Factors in Medical Student Beliefs about Electronic Health Record Use

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Abstract

Healthcare providers' ongoing investment in electronic health records (EHRs) necessitates an understanding of physicians' expectations about using EHRs. Such understanding may aid educators and administrators when utilizing scarce resources during EHR training and implementation activities. This study aimed to link individual medical student characteristics to their perceptions of EHRs' ease of use and usefulness. This study employed a cross-sectional survey of 126 third-year medical students at a large southeastern university. Using a questionnaire designed for this study and containing previously validated items, the study team measured and related students' expectations about EHR ease of use and usefulness to their computer self-efficacy, openness to change, personality traits, and demographic characteristics. On a seven-point scale, men reported, on average, ease-of-use scores that were 0.71 higher than women's ($p < .001$). Also, increased computer self-efficacy related to higher expectations of EHR ease of use ($p < .01$) and usefulness ($p < .05$). Openness-to-change scores were also associated with higher expectations of EHR ease of use ($p < .01$) and usefulness ($p < .001$). Finally, a more conscientious personality was positively associated with EHR ease of use ($p < .01$). Our findings suggest that medical educators and administrators may consider targeting EHR management strategies on the basis of individual differences. Enhanced training and support interventions may be helpful to women or to clinicians with lower computer self-efficacy, lower openness to change, or less conscientious personalities. Also, current and future physicians who rate higher in terms of self-efficacy, openness to change, or conscientiousness may be useful as champions of EHR use among their peers.

Keywords: electronic health records, organizational management, medical education, training, user acceptance

Introduction

The 2009 Health Information Technology for Economic and Clinical Health Act (HITECH) Act promotes widespread use of electronic health records (EHRs) by allocating billions of dollars for physician and hospital incentive payments and other programs.[1, 2] Policy makers expect EHRs to improve healthcare quality and reduce costs.[3–5] However, EHRs fundamentally alter how physicians interact with patients and otherwise perform their daily work.[6–10] Because EHRs alter physicians' work, realizing the promise of EHRs requires revamping clinical workflows that were established to be effective in a paper environment. Moreover, many physicians indicate that they receive inadequate technical support, they lack a direct incentive to use EHRs, and EHRs do not provide clinical value.[11, 12] If these problems are not well understood and addressed managerially, such as through improved support and physician-centered

system design and implementation, physicians' concerns about EHRs threaten to prevent effective widespread EHR use and undermine potential cost and quality benefits.

Medical students increasingly use EHRs in their training.[13, 14] Given technology's pervasiveness among young adults,[15] today's medical students also grew up using computers in their personal lives, education, and jobs. Therefore, physician resistance to EHRs may decrease as more technology-savvy clinicians enter the field.[16, 17] On the other hand, current EHRs often lack the usability of consumer applications, and younger, technology-savvy physicians may demand easier-to-use and more useful EHRs on the basis of their prior experience with technology.[18, 19] Medical educators and administrators need to understand medical students' beliefs and attitudes toward EHRs and individual characteristics that relate to these beliefs and attitudes. While many studies have examined practicing physicians, few researchers have studied antecedents of medical students' beliefs about EHRs and the implications for training strategies. Moreover, few researchers have examined the role of personality in health information technology use. In studies outside of healthcare, researchers have more extensively linked personality traits to students' beliefs and attitudes about information technology.[20–23] By better understanding individual differences among students and related technology beliefs, educators and administrators can customize medical school curricula and EHR training to maximize physicians' understanding and acceptance of EHRs.

This study aimed to identify personal characteristics that are related to medical students' beliefs about the ease of use and usefulness of EHRs. Generally, we expected that student demographics, openness to change in work, computer self-efficacy, and personality traits would predict differences in students' perceived ease of use and usefulness of EHRs. Our study team analyzed unique survey data collected from a class of third-year medical students just before its members began using an EHR in their clinical training. This study contributes insights that educators and administrators can use to help prepare current and future physicians for professional practice that relies on using and obtaining value from EHRs.

Methods

This cross-sectional study collected and analyzed anonymous survey data from incoming third-year medical students at a large southeastern university. In July 2010, the university's EHR training staff administered a paper-based survey to third-year medical students attending an ambulatory EHR training session. The university's medical students are demographically similar to students from other schools accredited by the Liaison Committee on Medical Education (LCME) in the United States. In particular, the surveyed third-year class had an average age of 24 years and was approximately half men and half women. All students participated in this two-hour training before they entered a live clinical practice environment. The EHR training covered chart review, progress notes, visit navigation layout, and review of medications, allergies, and problem lists. Prior to the start of the training, students voluntarily completed the survey. The survey, in addition to its questions, contained a brief description of the study purpose and assurance of respondents' anonymity. In total, 126 out of 128 students (98 percent) returned a survey. The study university's Institutional Review Board (IRB) judged the study to be exempt from the need for IRB approval.

The research team developed the survey (see Appendix) by drawing from existing, validated survey scales in the medical informatics, information systems, management, and psychology literatures. The research team chose perceptions of the *ease of use* (PEOU) and *usefulness* (PU) of the EHR system as the dependent variables. Many prior studies have found that PEOU and PU predict whether people, including physicians, accept and use information technology tools in their work.[24–26] The survey instrument measured PEOU with four items, each using a seven-point response scale ranging from "strongly disagree" to "strongly agree." The survey instrument measured PU with five items, each using a seven-point response scale ranging from "strongly disagree" to "strongly agree." Finally, the research team modified existing PEOU and PU item wordings[27] to specifically refer to a clinical work and EHR technology context.

The research team chose computer self-efficacy,[28] openness to change in work,[29] personality,[30] age, and gender as independent variables. Prior studies in the literature have found each of these variables to relate to beliefs about information technology use. However, these variables have not been fully examined in the context of EHR use. As with the dependent variables, the research team modified existing survey scales as needed so that their wording reflected a clinical work and information technology context. To assess computer self-efficacy, the survey employed a multi-item question that asked about students' confidence in completing a work task using a new computer application. Specifically, the self-efficacy question used four items, each containing seven-point response scales ranging from "totally unconfident" to "totally confident." To assess openness to change, the survey instrument employed a multi-item question that asked about students' openness to "changes that you face in your academic or professional work." Specifically, the openness-to-change questions used six items, each containing seven-point response scales ranging from "strongly disagree" to "strongly agree." To assess personality, the survey employed a 10-item version of the Big Five personality test.[31] The Big Five test has been widely used in psychology research, including studies of work and academic performance. The test classifies individual personalities according to five broad domains that are intended to capture most differences in human personality: extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience.[32] The 10-item version of the Big Five test is a brief inventory that contains two items to assess each of the five personality domains. Finally, students responded to each personality item using seven-point response scales ranging from "strongly disagree" to "strongly agree."

The research team assessed the reliability of all multi-item scales except the Big Five personality measure using Cronbach's alpha, with acceptable reliability assumed for values of 0.7 and higher. Given the broad nature of the five personality trait domains, the 10-item brief Big Five inventory was originally designed to maximize validity, not internal consistency, and thus alpha measures were not appropriate for this scale.[33] The research team averaged responses to the multi-item scales to produce a single value for each construct for each respondent.

The study's primary analysis assessed the relationships between students' characteristics and the dependent variables, PEOU and PU. First, *t*-tests and bivariate Pearson correlations assessed the unadjusted relationships between the individual independent variables—age, gender, personality traits, and computer self-efficacy—and each of the dependent variables. Next, two separate multivariate regressions assessed these same relationships while controlling for the other independent variables. The research team judged statistical significance at the $p < .05$ level.

Results

The survey sample contained 126 third-year medical students who ranged from 20 to 29 years of age (see Table 1). In general, students expected the forthcoming EHR to be both easy to use (4.80 ± 1.04) and useful to their clinical work (5.22 ± 1.01). Moreover, the students tended to report high computer self-efficacy (5.34 ± 1.16) and openness to change in work practices (5.69 ± 0.87).

Unadjusted bivariate analysis found that men reported statistically significantly higher mean PEOU scores (5.11) compared to women (4.49, $p < .001$). In contrast, the mean PU did not differ significantly between men (5.23) and women (5.22). Also, PEOU was positively and significantly associated with computer self-efficacy ($r = .37$, $p < .001$) and with openness to change ($r = .39$, $p < .001$). Similarly, PU was positively and statistically significantly associated with computer self-efficacy ($r = .29$, $p < .01$) and with openness to change ($r = .38$, $p < .001$). Finally, higher levels of conscientious personality were significantly associated with higher PEOU ($r = .29$, $p < .01$).

In the multivariate analysis, student factors explained more of the variance in PEOU ($R^2 = .38$) than in PU ($R^2 = .21$). Notably, while the student factors explain significant percentages of the variance in PEOU and PU, a large proportion of unexplained variance remains. In terms of individual characteristics related to PEOU and PU, multivariate results reflected the bivariate results (see Table 2). On average, men

reported PEOU scores that were 0.71 higher than those of women, and this relationship was statistically significant ($p < .001$). However, PU did not significantly differ by gender. Also, computer self-efficacy scores were significantly associated with higher PEOU. A one-unit increase in computer self-efficacy was associated with a 0.26 unit increase in PEOU scores ($p < .01$). Similarly, higher computer self-efficacy was significantly associated with higher PU scores ($p < .05$). Openness-to-change scores were also significantly associated with higher PEOU ($p < .01$) and with higher PU ($p < .001$). Finally, when controlling for other factors, a more conscientious personality was positively and significantly associated with PEOU ($p < .01$). No other personality traits were significantly associated with PEOU or PU.

Discussion

This study's primary findings were new relationships between gender and EHR perceptions and between computer self-efficacy and EHR perceptions among medical students. Compared to women, men predicted that a forthcoming EHR would be significantly easier to use. Also, this study found that computer self-efficacy predicted both higher perceived ease of use and higher perceived usefulness of EHRs. These results suggest the potential value of individually customized EHR training and implementation management to ensure that medical students are well trained and prepared for clinical careers that rely heavily on EHRs. For example, groups with lower perceived EHR ease of use might receive additional support or opportunities for supplemental training. Also, students who rank lower on openness-to-change scales might benefit from greater encouragement or more explicitly described benefits of EHR systems.

When healthcare organizations take on fundamental changes like EHR implementation, educators and administrators must employ flexible strategies in communicating with and educating technology users. Insufficiently flexible strategies decrease system acceptance and user satisfaction while increasing clinical workarounds and other project failures.[34] To avoid these pitfalls, medical educators and administrators could identify key individual differences, such as gender or relatively weak computer skills, and offer additional training opportunities to affected students or physicians. This study found that students with lower computer self-efficacy expected the EHR to be not only more difficult to use but also less useful in their practice. Because EHRs are anticipated to be critical to higher-quality and more efficient healthcare,[35–37] educators and administrators should pay particular attention to factors like computer self-efficacy that predict lower expectations of EHR value and may portend lower-quality EHR use and lower care quality.

This study also found that students with more conscientious personalities expected the forthcoming EHR to be easier to use. Conscientiousness is typically thought to reflect traits such as being careful, thorough, organized, hardworking, and achievement oriented.[38] Moreover, the relationship between conscientiousness and EHR ease of use existed even when controlling for computer self-efficacy, suggesting that conscientiousness did not simply reflect better computer skills. The results involving conscientiousness are consistent with research that finds that individuals who are more conscientious perform better academically and professionally, such as in dental school[39] and in medical care.[40] However, our prior study of faculty and resident physicians at the same university found no relationship between conscientiousness and EHR perceived ease of use.[41] The combined findings from these two studies may mean that differences in ease-of-use perceptions decrease as clinicians gain more professional experience. To better understand this potential relationship, future work should study longitudinal changes in physicians' ease-of-use perceptions.

This study also found that students who were more open to changes in work expected the new EHR to be easier to use and more useful. These relationships suggest that openness to change is another individual characteristic that medical educators and administrators should be aware of when designing EHR training and education. Among people who are less open to change, organizational change can negatively impact job satisfaction and can increase work irritation and intentions to quit.[42] Moreover, experiencing technological change can reduce future openness to change among more skilled workers,[43]

such as physicians. Because today's healthcare providers face significant changes in technology and organizational structures,[44, 45] educators and administrators should carefully attend to students and physicians who may be particularly vulnerable to the negative effects of change. For example, in the early stages of an EHR implementation, medical educators and administrators could offer more point-of-care EHR support to students or physicians who are more likely to struggle with change. Finally, today's technology-savvy medical students are likely to become tomorrow's champions and facilitators of EHR use among more experienced physicians. Therefore, medical educators and administrators should find ways to positively shape students' openness to EHR-related change and their EHR use expectations.

This study has some limitations. First, the study employed a cross-sectional design. Therefore, the relationships described in the results are not necessarily causal and may be affected by unobserved confounding factors. Also, this study was confined to one university, which limits the generalizability of the findings to other organizations. That being said, the university's medical student demographics are similar to other LCME-accredited public medical schools in the United States. This similarity likely helps mitigate the limited generalizability. Also, since the survey was administered at the time of initial EHR training, the study lacks measures of actual EHR use. However, prior literature has validated the importance of measuring technology use perceptions and their relevance to actual technology use.[46, 47] Finally, the study data were self-reported and thus subject to survey response biases. In particular, the computer self-efficacy measure is a subjective assessment that does not objectively assess student competence in using computers. Related to this, any systematic biases in how students respond to the self-efficacy measure, such as gender-based differences, could affect the study's conclusions regarding self-efficacy.

Regarding future work, this study identified new relationships that should be explored longitudinally and across multiple institutions. Such studies could help overcome some of the limitations described above. For instance, longitudinal studies could measure medical students' beliefs and EHR use over time to identify whether predictors of PEOU and PU persist as students progress in their training and clinical work. Longitudinal studies could also help tease out causal effects of factors such as computer self-efficacy on EHR beliefs by exploring potential changes in self-efficacy and EHR beliefs over time. Perhaps most importantly, future studies should extend their measurement to actual EHR use as well as EHR clinical value. Studies that relate student or physician beliefs and other characteristics to actual EHR use and value could enhance managerial understanding of how to implement EHRs and support EHR-mediated clinical work.

Conclusion

This study found that medical students' perceptions of EHR ease of use and usefulness were related to several individual characteristics. Medical educators and administrators can consider using these characteristics to identify and provide enhanced support to individuals with lower EHR expectations. Educators and administrators can also use these characteristics to identify individuals with higher expectations who may serve as EHR champions in their organizations. As EHRs continue to be implemented nationwide, researchers, medical educators, and administrators should continue exploring the relationships identified in this study and how they may be leveraged to ensure satisfactory and productive EHR use among physicians.

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Table 1

Characteristics of Student Sample

Characteristic	**Student Responses (*N* = 126)**
Gender, *n* (%)	
Men	60 (48.0%)
Women	65 (52.0%)
Age (years)	24.41 (1.44)
Computer self-efficacy (α = .90)	5.34 (1.16)
Openness to change in work (α = .88)	5.69 (0.87)
Personality traits	
Extraversion	4.50 (1.50)
Agreeableness	5.38 (0.98)
Conscientiousness	5.81 (0.97)
Openness	5.13 (1.13)
Emotional stability	5.28 (0.92)
EHR perceived ease of use (PEOU) (α = .96)	4.80 (1.04)
EHR perceived usefulness (PU) (α = .96)	5.22 (1.01)

Note: For all measures except gender, the mean is presented, with standard deviation in parentheses. Cronbach's alpha is reported for multi-item scales. Total observations range from 123 to 126 because of missing data.

Table 2

Multivariate Regressions of Electronic Health Record (EHR) Perceptions on Student Characteristics

	EHR Perceived Ease of Use (PEOU) (*N* = 121)	**EHR Perceived Usefulness (PU) (*N* = 121)**
Intercept	0.64	3.95*
Men (versus women)	0.71***	−0.10
Age	0.02	−0.06
Computer self-efficacy	0.26**	0.19*
Openness to change in work	0.33**	0.43***
Extraversion	−0.10	−0.006
Agreeableness	0.03	−0.009
Conscientiousness	0.26**	−0.11
Openness to experience	−0.15	0.04
Emotional stability	−0.10	−0.03

Note: *$p < .05$, **$p < .01$, ***$p < .001$. Estimates are ordinary least squares regression coefficients. $N = 121$ because of missing data. For PEOU model, $R^2 = 0.38$. For PU model, $R^2 = 0.21$.

Appendix

Items Used in Study Survey

What is your gender? Male Female

How old are you? _____ years

Computer Self-Efficacy

Using new computer applications

Please think about your experiences with computer software or computer systems that you have never used before. For the next five questions, imagine that you were given a new computer application for some aspect of your work. For each of the scenarios, please rate your confidence in your ability to complete a task using the new software on the scale of 1 (Totally unconfident) to 7 (Totally confident).

I could complete a task using the new software	Totally unconfident			Neither confident nor unconfident			Totally confident
If there was no one around to tell me what to do as I go.	1	2	3	4	5	6	7
If I had seen someone else use it before trying it myself.	1	2	3	4	5	6	7
If I could call someone for help if I got stuck.	1	2	3	4	5	6	7
If I had a lot of time to complete the task for which the software was provided.	1	2	3	4	5	6	7

Personality

How well do the following statements describe your personality?

Here are a number of personality traits that may or may not apply to you. For each statement, please rate your level of agreement with the statement given on the scale of 1 (Strongly disagree) to 7 (Strongly agree). You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

I see myself as	Strongly disagree			Neither agree nor disagree			Strongly agree
Extraverted, enthusiastic.	1	2	3	4	5	6	7
Critical, quarrelsome.	1	2	3	4	5	6	7
Dependable, self-disciplined.	1	2	3	4	5	6	7
Anxious, easily upset.	1	2	3	4	5	6	7

Open to new experiences, complex.	1	2	3	4	5	6	7
Reserved, quiet.	1	2	3	4	5	6	7
Sympathetic, warm.	1	2	3	4	5	6	7
Disorganized, careless.	1	2	3	4	5	6	7
Calm, emotionally stable.	1	2	3	4	5	6	7
Conventional, uncreative.	1	2	3	4	5	6	7

Openness to Change

We would like to know how you feel generally about changes that you face in your academic or professional work. For each statement, please rate your level of agreement with the statement given on the scale of 1 (Strongly disagree) to 7 (Strongly agree).

	Strongly disagree			Neither agree nor disagree			Strongly agree
I welcome the introduction of new technology in my work or studies.	1	2	3	4	5	6	7
I consider myself to be “open” to new work practices that are introduced in my work or studies.	1	2	3	4	5	6	7
I would rather that new technology not be introduced in my work or studies.	1	2	3	4	5	6	7
I am generally resistant when new ways of working are introduced in my work or studies.	1	2	3	4	5	6	7
I am willing to learn new skills to take advantage of new technology that is introduced in my work or studies.	1	2	3	4	5	6	7
I look forward to the advantages brought by new work or study practices that are introduced.	1	2	3	4	5	6	7

Perceived Ease of Use (Items 1-4) And Perceived Usefulness (Items 4-8)

Using the Epic system
Please answer the following questions based on your training and present knowledge of the Epic Electronic Medical Record system. For each statement, please rate your level of agreement with the statement given on the scale of 1 (Strongly disagree) to 7 (Strongly agree).

	Strongly disagree			Neither agree nor disagree			Strongly agree
Learning to operate the Epic system will be easy for me.	1	2	3	4	5	6	7
My interaction with the Epic system will be clear and understandable.	1	2	3	4	5	6	7
It will be easy for me to become skillful at using the Epic system.	1	2	3	4	5	6	7
I will find the Epic system easy to use.	1	2	3	4	5	6	7
Using the Epic system will improve my clinical performance.	1	2	3	4	5	6	7
Using the Epic system in my job will increase the quality of care my patients receive.	1	2	3	4	5	6	7
Using the Epic system will enhance my effectiveness as a medical student.	1	2	3	4	5	6	7
Using the Epic system will make it easier to do my job.	1	2	3	4	5	6	7
I will find the Epic system useful in my job.	1	2	3	4	5	6	7