Social Media as Online Mentoring Tools for STEM Students With and Without Disabilities

Robert L. Todd

Georgia Institute of Technology
CATEA
490 10th Street
Atlanta, GA 30318
USA
robert.todd@coa.gatech.edu

Abstract. Considerable attention has been given to the need for educating a diverse workforce in science, technology, engineering, and mathematics (STEM). Public and regulatory institutions have stressed the importance of efforts to recruit and retain students chronically underrepresented in STEM fields. Individuals with disabilities are among the most marginalized of these groups and face significant barriers to accessing higher education STEM programs. This paper will discuss affordances for e-mentoring of students in STEM education, with a focus on universal design for online learning and inclusion of all students, especially those with functional limitations due to disability. Preliminary data from ongoing research will be reviewed and discussed.

Keywords: e-mentoring, STEM, disability, social media, virtual worlds.

1 Introduction

Considerable attention has been given to the need for educating a diverse workforce in science, technology, engineering, and mathematics (STEM). United States National Science Foundation reports (NSF 1996, 2000, 2004) stress the importance of efforts to recruit and retain students chronically underrepresented in STEM fields. Individuals with disabilities are among the most marginalized of these groups (Wolanin & Steele, 2004) and face significant barriers to accessing higher education STEM programs (Burgstahler, 1994; NSF, 2000). This paper will discuss affordances for e-mentoring of students with disabilities (SwD) in STEM education as an important component in the solution to this lack of representation.

Students with disabilities and their teachers use a variety of social media and computer-mediated communication (CMC) tools in mentoring relationships through electronic mentoring (e-mentoring) (Todd, 2012). As e-mentoring can occur asynchronously, it has benefits not found with face-to-face (FtF) programs. While traditional FtF mentoring is often conceived as a dyadic relationship in which a senior, experienced individual provides support and guidance for a less-experienced one (Gay, 1994), e-mentoring has contributed to an expansion of this concept to include

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lateral, hierarchical, group and asynchronous versus synchronous mentoring and to applications in expanded contexts (Ensher, Heun & Blanchard, 2003).

A growing literature base describes e-mentoring programs and their usefulness in educational, business, human resources, and social environments (Gregg, Chang, & Todd, 2012; O'Neill & Harris, 2004; Single & Single, 2005) and e-mentoring has demonstrated positive impacts on at-risk students' educational and personal goals (iMentor project, MentorNet 2012, Todd, 2012). Furthermore, e-mentoring has shown benefits through removal of geographic boundaries, including international collaborations, and positive effects through multiple cohorts of students of different educational levels and inclusion of professionals (McCarthy, 2012). E-mentoring also has demonstrated advantages for numerically small, isolated members of underrepresented groups in specific STEM fields, empowering communication, support, information exchange and other mentoring activities where otherwise impossible (Jefferson, Hannula, Campbell, et al., 2010).

2 Computer-Based Social Media Mentoring

Potentially, any form of computer-mediated communication, from relatively early formats such as listservs and email to the latest applications can provide means for e-mentoring. But as social media platforms and tools (as typified by user-generated content (Agichtein, et al., 2008)) become more powerful and ubiquitous, options for e-mentoring continue to expand. McCarthy (2012) reports on the successful use of Facebook as an e-mentoring tool among students and professionals, across international boundaries and among multivariate cohorts. Jefferson, Hannula, Campbell, et al., (2010) discuss the affordances of online blogging tools as a means of mentoring among diverse and underrepresented geoscientists. Voice over IP (VoIP) tools like Skype have seen growing use as e-mentoring tools, both in one-on-one and group mentoring situations, and with disability-related support such as mentoring of special education teachers (Smith & Israel, 2010). In addition, dedicated mentoring platforms, both software and browser-based, have grown in number and breadth of application, such as SocialLearn, as reported by Liu, Macintyre & Ferguson (2012). In many e-mentoring programs, combinations of tools, processes and applications are employed to provide custom e-mentoring experiences, and researchers provide students with disability-specific solutions to accessibility challenges (Todd, 2012).

3 Virtual Worlds

Among the newer CMC technologies, virtual worlds, or simulated 2-D and 3-D online environments (e.g. Second Life), have become an increasingly common software platform for education and training applications during the last decade (cf. Chou & Hart, 2012; Cremorne, 2009; deNoyelles & Kyeong-Ju Seo, 2012; Kingston, 2011; Taylor, 2002; Jones, 2007; Brown & Bell, 2004; Gerald & Antonacci, 2009) including e-mentoring (Todd, 2012; de Freitas, 2008). Virtual platforms can present their own challenges to full accessibility, but proper design and use of assistive

technologies can make them usable and effective for SwDs (Todd, Baker & Pater, 2012; Folmer, Yuan, Carr & Sapre, 2009; Forman, Baker, Pater & Smith, 2012; Mancuso, Chlup, & McWhorter, 2010; Stendal, Molka-Danielsen, Munkvold & Balandin, 2011).

One common finding about the educational uses of virtual worlds is that immersion, or "the subjective impression that one is participating in a comprehensive, realistic experience" (Dede, 2009) can enhance the learning experience. Researchers have also observed that virtual worlds offer possibilities for experiential learning through specific mentoring activities; an approach that encourages students to engage in problem solving activities within a flexible environment that facilitates collaborative and constructivist learning (Cremorne, 2009). Educators have also been drawn to the potential that virtual worlds offer for distance mentoring through social interaction and learner engagement (Chou & Hart, 2012). In these applications, the presence of avatars can enhance "engagement and learning beyond computer-mediated communication without such agents" (Jarmon, 2008). Researchers have also noted the capacity of virtual worlds to facilitate experiential learning (Jarmon, Traphagan, Mayrath & Trivedi, 2009) via simulations, role-playing, and group work that can be used within mentoring activities (Duncan, Miller & Jiang, 2012; Inman et al., 2010).

4 Mobile Devices

Like many CMC solutions, virtual worlds are still most easily accessed from traditional personal computers (PCs), but there are opportunities to supplement PC based e-mentoring with mobile devices. Within the CMC rubric, modern students are increasingly turning to mobile computing platforms to stay connected when away from a PC, and the most commonly used devices are smartphones (Herrington, 2009). As a CMC platform, the smartphone is rapidly maturing. According to a yearly survey of college students, 99% own a cell phone, 69% of which are smartphones (Hanley, 2012). Hanley also reports that 99% of students use short messaging service (SMS), also known as "texting," many of whom text even while in class. Research suggests that SMS classroom communication can be educationally effective when properly implemented (Markett, Sanchez, Weber, Tangney, 2008), and instructors are taking advantage of texting to implement anonymous response systems, polling, and just-in-time communication techniques that have been used in mentoring (McClean, Hagan, & Morgan, 2010). While smartphone accessibility is far from perfect, studies indicate a growing trend for accessible input and output in these devices, increasing their use by SwDs (Lippincott, Morris & Mueller, 2011).

Smartphones also enable students to stay connected to social media on the go, including aforementioned tools such as Facebook. Patten, Sanchez and Tangney (2006) have identified several other common uses of smartphones by students, including video chatting and Tweeting. Research indicates that a majority of students use their smartphones for social stimulation, to remain continually available, to leave memos and reminders, and for time-keeping (Tindell & Bohlander (2012). These tools all have potential benefits for mentoring (Todd, 2012; Khalil, 2008).

5 Preliminary Results from BreakThru Research

Funded by the National Science Foundation Research in Disability Education division (award # 1027655), the Georgia STEM Accessibility Alliance provides online mentoring to secondary and post-secondary students with disabilities in STEM education through its BreakThru project. BreakThru studies the use and effectiveness of online mentoring in high schools, two-year college and university settings and on students with a wide range of disabilities, including learning, mobility, dexterity, health, sensory and cognitive concerns. Students are paired with mentors who are STEM instructors, graduate students, or professionals employed in the STEM workforce. Mentors provide guidance, support, information and networking assistance to enrolled students, with all contact effected through social media methods, including a 3-D virtual world island, e-mail, Skype (audio-only and video with audio), SMS (texting via smartphone), and telephone voice communication. BreakThru has created virtual world islands through the medium of Second Life, providing accessibility modifications and features to include all participants. Students and mentors in the program are allowed to freely choose their preferred methods of communication from the aforementioned tools. In addition, some student/mentor pairs include limited face-to-face contact, where appropriate.

The following project data is formative and preliminary, excerpted from Fall 2012 BreakThru results, but may help to shed light on the ways in which students, teachers and professionals can incorporate social and online media into mentoring activities. More complete interpretive and summative data from BreakThru will be published in future.

Thirty mentees completed a survey in Fall 2012 that was designed to gauge their satisfaction with mentoring. The following constructs were assessed on the mentee survey:

1. **Personal Responsibility:** degree to which mentor enhances interpersonal development among mentees
2. **Satisfaction:** sense of fulfillment in the mentoring relationship
3. **Communication-quantity:** satisfaction with frequency and duration of communication (extent)
4. **Communication-quality:** satisfaction with the quality of communication
5. **Support Seeking:** degree of support provided (academic and personal)

Additionally, the mentee survey explores the types of communication mediums being utilized and the level of satisfaction with each medium.

5.1 Results and Discussion

Table 1 summarizes mentees' average responses to the constructs listed above. It is evident that all constructs were rated above the optimal average of 4 on a 5-point likert scale where 1 signifies strongly disagree and 5 signifies strongly agree. The results show that participants enjoyed and saw the benefits of the mentor/mentee

program, especially in the communication realm. For example, all 30 of the mentees indicated that they always felt respected and supported during sessions with their mentors.

Table 1.

Constructs	Mean	Strongly Disagree (1)	Disagree (2)	Neither (3)	Agree (4)	Strongly Agree (5)
Personal Responsibility	4.34	0%	1%	10%	44%	46%
Satisfaction	4.53	0%	0%	7%	33%	60%
Communication-*quantity*	4.40	0%	0%	12%	36%	52%
Communication-*quality*	4.68	0%	0%	3%	25%	71%
Support Seeking	4.41	0%	0%	9%	42%	49%

The same students responded to measures of engagement in the mentoring process via Second Life and other BreakThru social networking tools, such as Facebook, Twitter, email and Skype). Results indicated generally positive engagement, but suggested that Second Life may require further training or experience to be used most effectively. Students were, in general, less experienced and confident in use of the virtual world platform as opposed to more familiar affordances, and expressed some difficulties with technical issues, such as audio input and output in Second Life.

Table 2.

Engagement	n	Mean	Strongly Disagree (1)	Disagree (2)	Neither/ Neutral (3)	Agree (4)	Strongly Agree (5)
a. Using Second Life for mentoring was a positive experience for me.	30	3.37	10%	10%	33%	27%	20%
b. I feel comfortable using Second Life for my mentoring.	29	3.31	10%	10%	31%	34%	14%
c. Using social networks (such as Facebook, Twitter, email, Skype) helped me build a relationship with my mentee.	30	4.27	7%	0%	10%	27%	57%

Table 2. (*continued*)

d. My background/ experiences allow me to relate to my mentee.	29	4.31	3%	0%	0%	55%	41%

Frequency of use of communication media and student self-report indicate that they tended to use the tools most familiar to them and most readily "at-hand," including tools available through portable mobile devices such as smartphones.

Table 3.

Check all the ways you communicate with your mentor (Please check all that apply.)	**n**	**%**	**Rank**
Second Life	14	47%	4
Email	29	97%	1 (highest)
Facebook	10	33%	5
Twitter	0	0%	8(lowest)
Skype	9	30%	6
Texting	18	60%	3
Telephone	23	77%	2
In person	7	23%	7
Other	0	0%	8 (lowest)

Results with students and mentors indicated a need for training on multiple levels, but especially in the use of the virtual world platform of Second Life, largely unfamiliar to all respondents. A 1.5 hour virtual training session was conducted with project participants in Fall 2012, and results from one cadre of 21 students and 12 mentor trainees are summarized below. Trainees were instructed in basic movement of avatars, communicating with others, and advanced features, such as accessing web media through Second Life, group communications, manipulating in-world objects and travelling to alternate destinations.

On average, participants rated all of the agenda items above the critical limit of 3.5 or higher. Overall, the participants rated the agenda topics as a 3.75 for informative, a 3.85 for useful, and a 3.74 for engaging on a 4-point likert scale where 1 signifies "not at all" and 4 signifies "very much." Given that the primary goal of Second Life is to interact and learn with other participants, reinforcing the importance of communicating with other avatars may warrant further training.

Table 4.

	Mean[1]	Rank
Basic Movement (forward, backwards, turning, jumping)	3.91	1 (*highest*)
Communicating with other users	3.68	3 (*lowest*)
Advanced features	3.70	2
Overall average	**3.76**	

In responses to the open-ended questions, participants indicated that they need additional technical assistance in creating and navigating their avatars, and in reconciling audio problems encountered during the training session(s).

Table 5.

Modules		N	Mean	1 (not at all)	2	3	4 (to a great extent)
Basic Movement (forward, backwards, turning, jumping)	Informative	20	3.95	0%	0%	5%	95%
	Useful	19	3.89	0%	0%	11%	89%
	Engaging	18	3.89	0%	0%	11%	89%
Communicating with other users	Informative	19	3.74	0%	5%	16%	79%
	Useful	19	3.74	0%	5%	16%	79%
	Engaging	19	3.58	0%	11%	21%	68%
Advanced features	Informative	20	3.55	5%	5%	20%	70%
	Useful	18	3.78	0%	0%	22%	78%
	Engaging	17	3.76	0%	6%	12%	82%

In terms of comfort using the Second Life platform for e-mentoring, the training indicates that both students and mentors can quickly achieve a reasonable level of satisfaction, but further training and experience may be necessary to achieve a target mean of 3.5 or higher, which would indicate "great extant" of comfort.

Table 6.

Based on today's training, I…	n	Mean	1 (not at all)	2	3	4 (to a great extent)
Am more comfortable using Second Life	21	3.48	0%	10%	33%	57%
Am better able to use Second Life to support students.[1]	12	3.50	0%	8%	33%	58%
Am comfortable with the amount of support the trainers provided.	21	3.62	0%	5%	29%	67%

6 Conclusion

CMC solutions, including virtual worlds and smartphone technologies, open new possibilities for e-mentoring SwDs. Virtual worlds include technology, accessibility and learning challenges for many students, but can provide a rich mentoring experience with increased sense of immersion, with proper training. Mobile computing platforms such as smartphones can supplement more traditional PC-based e-mentoring, and in some cases can provide equivalent affordances to typical CMCs, such as e-mail, Skype, Facebook, browser-based applications, and other social media tools. They also have the advantage of convenience and nearly ubiquitous access for many students.

Overall, the preliminary BreakThru results suggest that mentoring activities gravitate to media that are familiar and comfortable to participants. The top 3 media for communicating with mentors were: Email, Telephone, and Texting. It is also possible that because of technical complications (i.e. audio problems), mentors and mentees have made less use of the virtual world option than may otherwise have been the case.

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