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CLINICAL & BASIC RESEARCH

Can Medical Students Evaluate Medical Websites?

A mixed-methods study from Oman

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abstract: ***Objectives:*** This study aimed to discover the extent to which medical students can evaluate medical websites, evaluation criteria used, factors affecting their abilities and whether a teaching intervention could rectify problems. Medical students and practitioners are required to evaluate medical information available on the Internet. Most current medical students are familiar with the Internet, but their ability to evaluate material may require improvement. ***Methods:*** A class of undergraduate medical students evaluated an unreliable medical website, received a teaching intervention on website evaluation criteria and re-evaluated the same site. This mixed-methods study was conducted at Sultan Qaboos University, Muscat, Oman, from September to December 2018. ***Results:*** A total of 149 (response rate: 82.3%) students participated. Students spent, on average, 4.69 hours per day on the Internet. No significant correlations were found between demographic indicators and Internet time. On a 10-point Likert scale, students' scores ranged from 5–6, with no significant differences between the pre- and post-intervention evaluations, except for increased polarisation away from the mean. Qualitative comments indicated an awareness of relevant criteria but an overall inability to critically apply them. ***Conclusion:*** The results indicate that one cannot make a blanket statement about medical students' ability to evaluate medical websites despite their familiarity with technology. Moreover, website evaluation should be viewed primarily from the information perspective and that critical thinking ability may play a major role. Due to these overriding factors, short interventions are unlikely to have an impact, and other educational strategies should be developed. These are necessary to ensure that medical students can function independently as life-long learners and medical professionals.

Keywords: Internet; Medical Students; Oman.

Advances in Knowledge

- *Students of Medical and Basic Medical Sciences at Sultan Qaboos University appear to lack the skills required for appropriately evaluating the trustworthiness and value of medical-related information.*
- *A single intervention that identifies and teaches criteria found mixed results. Although some students appeared to be initially aware of valid judging criteria, these criteria were frequently incorrectly applied. Post-intervention evaluation indicated a similar result of incorrect and inconsistent application of the criteria.*
- *Part of the reason for the mixed results may be a lack of critical reasoning skills that should have been developed during schooling.*

Applications to Patient Care

- *Healthcare professionals need to keep themselves abreast of new information so that they may deliver high-quality healthcare.*
- *Currently, in the absence of traditional gatekeepers of knowledge, healthcare professionals must rely on their own ability to appropriately critically evaluate new information.*
- *The inability of the Medical and Basic Medical Sciences' students to perform this evaluation points to the need for some form of systematic training to develop these evaluation skills.*

In the 21st century, the internet is an essential source of medical information for medical practitioners, students and patients.[1–5]

The problem with the Internet, however, is that it contains too much information and distinguishing good (e.g. accurate, evidence-based and appropriate) information from bad (e.g. inaccurate, unsubstantiated or inappropriate) is time-consuming and difficult.[6]

Before the Internet, medical practitioners and students considered librarians to be the gatekeepers of information and, thus, relied on; for information on the Internet, in many cases, such human gatekeepers have been removed. Physicians rely on medical search engines (e.g. PubMed [US National Library of Medicine, Bethesda, Maryland, USA]) or broader search systems (e.g. EBSCOHost [EBSCO Information Services, Ipswich, Massachusetts, USA]) to perform gatekeeping, while most medical practitioners mainly use general search engines such as Google (Google LLC, Mountain View, California, USA).[7,8] Physicians are required to critically appraise and evaluate the information they have found.[8]

Experienced physicians can rely on their medical expertise and experience to determine information

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accuracy; however, information changes over time and medical students and newly-qualified physicians do not always have the required knowledge and expertise to evaluate medical information accuracy and quality.[9,10] Medical educators are, therefore, concerned about medical students' ability to critically analyse and review literature.[8,11,12] Studies of these skills frequently focus on theoretical aspects instead of on the students' applying these skills.[10,12] The development of these skills requires the ability to critically evaluate and appraise medical literature.[13] The need to teach these skills has been recognised since 2009 by the UK's General Medical Council.[14]

Students' familiarity with computers and the Internet may not translate into an ability to appropriately deal with information from the Internet. Just like knowing how to read and write does not necessarily mean one knows how to read and write for academic and medical research purposes, knowing how to use the Internet does not necessarily mean one knows how to use it for academic, research or medical work; other skills may be needed. Even if students are familiar with the technology, one should not assume they can reliably evaluate websites and can, therefore, quickly filter out unreliable websites for themselves.

No set of internationally recognised website evaluation criteria exists,[8] although there is the HONCode system (https://www.hon.ch/HONcode/) as well as several guides. A widely cited and popular system for website evaluation is Kapoun's five criteria: accuracy, authority, objectivity, currency and coverage.[15] Kapoun's criteria cover most issues or concerns on the accuracy and credibility of any website (or any document) and form a simple and short list which is ideal for introducing students to the skills required for evaluating the information on the Internet.

Considering that the literature has identified the need to understand and develop medical students' ability to critically analyse textual information and that so much of their information is unfiltered from the Internet, this study attempts to answer three research questions: (1) Prior to any teaching, to what extent can undergraduate medical students evaluate the quality of a medical-related website, and on what criteria do they base their evaluation?; (2) Is their evaluation related to prior computer usage or other experience?; (3) After receiving basic instruction on website evaluation, how would the new knowledge affect their ability to evaluate the same website?

Methods

This mixed-method study was conducted at Sultan Qaboos University, Muscat, Oman, from September to December 2018, with 181 Medical and Basic Medical Sciences students from the Medical Informatics I course. Students were taught in three sections, on three consecutive days, by the same teacher, at the same venue, using the same notes and methods.

As part of their Medical and Basic Medical Sciences' undergraduate degrees, students complete a semester-long Medical Informatics I course. Highlighting and teaching the basics of website evaluation is part of the course. Most of the students have been admitted straight from school and may have attended a foundation year at the University, which includes computer literacy. Some students are in their first semester and others are in their third.

A US-based, health-related website was used in the study. The website's complete name and URL was disclosed to the Sultan Qaboos University College of Medicine and Health Sciences Medical Research Ethics Committee for ethical approval and is available upon request. It is a public website and contains health-related information with superficial indicators of authenticity. The name of the website is 'Global [medical procedure] Institute' and it offers access to textbooks with medical titles. The topics on the website are medical related and it claims to contain open and uncensored information on these medical topics. The 'About Us' link on the website describes the institute's history. Closer inspection of the website reveals several problems; it has no physical address and no identity or qualifications of the website's authors or owners. Moreover, it is a publishing house. On the 'About Us' page, only after clicking on a single 'Disclaimer' link does one find that the information on the website is for 'educational and informational purposes only' and is not to be taken as medical advice, that all data on the website should be verified, that it is not endorsed by "the American Academy of Pediatrics, the FDA, CDC or any other federal, state or "official" organization" and that the website does not carry an HONCode or any similar certification. Finally, the disclaimer's last line says that the website's authors are not medical practitioners. All this information is 'buried' away from the front page. No medical knowledge is required to determine the reliability of the information on the website.

An electronic questionnaire was created for the students to complete anonymously through their learning management system. In addition to students' demographic data, the questionnaire was based partially on a study that examined students' ability to create mobile apps, in which students had been asked about their previous information technology (IT) and health sciences' education and training (examples were included in the questionnaire), experience as a

programmer, electronic device usage and daily hours spent on the Internet.[16] It was believed that asking about this broad spectrum of experiences would help identify any experiential subtleties that may impact students' ability to evaluate the website.

Regarding students' perception of the website, three questions were asked on the site's trustworthiness, whether they would recommend the website to a patient and the website's overall quality, using a Likert scale (0–10). Finally, an open-ended question was asked on the students' reasons and the criteria followed to answer the questions regarding the website's quality.

The overall process followed the standard, established format of a pre-test, single intervention (with practice) and post-test design commonly performed in clinical and non-clinical medical education and training interventions.[17–19]

The process was as follows: (1) students were directed to the website and allowed to explore it for 10–15 minutes; (2) students completed the anonymous questionnaire (using temporary identifications), including a consent form; (3) for the intervention, the teacher didactically taught the students Kapoun's evaluation criteria and focused on his criteria and related questions (this took approximately 45 minutes and the students were provided notes so that they could refer to them during the subsequent evaluations);[15] (4) students worked in pairs or groups of three and evaluated different websites to practice their new skills (they chose a website from a list that excluded the website listed in step 1); and (5) after gaining feedback on and participating in discussions about their practice websites, the students re-evaluated the original website and completed the second questionnaire, which asked for the identification code and the same questions on website evaluation as before.

Data were included in the analysis only if the student completed both the pre-and post-intervention questionnaires and identified themselves with their temporary usernames consistently. Data collected pre- and post-intervention were compared to track changes in students' perceptions.

The raw quantitative data were captured in Microsoft Excel, Version 2016 (Microsoft Inc., Redmond, Washington, USA) by one researcher, and statistical tests were performed. A second researcher independently performed the same statistical tests using the Statistical Package for the Social Sciences (SPSS), Version 25.0 (IBM Corp., Chicago, Illinois, USA). The results were inspected and verified by all researchers.

As per the Kolmogorov–Smirnov test, quantitative data were normally distributed. The means, standard deviations and frequencies were also calculated. Analysis of variances were conducted to identify significant age differences. To evaluate pre- and post-intervention data, t-tests for dependent samples were used. For correlations, Pearson's correlations were obtained. Associations between variables (based on information from the literature) and differences regarding the evaluations were tested. A difference was considered statistically significant at $P < 0.05$.

Qualitative data were themed by one researcher using QDA Miner Lite, Version 2.0.6 (Provalis Research, Montreal, Canada) by employing Kapoun's five criteria: accuracy, authority, objectivity, currency and coverage. The comments were subjectively classified as 'negative' or 'positive', based on the attitude expressed. Themes and raw data were inspected and verified by the other researchers. As many students also referred directly to whether or not they would recommend the page to patients, this theme was added. Finally, students made more general comments on design and security; therefore, an 'Other' theme was added as well.

Ethics approval for the study was obtained from the Sultan Qaboos University College of Medicine and

Table 1: Number of hours spent on the Internet per day by the included students (N = 149)

Hours	n (%)	Percentage
<1	1 (0.67)	0.67
1–2	17 (11.4)	11.41
3–4	65 (43.6)	43.62
5–6	37 (24.8)	24.83
7–8	20 (13.4)	13.42
9–10	6 (4)	4.03
11–12	3 (2)	2.01

Table 2: Students' pre- and post-intervention Likert scale mean scores when evaluating a medical website (N = 149)

Question	Mean ± SD		*P* value
	Pre-intervention	Post-intervention	
How trustworthy would you judge the website to be?	5.60 ± 2.50	5.45 ± 2.98	0.471
How likely are you to recommend this website to a patient?	5.28 ± 2.60	4.95 ± 2.82	0.105
How would you judge the quality of the website?	5.30 ± 2.50	5.36 ± 2.79	0.757

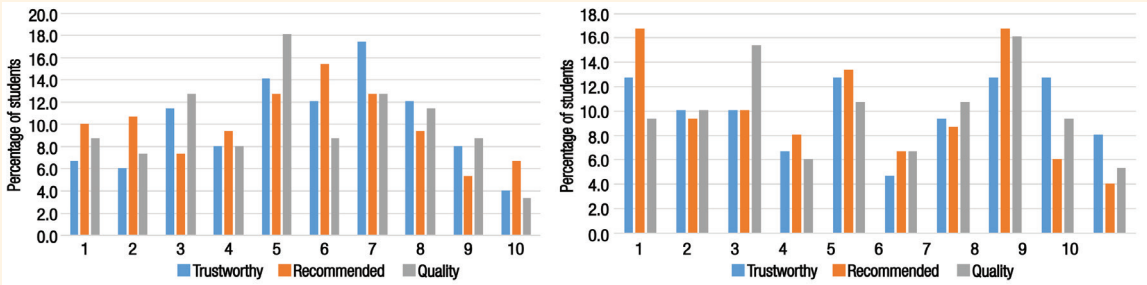

Figure 1: Pre-and post-intervention distribution of scores on students evaluating a medical website.

Table 3: Students' changes in scores when evaluating a medical website (N = 149)

Question	n (%)		
	Lower	Equal	Higher
How trustworthy would you judge the website to be?	59 (39.6)	43 (28.9)	47 (31.5)
How likely are you to recommend this website to a patient?	62 (41.6)	48 (25.5)	39 (32.9)
How would you judge the quality of the website?	60 (40.3)	37 (24.8)	52 (34.9)

Health Sciences Medical Research Ethics Committee (MREC#1792).

Results

Of the 181 registered students, a total of 149 (response rate: 82.3%) were included in the study. Of these 149 students, 70 (47.0%) were female, 69 (46.3%) were male and 10 (6.7%) did not indicate their gender. The sample's gender proportions were not statistically different from that of the class population (P = 0.100). The students' ages ranged from 17 to 21 years (mean age: 18.86 ± 0.80 years).

Information was obtained on the students' prior training. There were 12 (8.1%) students who had health-related training, 23 (15.4%) had IT-related training and 29 (19.5%) had programming experience.

On average, the students spent 4.69 hours on the Internet per day [Table 1]. No correlation was found between the number of hours spent on the Internet and age (r = 0.079; P = 0.340) or gender (P = 0.513).

On average, the students spent 22.3% of their Internet time on health-related searches. No significant differences were present in the number of hours spent on the Internet based on age (r = 0.021; P = 0.713) or gender (male = 19.0 ± 0.77, female = 18.7 ± 0.83; P = 0.069).

Students' pre- and post-intervention Likert scale scores and the reasons for their scores were obtained. Two important results stand out: (1) on the 10-point Likert scale, students rated the websites as being slightly above average. Second, no significant change was observed in the ratings made pre- and post-intervention [Table 2].

These mean values, however, hide important information on the results' distribution. The students did not merely give the same answers pre- and post-intervention and a score polarisation tendency was present, with shifts in score increases and decreases [Figure 1].

Data showed that this polarisation is seen yet again in the score changes. This indicates that, while many students adjusted their ratings correctly after the intervention, many changed their ratings in the opposite direction. This polarisation is obscured by the nominal shift in the mean scores [Table 3].

Associations were sought between the other variables and the scores allocated for these questions. No demographic or activity variables (age, gender, amount of IT training, health training, hours spent on the Internet or the usage of the Internet for health-related searches) were found to be associated with any scores (all P >0.05).

As the qualitative data were themed according to Kapoun's criteria, the data were laid out in that format [Tables 4 and 5]. In the pre-intervention evaluation, it was found that 54 negative and 46 positive comments could be classified under 'Other', many of which were unspecific comments about the website's being of good or bad quality, unattractive, not secure or boring and other personal opinions. Additionally, 15 students commented that they did not have the knowledge or expertise to properly comment on the website. In total, students made 134 (53.2%) negative comments and 118 (46.8%) positive comments. Of these, 80 (59.7%) of the negative comments and 72 (61.0%) of the positive comments aligned with Kapoun's criteria or were aimed at the site's value to patients.

In the post-intervention evaluation, it was found that 40 negative and 47 positive comments of the students could fall under the 'Other' category. In total, students made 245 (54.2%) negative comments and

Table 4: Theme, rating (negative or positive), number of comments and examples before the teaching intervention on students evaluating a medical website

Theme	Rating	n	Examples
Accuracy	Negative	12	[N]ot all information in the website are correct. Some information needs more statistics.[#60]
	Positive	2	[T]he article and studies help to have more accuracy.[#15]
Authority	Negative	22	They have not mentioned their level of education or the field they are working in.[#95]
	Positive	27	The website has a lot of references where you know that the information are true and right and know from where they got the information.[#5]
Objectivity	Negative	11	[T]he website uses false information to promotes the sales of his book .... the reason for that website is not to help further the medical research domain but for commercial reasons. [#59]
	Positive	0	
Currency	Negative	6	The articles are old. So, its information may had changed and not updated.[#65]
	Positive	0	
Coverage	Negative	3	It is true that this website have a large information about vaccination but that does not mean that it have everything we need to know.[#55]
	Positive	11	[I]t gives access to pdf's that help a person with their inquiry and provides alternatives for your problem. [#101]
Appropriate for Patients	Negative	26	Some patient will misunderstand the information because they do not have enough knowledge. [#149]
	Positive	32	[T]his website is useful and make the patient life more easily because it has the necessary information and data for make the right decision.[#30]

207 (45.8%) positive comments. Of these, 205 (83.7%) of the negative comments and 160 (77.3%) of the positive comments aligned with Kapoun's criteria or were aimed at the website's value to patients.

Table 5: Theme, rating (negative or positive), number of comments and examples after the teaching intervention on students evaluating a medical website

Theme	Rating	n	Examples
Accuracy	Negative	23	First point is the accuracy the website promotes false information.[#59]
	Positive	29	[V]ery good website with a high accuracy. [#14]
Authority	Negative	63	[I]t does not provide secure information, from trust sources [#109]
	Positive	59	[A]ll the information have a reference and copy right which varify information.[#89]
Objectivity	Negative	54	[I]t is looks like an advertisement[#50]
	Positive	12	This website is a good website because it is accurate and objective. [#85]
Currency	Negative	27	[N]o updated studies, most of them are old. [#32]
	Positive	17	[I]t was updated recently.[#17]
Coverage	Negative	21	[T]he coverage looks incomplete, there are no sources given.[#1]
	Positive	24	[T]here are sources for additional information. [#25]
Appropriate for Patients	Negative	17	I will not prefer to recommend it for my patients, as it contain some difficult articles. [#132]
	Positive	19	It covered most of the information so it can [be] rated as a good website. I recommend this website for the patients.[#85]

Discussion

This study examined medical students' ability to evaluate websites, particularly as they would be expected to do so in the absence of traditional gatekeepers such as librarians. The average amount of time these students spent on the Internet was typical of students internationally.[20] Students evaluated a medical-related website, received a teaching intervention and then re-evaluated that same website. No examples of a comparative exercise had been found in the literature; previous studies tested students on reputable or well-controlled websites or students self-selected a broad range of websites and commented on

them.[8,21] For the current study, a highly questionable website was chosen to determine whether or not the students could identify the problems within it. The choice of a single website (rather than multiple) allowed for a more comprehensive view of the website across the full sample of students. While the broad results indicate a positive view of the website, a more detailed evaluation of the data reveals other subtleties and indicates that universal statements on current medical students' ability to evaluate websites should be treated carefully.

With regards to the first research question (prior to any teaching, to what extent can undergraduate medical students evaluate the quality of a medical-related website, and on what criteria do they base their evaluation?), students made more negative than positive comments but their overall rating was positive. Despite this positive tendency, results show a disparity across the student population, a mixed ability and that one cannot make a blanket statement about their evaluation ability [Figure 1A].

The high percentage of alignment between the students' comments and Kapoun's criteria is encouraging. The high number of positive comments, however, is discouraging. It indicates that even though students are aware of the criteria, their ability to match the case to the criteria is not optimal.

These results extend the researchers' arguments that these skills are necessary for medical students.[10–13] Furthermore, the current research demonstrates the extent to which these skills are lacking among these students.

With regards to the second research question (is their evaluation related to prior computer usage or other experience?), studies have demonstrated an association between familiarity with one technology leading to ease of use with another technology.[16,22–24] In this study, no association was found between familiarity with technology and the ability to evaluate websites or improve that ability. This is in agreement with the argument that teaching students the mechanics of using academic and medical search engines is only part of the solution; "the problem remains on how to educate students to critically evaluate information obtained using popular search engines".[8]

As no correlation was found between students' health-related training and evaluation scores, it is apparent that they have no bearing on students' ability to evaluate websites.

With regards to the third research question (after receiving basic instruction on website evaluation, how would this new knowledge affect their ability to evaluate the same website?), when examining the mean scores only, it appears the teaching intervention had no impact on students' website evaluation ability. The polarisation, however, indicates that the criteria are not necessarily being applied correctly.

Thus, the answer to this question is that students demonstrated a greater awareness of the criteria taught and, while many applied the criteria correctly, a similar number applied them incorrectly.

This situation appears to echo a common complaint from clinical teachers that many students can recite rote-learnt lists of conditions but, when faced with a patient, are unable to match the patient to the list of conditions and arrive at a diagnosis. This indicates that broader critical thinking skills need to be focused on; these skills are derived within a broader educational and sociological context.

The lack of association between the level of technological prowess and website evaluation may not be entirely surprising. The reason for this lack of association is that the skillsets required for each may be different and it would be a mistake to consider a website as only a technological entity rather than a source of information requiring critical thought and evaluation.

Whether one uses Kapoun's criteria or any other system, critical evaluation of information and the required skills for this activity appear to have little to do with technological familiarity. Instead, critical insights, reasoning and evaluation skills are needed. An examination of students' critical thinking skills may, indeed, point to the reasons behind students' poor evaluation ability.

A 2003 United Nations (UN) report on development in the Arab World reported a severe lack of critical thinking skills among school-leaving Omanis.[25] Since then, Oman's higher education institutions have attempted to measure and address this. Unfortunately, follow-up studies indicate that Omani university students' critical thinking, interpretation and evaluation scores are significantly below international standards.[26–28]

Critical thinking and critical appraisal skills are essential for medical students; they cannot be assumed and need to be developed.[10,11,13] In the current study, the causes of poor critical thinking skills are likely to be from a poor schooling system. The UN report argues, "[T]he curricula taught in Arab countries seem to encourage submission, obedience, subordination and compliance, rather than free critical thinking. In many cases, the contents of these curricula do not stimulate students to criticise political or social axioms. Instead, they smother their independent tendencies and creativity".[25] Furthermore, the report goes on to say, "Generally speaking, the assigned curricula, starting from preliminary school or even

before, embody a concept that views education as an industrial production process, where curricula and their content serve as moulds into which fresh minds are supposed to be poured…. Students can do little but memorise, recite and perfect rote learning".[25]

Thus, when considering medical students' ability to evaluate a website, the results of the current study point to the influence of factors much bigger than just level of knowledge and certainly there is a need for correction on a more profound level than can be accomplished by a single intervention. Further research assessing critical thinking skills and its relationship to this evaluative ability would be required for a more definitive understanding of these factors.

The current study was limited because it was conducted in a single year on one group of students. Moreover, no research has been conducted on the long-term impact of teaching, which could be studied in follow-up research.

Conclusion

This study found that the included undergraduate medical students' ability to evaluate the quality of health-related websites is mixed. Prior exposure to and use of technology has no bearing on this ability. A single intervention has a limited and mixed impact, possibly as a result of poor prior critical thinking skills. Given that medical students and health professionals increasingly rely upon websites and other information sources that do not undergo quality control, it is recommended that training and practice of the required skills be reinforced.

AUTHORS' CONTRIBUTIONS

TL, KM, SZ and AH-W conceptualised and designed the study. TL, KM and AH-W created the instrument used. Instrument and intervention delivery was conducted by KM. TL and KM analysed the quantitative data. KM produced the themes of the qualitative data, while TL, KM, SZ and AH-W verified the qualitative data. TL, KM and AH-W interpreted the data. All authors drafted and revised the manuscript. All authors approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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