

# Social Media Use in Medical Education: A Systematic Review

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## Abstract

### Purpose

The authors conducted a systematic review of the published literature on social media use in medical education to answer two questions: (1) How have interventions using social media tools affected outcomes of satisfaction, knowledge, attitudes, and skills for physicians and physicians-in-training? and (2) What challenges and opportunities specific to social media have educators encountered in implementing these interventions?

### Method

The authors searched the MEDLINE, CINAHL, ERIC, Embase, PsycINFO, ProQuest, Cochrane Library, Web of Science, and Scopus databases (from

the start of each through September 12, 2011) using keywords related to social media and medical education. Two authors independently reviewed the search results to select peer-reviewed, English-language articles discussing social media use in educational interventions at any level of physician training. They assessed study quality using the Medical Education Research Study Quality Instrument.

### Results

Fourteen studies met inclusion criteria. Interventions using social media tools were associated with improved knowledge (e.g., exam scores), attitudes (e.g., empathy), and skills (e.g., reflective writing). The most commonly reported

opportunities related to incorporating social media tools were promoting learner engagement (71% of studies), feedback (57%), and collaboration and professional development (both 36%). The most commonly cited challenges were technical issues (43%), variable learner participation (43%), and privacy/security concerns (29%). Studies were generally of low to moderate quality; there was only one randomized controlled trial.

### Conclusions

Social media use in medical education is an emerging field of scholarship that merits further investigation. Educators face challenges in adapting new technologies, but they also have opportunities for innovation.

The ubiquitous nature of social media is undeniable. According to Facebook, by mid-September 2012 the social networking Web site was hosting 1 billion active monthly users,<sup>1</sup> or 14.2% of the world's population.<sup>2</sup> In 2012, Twitter announced its users were sending 340 million tweets per day, up 170-fold from 2 million per day in 2009.<sup>3</sup> Social media sites and applications have also found their way into the toolboxes of medical students, residents, physicians, and medical educators across the globe.<sup>4-7</sup> Given this, harnessing social media's potential to enhance learning is the

logical next step in the evolution of medical education technology.

Web-based tools offer several advantages over in-person/print educational tools: they can overcome physical or temporal barriers, provide searchable content, and encourage interactivity.<sup>8</sup> Previous literature reviews have indicated that e-learning can be as efficacious as traditional teaching formats in imparting knowledge.<sup>9-12</sup> Looking ahead, an emerging trend in medicine is the use of open-source, user-focused Web-based tools sometimes referred to as "Web 2.0."<sup>13,14</sup> McGee and Begg<sup>15</sup> define Web 2.0 as a "collection of Web-based technologies that share a user-focused approach to design and functionality, where users actively participate in content creation and editing through open collaboration between members of communities of practice."

Social media, which have emerged from this broader context, have been defined in a variety of ways.<sup>9,13,15,16</sup> Some definitions are synonymous with those of Web 2.0, some encompass e-learning and distance learning tools, and others take a narrower focus. McGowan and colleagues<sup>7</sup> state that:

Social media websites and applications are online environments where users contribute, retrieve, and explore content primarily generated by fellow users. As opposed to more traditional forms of information and communication technologies used in health care organizations, the content generated through social media is typically created by users for users, thus allowing knowledge and support to flow more effectively.

Social media tools have the potential to build on the interactivity of e-learning with additional features that are more learner-generated, collaborative, and engaging.<sup>17</sup> However, use of social media by physicians and medical trainees has given rise to concerns about patient privacy and online professionalism.<sup>18-21</sup> There is an urgent need for a synthesis of the evidence on social media use in medical education to inform educators and researchers of any demonstrated benefits that would justify the potential risks of incorporating social media tools into educational interventions. Such evidence may lessen the "cultural lag" that often accompanies the adaptation of novel technology to medical education.<sup>22</sup>

We performed a systematic review of the literature to identify and evaluate

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studies of educational interventions for physicians or physicians-in-training that included one or more social media tools as a key component of the teaching method. We sought to answer the following questions: (1) How have educational interventions using social media tools affected outcomes of satisfaction, knowledge, attitudes, and skills for physicians and physicians-in-training? and (2) What challenges and opportunities specific to social media use have educators encountered in implementing these interventions?

## Method

### Literature search strategy

We searched the literature in nine databases (MEDLINE, CINAHL, ERIC, Embase, PsycINFO, ProQuest, Cochrane Library, Web of Science, and Scopus), from each database's start date through our search date (September 12, 2011), for English-language studies on social media use in medical education published in peer-reviewed journals. We defined *social media* as Web-based technologies that facilitate multiuser interaction around expressive, user-generated content that goes beyond fact sharing. This definition, which was based on an examination of key articles,<sup>7,13,14</sup> excluded online technologies that distribute static information (i.e., distance learning) in favor of identifying tools that facilitate idea sharing and evolution through collaboration, interaction, and discussion. We defined *medical education* as all levels of physician training: medical school, residency, fellowship, and continuing medical education.

Our key search terms were *medical education*, *undergraduate medical education*, *graduate medical education*, *continuing medical education*, *medical student education*, and *resident education* in combination with variations of the following "[All Fields]" terms: *social media*, *social network*, *Facebook*, *Web 2.0*, *Web log*, *blog*, *Twitter*, *podcast*, and *Webcast*. For example, we searched MEDLINE using the following strategy:

("Facebook"[All Fields] OR  
"Twitter"[All Fields] OR blogging[MeSH  
Terms] OR "Webcast"[All Fields]  
OR "Webcasting"[All Fields] OR  
"Webcasts"[All Fields] OR "podcast"[All  
Fields] OR "podcasts"[All Fields] OR  
"podcasting"[All Fields] OR "Web  
2.0"[All Fields] OR "social media"[All

Fields] OR "social networks"[All Fields]  
OR "social networking"[All Fields])  
AND (medical education[MeSH Terms]  
OR "resident education"[All Fields] OR  
"medical student education"[All Fields]).

To identify additional studies, we hand-searched the reference lists of the studies included in our full-text review.

### Article selection and eligibility criteria

Two of us (T.F., M.C.) reviewed the titles and abstracts of publications identified in the search and selected relevant articles for possible inclusion. We retrieved the full text of these articles for further review against our inclusion criteria, which were as follows: English language, published in peer-reviewed journals, studies of physicians or physicians-in-training, and evaluations of educational interventions (e.g., courses, training activities) that used social media tools. We excluded articles whose full text was not accessible and those that were published in conference proceedings. We resolved any disagreements through discussion until we reached consensus.

### Data extraction and synthesis

We developed and piloted a form to extract data from each study that met the inclusion criteria. Data extraction for each study was performed independently by two of three authors, and any differences were resolved by the third author. Our data extraction variables included study authors, year of publication, description of intervention (content, timing, participants), intervention goals, study design (quantitative and/or qualitative), main findings, social media technology used, and opportunities and challenges identified in using this technology.

After data extraction, we reviewed, discussed, and categorized the opportunities and challenges in using social media tools reported by each article. Subsequently, one of us (C.C.) re-reviewed the extracted data to assign categories to each article.

### Quality assessment

We assessed the quality of each included study using the Medical Education Research Study Quality Instrument (MERSQI), a tool designed to evaluate quantitative educational studies.<sup>23</sup> The 10-item MERSQI—which has a total possible score of 5 to 18, with higher

scores indicating higher quality—assesses the following domains:

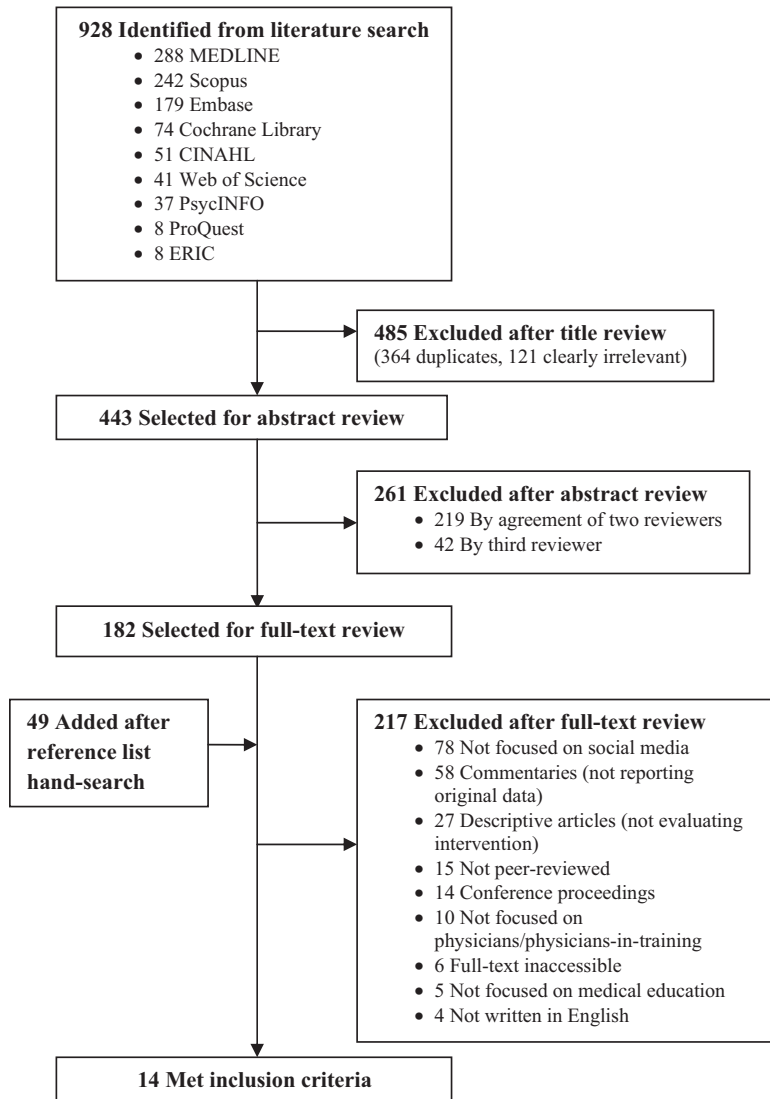
- study design (single-group cross-sectional or posttest only, single-group pre- and posttest, two groups nonrandomized, or randomized controlled trial);
- sampling (number of institutions and response rate);
- type of data (assessment by study participant or objective measurement);
- validity of evaluation instrument (internal structure and content, relationships to variables);
- data analysis (appropriateness and complexity); and
- outcomes (satisfaction/attitudes/opinions, knowledge/skills, behaviors, and/or patient/health care outcomes).

In prior studies, intraclass correlation coefficients have been reported at 0.72 to 0.98 for interrater and 0.78 to 0.998 for intrarater reliability.<sup>23</sup> Criterion validity has been assessed by expert quality ratings, citation rates, and publication impact factors.<sup>23,24</sup> For this systematic review, two of three authors scored each article independently. We resolved discrepancies by discussion. We assessed interrater reliability for each MERSQI domain by calculating a weighted Cohen kappa statistic using R Version 2.14.1.<sup>25</sup>

## Results

Our initial database search identified 928 titles from which we selected 443 for abstract review, after removal of duplicates and clearly irrelevant titles. After reviewing abstracts, we selected 182 articles for full-text review. We identified 49 additional articles for full-text review by hand-searching the references of these 182 articles. After full-text review, we determined that 14 studies<sup>26–39</sup> met our inclusion criteria (Figure 1).

Although the earliest of the 14 articles was published in 2006,<sup>26</sup> few studies reporting results of medical education interventions involving social media followed until 2011, when 7 (50%) of the included articles were published. Half of the included articles appeared in medical education journals. The others were published in subspecialty (e.g., nephrology, emergency medicine, dermatology; n = 4; 29%), medical



**Figure 1** Flowchart for search strategy and review of English-language, peer-reviewed studies on educational interventions for physicians or physicians-in-training using social media tools published through September 12, 2011.

librarian/informationist ( $n = 2$ ; 14%), and general medicine ( $n = 1$ ; 7%) journals. Most articles ( $n = 10$ ; 71%) reported no funding source.

Appendix 1 presents an overview of the 14 included studies' MERSQI scores, social media tools, participants, aims, evaluation methods, and major findings. The mean MERSQI score was 8.89 (SD: 3.39; range: 5–15.5). Mean domain scores were highest for data analysis (2.00 of 3) and lowest for validity (0.93 of 3). Our mean interrater reliability for all domains was 0.846, indicating excellent agreement.

### Social media tools used

Blogs were the most commonly employed social media tool ( $n = 10$ ; 71%), followed

by wikis ( $n = 3$ ; 21%), Twitter ( $n = 2$ ; 14%), and Facebook ( $n = 2$ ; 14%). Seven studies (50%) used a single tool, one study (7%) used two, and three studies (21%) used three or more. One study employed a custom online learning environment, similar to a blog, in which student groups uploaded user-generated content to address questions surrounding clinical cases and posted related comments or questions.<sup>29</sup> Another study used Google Maps Application Programming Interface (API) technology to enable students to post annotations to virtual microscopy slides and to provide a social networking component.<sup>39</sup> Complementary tools included video conferencing (Skype), media sharing sites (YouTube or Flickr), podcasts, and online modules.<sup>30,32,37</sup>

### Study participants

Eleven studies (79%) involved undergraduate medical students only, whereas the other three included practicing physicians,<sup>32</sup> staff members,<sup>35</sup> or a combination of undergraduates, residents, fellows, and practicing physicians.<sup>34</sup>

### Study aims and design

The main aims of the included studies were to promote empathy, reflection, or professionalism ( $n = 5$ ; 36%), to enhance clinical skills or knowledge ( $n = 7$ ; 50%), and to increase interest in a field ( $n = 2$ ; 14%).

Nine studies (64%) used a single-group cross-sectional or posttest-only design, whereas four studies (29%) employed a two-group nonrandomized design. Only one study (7%) was a randomized controlled trial.<sup>29</sup> Nine studies (64%) administered a postintervention survey on user satisfaction and attitudes, whereas two (14%) implemented both pre- and postintervention surveys on technology use, student preferences and satisfaction, or demographics. Seven studies (50%) extracted technology usage data using tools such as Web site hit counters or access history. Four studies (29%) evaluated knowledge using exam scores, three (21%) conducted interviews or focus groups, and two (14%) conducted postintervention analysis of the depth of reflection in student blog entries. One study (7%) measured change in empathy over time using a validated survey instrument.<sup>38</sup>

### Study outcomes

Learner satisfaction with social media interventions was described as positive, although in most studies no comparison group was offered.<sup>26,33–35</sup> The results of studies that assessed more than one intervention were mixed. For example, students generally favored blogging over essay writing for reflection,<sup>36</sup> but they favored in-person problem-based learning (PBL) over virtual collaborative learning for improvement of clinical reasoning skills.<sup>29</sup>

Interventions to improve knowledge demonstrated equivalent test scores for students who did and did not use social media tools.<sup>29,39</sup> However, students who actively participated in a blog-based discussion forum had higher grades than

students who posted less often.<sup>30</sup> One study reported high knowledge scores on postintervention tests but did not compare participants' scores with those from nonintervention groups.<sup>28</sup> Another study reported quantitative assessment of empathy using the Jefferson Scale of Physician Empathy—Medical Student version.<sup>38</sup> It showed that third-year medical students who participated in a humanism and professionalism course that included a blog showed no decline in empathy during their yearlong clerkships; in contrast, previous studies showed a significant decline in empathy among third-year medical students.<sup>38</sup> Students reported that the most useful components of the course were the small-group discussions and blog participation, but the effects of activities were not analyzed separately in the study.

In one study, participation in faculty-moderated course blogs and traditional small-group discussions with essay writing were equally effective in fostering medical students' reflective writing skills.<sup>36</sup> Another study found that 169 (95%) of 177 student entries to a faculty-moderated blog were deemed "reflective" and that instructor feedback could stimulate further reflection.<sup>27</sup>

Most studies did not report intervention costs, but one described changes in resource use,<sup>39</sup> including reductions in faculty time and lab session hours, after implementation of a virtual microscopy system for histology teaching. Another study reported cost as a potential barrier to providing portable devices for learners, but this was not quantified.<sup>32</sup> No studies evaluated patient outcomes.

### Challenges and opportunities specific to social media use

**Challenges.** Technical challenges in the use of social media were reported by six (43%) of the included studies. For example, signing all students up to participate in a course blog was more time-consuming than expected.<sup>27</sup> Another study noted that students initially had trouble posting due to a problem with security settings, but this issue was easily corrected.<sup>33</sup> Faculty also encountered technical difficulties in facilitating online discussions.<sup>36</sup>

Variable levels of learner participation were reported as a challenge in six (43%) of the studies. For example, some groups

of students were more active than others on a course wiki, and some students only read others' posts without contributing their own.<sup>31</sup> In another study, 29.0% of students reported that they did not read other students' posts, and 40.6% indicated that they lost interest in the online component during the course.<sup>29</sup>

None of the studies reported any adverse events (e.g., breaches of professionalism, compromised patient privacy) during the interventions. Four studies (29%) mentioned specific measures that were considered during design and implementation to address potential privacy concerns, such as including security settings on course blogs to avoid student posts being accessible by anyone outside the course.<sup>27,36</sup>

Demands on time were also cited as a possible challenge in three (21%) of the studies. Students participating in online PBL groups spent more time on clinical reasoning cases than did students in in-person PBL discussion groups.<sup>29</sup> Blog facilitation required more faculty time than did traditional discussion groups, but facilitators reported that this time was well spent and that sharing comments added value to the assignments.<sup>36</sup> In contrast, one study found that moving from traditional to virtual microscopy saved faculty time and shortened laboratory sessions.<sup>39</sup>

**Opportunities.** Ten studies (71%) reported learner engagement as an important benefit of social media use. By stimulating interaction and learner-generated content, social media tools appeared to promote active learning. Students' active participation in a course blog correlated with improved grades.<sup>30</sup> In addition, the flexibility of online tools allowed customization of learning to fit learners' needs.<sup>28</sup>

An advantage of social media tools over traditional teaching methods was that social media tools provided opportunities for more feedback, as reported in eight (57%) of the studies. Social media facilitated faculty and peer feedback to learners on their performance.<sup>33</sup> Peer review of posts also overcame potential concerns that students might share inaccurate information.<sup>39</sup>

Other opportunities included enhanced collaboration (n = 5; 36%), professional

development (n = 5; 36%), career advancement/networking (n = 3; 21%), and supportive learning communities (n = 2; 14%). In addition, social media tools were popular with learners (n = 3; 21%), particularly medical students. In four studies (29%), social media tools provided a valuable means of connecting learners to resources and activities to which their access would otherwise be limited by geographic distance or scheduling barriers.

### Discussion

To the best of our knowledge, this systematic review represents the first synthesis of the English-language peer-reviewed literature evaluating the use of social media tools in medical education. In the 14 studies of medical education interventions included in this review, blogs were the most commonly assessed social media tool, and undergraduate medical students were the most commonly targeted population. The included studies demonstrated favorable results related to learner satisfaction, knowledge, attitudes, and skills. Although most of the studies were not of high quality—based on their MERSQI scores (which took into account the studies' lack of randomization, comparison groups, or validated evaluation instruments)—this is a new area of inquiry, and, thus, it is encouraging to see that several relatively rigorous studies have emerged so early.

Whereas prior reviews have explored the advantages of e-learning over traditional teaching methods in medical education,<sup>9–12</sup> we investigated newer social media tools' potential to enhance learning among physicians and physicians-in-training. Social media tools offer opportunities to foster collaborative learning and engagement. Although privacy breaches are legitimate concerns, none of the studies reported any adverse events. (This may be due to reluctance to share these events or risk minimization through supervision of learners.) Our findings suggest that social media tools can be used safely in medical education settings and that their use may have a positive impact on learner outcomes. These findings have exciting implications for educators and researchers.

For educators, this systematic review presents the small—but growing—body of evidence for the efficacy of



social media tools in enhancing medical education. In developing and implementing future interventions, educators should consider ways to maximize the opportunities provided by social media, such as active learning through engagement in user-generated content, facilitation of communication and feedback, collaboration, and access to resources and interaction without physical location restrictions. In addition, they should take into account the challenges reported in the studies reviewed here, including technical issues, varying learner participation, and tools' security settings. Although the use of social media components in courses and other learning activities can save time by increasing efficiency, it can also be time-consuming. The time spent by faculty and learners on social media should add value to face-to-face instruction if these tools are to be incorporated successfully into medical education curricula.

Researchers should be assured that social media use is a legitimate topic of scientific study.<sup>40–42</sup> The body of literature evaluating use of social media in medical education holds ample room for further inquiry. We found there to be a lack of high-quality evidence (e.g., only one randomized controlled trial), infrequent assessment of skill- or behavior-based outcomes, and no assessment of patient-based outcomes in the studies included in this review. New technologies evolve rapidly, often faster than sound evidence for their effectiveness can be established. Although this presents a challenge to researchers, the pace of change can also offer opportunities for innovation, such as engaging learners in curricular development.

Since conducting our literature search, we have endeavored to remain up-to-date in this expanding literature through ongoing reading, discussions with experts in the field, and publication alerts from the MEDLINE and Scopus databases. To our knowledge, two relevant studies have been published since the end date of our search. One study used Twitter and Facebook to share important concepts in a yearlong elective ultrasound course for fourth-year medical students.<sup>43</sup> Of the 27 participants who completed the study's follow-up survey, 88.9% found these social media tools to be user-friendly, and 81.5% found the educational content to be useful. The second

study used a social networking portal compatible with low-bandwidth Internet connections to deliver dermatology instruction to eight medical students and interns in Somaliland and to allow participants to interact in real time with a tutor in the United Kingdom.<sup>44</sup> All six of the trainees who completed the feedback questionnaire indicated that the interactive format was more useful than textbook reading for learning the material, and four reported that they felt more confident in describing rashes after completing the tutorial.

This systematic review has several limitations. Given the recent rapid growth in this literature, relevant articles have continued to be published since we conducted our search, as discussed above. In addition, articles identified in our search did not always clearly define the form or content of social media technology used, so some may have been inappropriately excluded from this review. Publication bias favoring articles demonstrating benefits of social media use versus those demonstrating equivalence or negative results must be recognized, as in the context of any systematic review. Finally, the studies included in this review were too heterogeneous to perform sensitivity, subgroup, or meta-analyses.

Despite these limitations, this systematic review offers a foundation for future research and guidance for incorporating social media tools into medical curricula. Future scholarship in this new field should include clear definitions of social media technologies and their components to allow appropriate comparisons and data synthesis. In addition, it would be helpful to compare social media use with other educational methods, explore a variety of learner populations, and examine skill- or behavior-based outcomes. Additional, higher-quality research is needed to establish best practices in the development of social media technology to enhance medical education.

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## Appendix 1

**Summary of 14 Studies Evaluating the Use of Social Media Tools in Medical Education Interventions, Included in a Systematic Review of the English-Language Peer-Reviewed Literature Published Through September 12, 2011**

Study authors and date <sup>ref</sup>	MERSQI score*	Social media tool(s) used in intervention	Participants and study period	Aim(s)	Evaluation method(s)	Major findings
Raupach et al, 2009 <sup>29</sup>	15.5	Online course on clinical reasoning (with live chats, asynchronous group discussions, and document exchange similar to a blog) versus in-person problem-based learning (PBL) clinical reasoning course	Nine groups of 8 fourth-year medical students in each arm completed six-week course (total 72 students in each version of the course)	Improve clinical reasoning skills	<ul style="list-style-type: none"> <li>Examination assessing clinical reasoning skills at the course end</li> <li>Pre- and postintervention student surveys on computer use and course satisfaction, respectively</li> <li>Usage history data</li> </ul>	There were no significant differences between the mean scores of the groups. In virtual learning groups, costs for diagnostic tests were significantly higher for frequent contributors to online group discussions. Evaluation data favored traditional PBL sessions over virtual collaborative learning.
Fischer et al, 2011 <sup>36</sup>	13	Two writings and at least one comment posted to a faculty-moderated group blog versus traditional reflective essay and faculty-moderated, small-group discussion	95 third-year medical students during an internal medicine clerkship (undefined duration) at two institutions	Promote reflection	<ul style="list-style-type: none"> <li>Writings coded for theme and level of reflection by two blinded authors</li> <li>Anonymously pre- and postclerkship student surveys</li> </ul>	Main themes and level of reflection were similar across institutions and study arms. Students generally favored the method they used.
Rosenthal et al, 2011 <sup>38</sup>	13	Blogging component during mandatory, longitudinal "Humanism and Professionalism" clerkship course, which also included small-group discussions, articles, clinical experiences, and seminars	209 third-year medical students in two medical school classes completed yearlong course	Maintain empathy	<ul style="list-style-type: none"> <li>Pre- and postintervention assessment of empathy using Jefferson Scale of Physician Empathy Medical Student Version (JSPE-MS)</li> <li>Postintervention questionnaires to gather demographic information and assess student satisfaction</li> </ul>	Students who participated in the course did not show significant decline in empathy. Students selected for a Humanism Honor Society were significantly different from their peers in empathy scores. Knowledge of honor society selection seemed to positively influence students' empathy scores. Students reported that small-group discussions and blog participation were the most useful components of the course.
Triola and Holloway, 2011 <sup>39</sup>	12.5	Virtual microscopy system using Google Maps engine with collaborative annotation and social networking features	164 first-year medical students, with data gathered over one month	Improve histology knowledge	<ul style="list-style-type: none"> <li>Detailed Web site usage data</li> <li>Comparison of student performance on a final exam before and after intervention implementation across years</li> <li>Analysis of faculty time and resources</li> </ul>	Students viewed an average of 56.3 slides per month at all hours of the day. Faculty added 26.2% of the 621 annotations on 126 slides, and 73.8% were added by students. The system reduced dedicated faculty time by 210 hours, but did not reduce the number of lab sessions or required faculty. Lab sessions were reduced from three hours to two hours because of greater efficiency.
Chretien et al, 2008 <sup>27</sup>	9.5	Two reflective postings on class blog required during clerkship	91 "clinical medical students" in four-week basic medicine clerkship over a one-year period	Enhance professionalism through reflection	<ul style="list-style-type: none"> <li>Descriptive usage data</li> <li>Postintervention student satisfaction survey</li> <li>Qualitative analysis of blog themes to determine depth of reflection</li> </ul>	91 students wrote 177 posts, of which 169 demonstrated "reflection." One-third of students left feedback comments. The majority of students enjoyed the activity and found the instructor's feedback helpful. Posts included reflections on experience, heavily concerned with behavior and affect. Certain posts provided insight to the hidden curriculum.

(Appendix Continues)

## Appendix 1, Continued

Study authors and date <sup>ref</sup>	MERSQI score*	Social media tool(s) used in intervention	Participants and study period	Aim(s)	Evaluation method(s)	Major findings
Dinh et al, 2011 <sup>35</sup>	9	Individual, customizable Web sites containing e-learning tools, discussion threads, interaction via Facebook and Twitter, and knowledge repositories networked within single organizational domain	74 staff members over 9 months	Improve training and educational capacity in the emergency department (ED)	<ul style="list-style-type: none"> <li>Web site usage data</li> <li>Postintervention usability assessment</li> <li>Semistructured interviews</li> </ul>	54 individual sites were created by 74 eligible staff members. There were 251 registered users, including users outside the ED, and 7 494 access events. 88% of staff members agreed or strongly agreed that the collaborative learning application had improved learning capacity within the ED.
Carvas et al, 2010 <sup>30</sup>	8.5	Clinical research training course combining discussion forum, blogs, weekly poll, podcasting, and a mock grant group project using the wiki platform; interactions with faculty and staff through chat and two-way video-conference system	Based at Harvard Medical School and "broadcast to several participating centers over the world" over six months (undefined number of participants)	Improve knowledge and skills in conducting clinical research	<ul style="list-style-type: none"> <li>Postintervention exam</li> <li>Individual Web site participation data</li> </ul>	There were significant differences between the final grade of the 25% participants with the greatest number of postings and the 25% with the least postings ( $P = .006$ ), such as that students with a higher number of posts had better grades than students with a lower number of posts.
Geyer and Irish, 2008 <sup>28</sup>	7.5	Longitudinal informatics course with workshop and online module, reading, online teaching, and Web-based self-directed learning with clinical integration; blog used for clinical integration	All enrolled medical students at one institution (undefined number) over four years	Enhance knowledge in evidence-based medicine informatics	<ul style="list-style-type: none"> <li>Postintervention online course evaluations and evaluative comments from retention exam</li> <li>Unsolicited faculty feedback</li> <li>Exam pass rates</li> </ul>	The exam pass rates were high, but there was no comparison to prior years. Students rated the intervention good, very good, and excellent, primarily.
Poonawalla and Wagner, 2006 <sup>36</sup>	7	Blog for dermatology interest group at medical school	16 interest group members after nine months' experience	Increase interest in dermatology	<ul style="list-style-type: none"> <li>Postintervention survey of the 16 interest group members, with 13 respondents</li> <li>Hit counter data (added eight months after blog launch)</li> </ul>	There were 149 visits over the one month for which data were available; 76% of respondents found the blog to be extremely or somewhat useful, but only 38% visited the site once a month or more. They found almost all features useful except the comment system.
Varga-Atkins et al, 2010 <sup>31</sup>	7	Private online wiki for four PBL groups	32 first-year medical students in four PBL groups completed two 2-week modules	Enhance professionalism	<ul style="list-style-type: none"> <li>Postintervention student survey</li> <li>Four focus groups</li> <li>Facilitator interviews</li> <li>Wiki usage statistics</li> <li>Midintervention user satisfaction survey delivered through a standardized anonymous questionnaire</li> <li>Focus group discussion</li> </ul>	Several factors affected individual student and group engagement, including positive group dynamics. Students reported that sharing Web links helped to clarify PBL discussions. Reading their peers' posts increased their confidence in learning the course material. Educational modules on mobile phones can give flexibility to health care workers for accessing learning content anywhere. Lack of software interoperability and high investment cost could represent a limitation to widespread use.
Zolfo et al, 2010 <sup>32</sup>	7	Interactive clinical cases adapted for use on smartphones, with HIV specialists available via discussion forum for back-up of the medical information, connected via Facebook and Skype	20 physicians in urban and peri-urban HIV/AIDS clinics in Peru completed the three-month continuing medical education program	Share clinical resources internationally		Educational modules on mobile phones can give flexibility to health care workers for accessing learning content anywhere. Lack of software interoperability and high investment cost could represent a limitation to widespread use.
Abate et al, 2011 <sup>33</sup>	5	Blog and audience response system (ARS) during didactic librarian-taught sessions on medical information resources	190 undergraduate medical students attended four 1.5-hour lectures	Enhance knowledge and skills in accessing medical information resources	<ul style="list-style-type: none"> <li>Informal student and instructor feedback</li> <li>Immediate postintervention student feedback via ARS</li> </ul>	Students were lively contributors to the blog. During sessions, they were quick to use the ARS, ask questions, and supply opinions. The immediate student feedback was "positive."

(Appendix Continues)



## Appendix 1, Continued

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Calderon et al, 2011 <sup>34</sup>	5	Nephrology teaching tools using blogs, interactive cases, role play, writing exercises, and concept maps	220 survey respondents including students, residents, fellows, and other physicians (undefined duration)	Increase interest in nephrology	<ul style="list-style-type: none"> <li>• Postintervention online survey assessing respondents' opinions of intervention tools, compared with traditional teaching methods</li> </ul>	45% of respondents reported that they thought blogs would enhance nephrology education. Fewer than 10% thought that blogs would not help nephrology education; 63% agreed that incorporating all the intervention tools to teach residents and students would increase their interest and help them choose nephrology as a career.
George and Dellasega, 2011 <sup>37</sup>	5	Twitter, YouTube, Flickr, blogging and Skype incorporated into two medical humanities courses	15 fourth-year medical students in each class completed monthlong course (total 30 students)	Promote reflection and creativity	<ul style="list-style-type: none"> <li>• Postintervention student course evaluation with open-ended comments</li> <li>• Analysis of journal entries from one course intervention</li> </ul>	Students rated both courses highly on overall quality, course design, and quality of teaching. Students commented that social media augmented learning and collaboration. Students identified challenges including demands on time, concerns about privacy, and lack of facility with technology. Benefits included real-time communication outside the classroom, connecting with medical experts, collaborative opportunities, and enhanced creativity.

\*MERSQI indicates Medical Education Research Study Quality Instrument.<sup>23</sup> Articles are ordered by descending MERSQI score.