischer, 2006). We might think of this as accepting arguments uncritically despite contradictions and