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Digitalization and Physician Learning: Individual Practice, Organizational Context, and Social Norm

Helena Vallo Hult; Anders Hansson, MD, PhD; Martin Gellerstedt, PhD

Introduction: The emerging context of online platforms and digitally engaged patients demands new competencies of health care professionals. Although information and communication technologies (ICTs) can strengthen continuous professional development (CPD) and learning at work, more research is needed on ICT for experiential and collegial learning.

Methods: The study builds on prior qualitative research to identify issues and comprises a quantitative assessment of ICT usage for learning in health care. A survey was administered to Swedish physicians participating in a CPD program as part of specialist medical training. Conclusions focused specifically on learning dimensions are drawn from correlation analyses complemented with multiple regression.

Results: The findings show that physicians' actual use of ICT is related to perceived performance, social influence, and organizational context. Social norm was the most important variable for measured general usage, whereas performance expectancy (perceived usefulness of ICT) was important for ICT usage for learning. The degree of individual digitalization affects performance and, in turn, actual use.

Discussion: The study highlights the need to incorporate ICT effectively into CPD and clinical work. Besides formal training and support for specific systems, there is a need to understand the usefulness of digitalization integrated into practice. Moving beyond instrumentalist views of technology, the model in this study includes contextualized dimensions of ICT and learning in health care. Findings confirm that medical communities are influencers of use, which suggests that an emphasis on collegial expectations for digital collaboration will enhance practitioner adaptation.

Keywords: CPD, digitalization, health informatics, ICT, information systems, physicians, workplace learning

DOI: 10.1097/CEH.0000000000000303

Information and communication technology (ICT) is a growing feature of physicians' work and learning. Evidence-based medicine[1] is integrated into clinical practice, along with digital tools for guidance and clinical recommendations.[2] Although ICT can also support doctors' needs for continuing education and currency, this capability is not yet integrated into practice; and research shows that physicians' information needs go unmet during daily routines.[3,4] They may use Google or medical websites to access to medical information, indicating a need for tools to compile and curate relevant search results.[5,6] Lack of interest, skills, or information security are known barriers to physicians' adoption of ICT.[7] Other challenges concern professionalism and information integrity: accuracy, safety, legality, and privacy.[8,9] The shift to real-time health data across personal and professional platforms changes role relationships,[4,10] as health professionals and digitally engaged patients seek information, discuss with peers, and make treatment choices online.[11–13] This creates both challenges and opportunities for shared learning.[3,14] A literature review revealed a significant gap in the knowledge health care professionals need to integrate digitalization into practice. This includes ethical, social, and communication skills, along with willingness to adopt digitalization in professional contexts.[15]

Developing trends in technology and medicine thus demand new competencies of health care professionals, suggesting a need for changes in medical education and training. There is relatively little research on self-directed informal digital learning.[16] Although a commitment to lifelong medical learning is known to be important,[17] less attention is paid to physicians' workplace learning,[18,19] especially during residency.[20] Clearly, continuous professional development (CPD) through formal education and certification is important. However, physicians also learn through everyday activities of information-seeking, collegial communication, and collaboration.[4,20] Workplace learning theorists have highlighted the importance of both interactional learning (learning from others, eg, collaboration and communication) and task-based learning (learning through experience and reflection) across occupational settings.[21] Other studies on workplace learning[22] stress the need to reflect with peers, and previous research suggests ICT can improve that mode of learning with environments to support reflection, collaboration, and knowledge sharing.[23–25]

Disclosures: The authors declare no conflict of interest. According to Swedish regulations, no ethical approval was required for this study.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.jcehp.org).

Ms Vallo Hult: *PhD Candidate, University West, School of Business, Economics and IT, Trollhättan, Sweden, and NU Hospital Group, Trollhättan, Sweden.* ***Dr. Hansson:*** *Research Supervisor, University Health Care Research Center, Faculty of Medicine and Health, Orebro University, Sweden.* ***Dr. Gellerstedt:*** *Associate Professor in Informatics, University West, School of Business, Economics and IT, Trollhättan, Sweden.*

Correspondence: *Helena V. Hult, University West, School of Business, Economics and IT, S-461 86 Trollhättan, Sweden; e-mail: helena.vallo-hult@hv.se.*

Studies of health care settings show that ICT can play a role in fostering support for practitioner reflection and everyday learning.[4,14] Social media can be used in health care for professional development through knowledge exchange and networking.[26,27] Mobile learning for CPD is increasing, especially for "just-in-time" situations.[15] Current learning literature calls for multiple approaches, whereas much ICT training focuses on classroom-based learning of organizationally sanctioned systems and tools. ICT skills could instead be incorporated in medical practice and training and assessed with other clinical skills.[28–30] Although residents are urged to develop lifelong learning habits, without incorporating ICT, the information management aspect may suffer.[4,31]

The concepts of digitalization and digital transformation are used, often interchangeably, to describe technical, organizational, and social changes occasioned by the ongoing integration of digital technologies into professional and private life.[32] In this study, we define ICT broadly to "encompass all digital technologies that facilitate the electronic capture, processing, storage, and exchange of information."[33] That includes the digitalization of health care services, including data (eg, telehealth and electronic patient records), patient-centric technologies (eg, health platforms and wearables), information retrieval and decision-making (eg, clinical decision support, electronic libraries, guidelines), and knowledge sharing and peer support (eg, collaboration systems, intranets, email). Prior research claims that when ICT is integrated into clinical work, physicians are more likely to see benefits and adopt available opportunities.[3,4,7] This article argues that digitalization can increase learning as well as increased efficiency, patient safety, and quality of care,[34,35] focusing on the general role of ICT for physicians rather than on specific tools.

We build on prior research into physicians' everyday use of ICT to integrate digital support for collaboration and reflection in CPD and clinical work. The question is whether established predictors of ICT usage (ie, attitudes, effort, and perceived usefulness) carry over to learning models in clinical practice. Organizational context and social norm are seen as potential predictors of ICT usage. *The study thereby aims to add to knowledge and constructs that can explain physicians' usage of ICT for workplace learning and in turn facilitate enabling practices.* The article addresses the following research question: In the context of workplace learning in health care, how does ICT usage relate to other areas of digitalization, individual practice (expectancies and attitudes), organizational context, and social norm?

THEORETICAL FRAMEWORK AND HYPOTHESES

This section reviews relevant literature and presents the main hypotheses and theoretical model for the article (Fig. 1). The theoretical basis is the Unified Theory of Acceptance and Use of Technology (UTAUT; UTAUT2).[36,37] UTAUT is a synthesis of technology adoption research, from the Technology Acceptance Model (TAM).[38] In UTAUT2, the model extends beyond organizational acceptance and use to include consumer settings and individual differences.[36] TAM models are used in Information Technology (IT) adoption research to assess the fit between new organizational systems intended users.[39,40] That work foregrounds technology and individuals; attitudes toward IT are explained in terms of performance expectancy (PE) (usefulness) and effort expectancy (EE) (ease of use).

However, TAM overlooks social consequences of introducing new technologies[41] and presumes the fit of given technologies to tasks. Other analyses of IT adoption and use regard TAM as too narrowly focused on individual users and technical systems.[42] TAM includes theories of reasoned action and planned behavior[43,44] to explain technology use in terms of organizational support and social norms but does not address work practice. These sociotechnical dimensions of ICT that create new work practices are, however, essential in complex settings such as health care.[45,46] Another approach, interaction theory, includes organizational power distribution and explains nonadoption as a practical response to redistribution of power.[42] Physicians' professional roles and social influence (power/autonomy) are essential considerations for ICT adoption in health care, compared with other contexts and professions.[47,48]

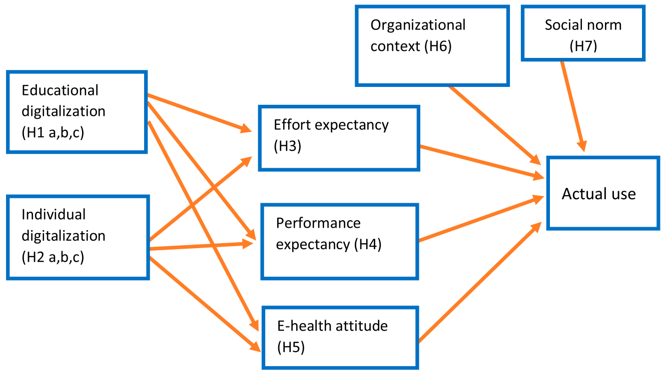

FIGURE 1. The conceptual model used in this study.

The conceptual model used in this study incorporates previous models, extended to include contextual factors relevant for learning in health care. It consists of seven dimensions (with corresponding hypothetical relationships), directly or indirectly related to actual use (AU) (Fig. 1).

The following subsections provide details. The hypothetical relationships are explained in the methods section, and significant correlations are included in Supplemental Digital Content 1 (see Appendix III, http://links.lww.com/JCEHP/A92).

Educational and Individual Digitalization

Physicians' experience of ICT varies by differences in educational curricula and individual preferences. Time and support for training have been identified as enabling factors for the successful implementation of health information systems (ISs).[49,50] Results from a Cochrane review[51] showed that ICT usage increases as a function of training. Specifically, research shows that digital literacy facilitates e-learning,[52] and "meaningful experiences" with technologies should be included in training.[29] This is consistent with prior work concluding that inclusion of ICT in medical education influences physicians' attitudes toward ICT.[4] Given that ICT can be central to for physicians' CPD, it is important to integrate both ICT and learning into everyday practice. This study confirms and extends these previous results. We hypothesize that *educational digitalization (ED) is an important background factor,* and propose the following subhypotheses:

H1a: ED is related to EE.
H1b: ED is related to PE.
H1c: ED is related to e-health attitude (A).

ICT adoption also depends on the level of individual digitalization (ID), ie, the practical experience of ICT in everyday life (eg, Internet use for shopping, travel, banking, or learning).[7,53] Earlier findings from the current project likewise highlight the need to incorporate ICT into everyday work.[3,4] There is little research on professionals' perceptions of technology in relation to workplace e-learning. This is important because adopting new tools for learning depends on these perceptions.[52] Consequently, we propose that besides formal training and technical support, it is important to consider the influence of ID. We hypothesize that *ID is an important background factor,* and propose the following subhypotheses:

H2a: ID is related to EE.

H2b: ID is related to PE.

H2c: ID is related to e-health attitude (A).

Technology Adoption: Effort, Performance, and Attitudes

Much prior research has been instrumentalist, focused on benefits to organizations rather than on enhanced practitioner experience and learning. Although qualitative methods and surveys are common in health care research, they do not employ the unifying framework of TAM used in ISs studies for health ICT. Similarly, IS adoption literature emphasizes training, whereas peer influence is emphasized in health care research.[54] The primary health care focus has been on electronic health records[55] and specific eHealth applications.[56] Other applications are relatively neglected.[54,57]

Collegial learning is important for both medical technical learning because little time is allocated to formal training, and expertise is distributed within groups.[47] Meanwhile, ICT is becoming essential in work-integrated learning (WIL)[25] and professional development for collegial knowledge and expertise sharing. Our study follows from Computer-Supported Collaborative Work studies where knowledge and work are intertwined, and theoretical models include social relationships, resulting in recommendations for ICT knowledge sharing and learning support.[58–60]

Accordingly, the adoption model we use includes dimensions such as adaptation to informed patients, peer discussions, and online health information. It expands attitude-based theories with social factors and contextualizes standard TAM dimensions of effort (ease of use) and PE (usefulness)[54,55] with hypotheses for collaboration, expertise sharing, or WIL.[53,61] Hence the following hypotheses:

H3: EE is related to AU.

H4: PE is related to AU.

H5: E-health attitude (A) is related to AU.

Organizational Context and Social Norm

Physicians may be cautious about ICT in health care[54] because it requires practice changes in high-risk settings where patient safety is the priority. Professional values from medical education and the community affect physicians' attitudes and behavior[54,62]; the risk of appearing unprofessional was identified as a barrier to seeking information from mobile technologies at the point of care.[16]

Collegial support, leadership, training time, and fit between social, technological, and organizational domains are other factors influencing health care professionals' adoption of ICT.[15,49,63] Individual belief that an organizational and technical infrastructure supports system use, referred to in the UTAUT model as the facilitation factor, is a model for this aspect of the study.[37] The model also integrates pedagogy, technology, and how these interplay with the subject (cf, TPACK)[64] as variables. This emphasizes the usefulness of digitalization over technology per se. Thus, we hypothesize:

H6: Organizational context is related to AU.

H7: Social norm is related to AU.

METHOD

Two qualitative research studies of how physicians use ICT for workplace learning,[4] and the effect of patient technology use on professional practice[3] form the basis for this follow-up study. Considering the alternative views of technology described above, and the new context of online health information platforms, we conducted interviews about impacts of the new health care environment. This includes technologically altered relationships between physicians and their peers, patients, data, and organizations. The project that encompasses this empirical study investigates those changed relationships. The current effort examines physicians' attitudes along TAM dimensions, augmented to reflect an organizational learning perspective on ICT in health care.

Material, Respondents and Data Analysis

The survey was distributed to Swedish physicians enrolled in a CPD course for specialist medical training, using SurveyMonkey. A total of 148 physicians (57% of initial sample) participated in the survey; 123 responses were included in the final analysis. Ten respondents filled out only background questions and were excluded from analysis. Participation was voluntary and anonymous, and per Swedish regulations, no ethics approval was required. A hospital research group, which includes expertise in statistical methods (second author) collectively developed and tested the survey instrument. As stated above, the questionnaire includes items from conventional adoption models along with new items from the qualitative study and a related survey from a university population.[53] EE and PE were measured both with generic TAM questions and health care-specific questions. A description of the dimensions and example items included in the questionnaire is provided in Supplemental Digital Content 2 (see Appendix I, http://links.lww.com/JCEHP/A90).

Questions about individual and ED were also included in the model. Generic *EE* is the degree to which an IS is perceived as easy to use regardless of context, whereas *health-specific EE* in this study refers to ease of use in clinical practice and point of care. Generic *PE* refers to usefulness for increased productivity and efficiency. Expectancies may differ depending on whether ICT is changing the work practice or replacing or existing tasks. Besides job performance, this study includes *usefulness for learning*, such as support for physicians' CPD. Physicians' professional development items were added to generic items for PE (eg, statements such as "useful in my job"). Ease of use for health-specific ICT items were added for EE. Psychosocial and organizational factors were derived from UTAUT[37] and complemented with technological pedagogy items to highlight learning as a dimension of digitalization. The social norm questions address management and colleague expectations to use ICT.

The dependent variable in most TAM studies is intention to use. In our case, the focus is on ICTs already existing in the organization, with many systems being mandatory. The TAM model provides limited utility for mandatory systems where usage is a job requirement.[65] Consequently, we considered usage frequency a more adequate dependent variable. Few studies measure usage objectively, eg, by using log-files; instead self-reported use is the common metric, and models tend to be better at predicting self-reported usage than objectively measured use.[66]

A Likert scale was the measure of agreement for all statements in the questionnaire. This standard rating includes five balanced responses—completely disagree, slightly disagree, undecided, slightly agree, and completely agree—graded from 1 to 5 for calculations. Self-reported usage is measured with questions such as "How often do you use an iPad?" with alternative answers such as "never-rarely-often-very often."[7] Our questions focus on the purposes for using digital artefacts, eg, "How often do you use ICT for finding information about a treatment?" For this, we used a more objective time-specific scale: "never-monthly-weekly-daily-several times each day." The average of the items for each variable was calculated to construct an index for each factor in the model. Beyond the generic dimensions for effort, performance, facilitation, and AU to items specific to health care and learning, we calculated the average for each subdimension, in addition to the general index. A summary description of the indices and subindices is provided in Supplemental Digital Content 3 (see Appendix II, http://links.lww.com/JCEHP/A91). The indices were calculated even when answers to individual items were missing. At least half had to be answered to calculate an average.

The main results presented here are based on correlation analyses. We regard values between 0.1 and 0.3 as weak, 0.3 to 0.5 as moderate, and above 0.5 as strong correlations.[67] To support the primary aim of the study, multiple regression was used to complement bivariate correlation analyses. Generally, *P*-values below 5% are considered statistically significant. As a measure of reliability in terms of internal consistency, classic Cronbach alpha was used. The Cronbach alpha for ID was 0.90, which is consistent with previous use of this index.[25,53] Internal consistency was high for all indices and subindices (ranging from 0.76 to 0.95).

RESULTS

Demographics

A majority of respondents (78 or 63.4%) were family practice physicians working in outpatient clinics, followed by anesthesia and intensive care (27 or 22%), and other specialties (18 or 14.6%) working in hospital settings. Of these, (65 or 53%) were female and (58 or 47%) were male, ranging in age from 27 to 59 years. Median experience (years since graduation) was 7 years.

The Importance of ED and ID

ED showed weak positive correlation with EE (r = 0.19, P = .032). This is mainly due to a medium correlation between ED and the subindex health care-specific EE (r = 0.30, P = .001) because the correlation between ED and generic EE was not significant (r = −0.01, P > .20). There were no significant correlations between ED and PE (r = −0.1, P > .20) and the subindices generic PE (r = −0.12, P = .174) or WIL PE (r = 0.02, P > .20). There was no correlation between ED and attitude (r = −0.10, P > .20), and no significant correlation between ED and ID.

TABLE 1.

Correlations Between AU and Independent Variables

	AU	Effort	Performance	Attitude	Organization	Social Norm
AU	1	0.16	0.38*	0.12	0.38*	0.45*
Effort		1	0.25†	0.04	0.42*	−0.08
Performance				0.38†	0.28†	0.30*
Attitude				1	0.08	0.09
Organization					1	0.33*
Social norm						1

*P < .001.

†P < .01.

AU indicates actual use.

There was no correlation between ID and overall EE (r = 0.01, P > .20), a weak positive correlation between ID and generic EE (r = 0.26, P = .003); the correlation between ID and the subindex health-specific EE was negative, (r = −0.25, P = .005). There were strong positive correlations between ID and overall perceived PE (r = 0.59, P < .001) as well as to generic PE (r = 0.55, P < .001) and WIL PE (r = 0.5, P < .001). The correlation between ID and e-health attitude was positive and of medium strength (r = 0.31, P < .001).

In sum, ID is correlated with PE as well as e-health attitude, whereas ED is correlated only with health-specific EE. Correlations for ID and ED are included in Supplemental Digital Content 1 (see Appendix III, http://links.lww.com/JCEHP/A92).

AU

The data for AU displayed a symmetrical distribution with a mean of 2.61 and an SD of 0.55. The overall index for AU was divided into subindices for learning, collaboration, and mixed work tasks. The subindex for AU learning was highest with mean 3.29, whereas the subindex for AU collaboration showed the lowest mean 2.08.

There was no correlation between overall EE and AU (r = 0.16, P = .076), or between the subindices generic EE and health-specific EE (r = 0.16, P = .079, r = 0.09, P > .20, respectively), nor attitude (r = 0.12, P = .196). Overall organization (r = 0.38, P < .001), organization-usefulness (r = 0.32, P < .001), and organization-technology (r = 0.32, P < .001) all had medium positive correlations with AU. PE was also positively correlated with AU (r = 0.377, P > .001) as were the subindices generic PE (r = 0.25, P = .005) and WIL PE (r = 0.39, P < .001). Social norm had the strongest relation to AU with a medium positive correlation coefficient of 0.45 (P < .001). See Table 1 for an overview.

Subindices Focusing on Learning

A specific focus was placed on the dimension WIL, using correlation analyses and multiple regression (Table 2). PE and AU

TABLE 2.

Correlations for Subindices Focusing on Learning

	PE TAM	PE Collegial WIL	PE Individual WIL
AU mixed	0.25*	0.38*	0.30*
AU collegial WIL	0.14	0.31*	0.18
AU individual WIL	0.29*	0.30*	0.35*

*P < .01.

AU indicates actual use; PE, performance expectancy; TAM, technology acceptance model; WIL, work-integrated learning.

TABLE 3.

Multiple Regression With Overall AU and Subindices as Independent Variables

	AU			AU Mixed			AU Collaboration			AU Learning		
	B	Pr	P	B	Pr	P	B	Pr	P	B	Pr	P
Performance	**0.20**	**0.24**	.007	0.15	0.17	.064	**0.17**	**0.21**	**.023**	**0.20**	0.20	.027
Organization	**0.17**	**0.23**	.011	**0.22**	**0.24**	.009	**0.21**	**0.22**	.013	0.08	0.10	>.2
Social norms	**0.19**	**0.33**	<.001	**0.26**	**0.35**	<.001	0.11	0.16	.081	**0.29**	**0.40**	<.001
R-square	0.31			0.28			0.18			0.30		

AU indicates actual use (overall, for mixed work tasks, for collaboration and for learning); B, estimates of slopes; Pr, partial (adjusted) correlation.

were divided into subindices for individual learning (I-WIL) and collegial learning (C-WIL). For AU-collaboration, PE-collaboration was used as an explanatory factor; likewise, for AU-learning, PE-individual learning was an explanatory factor.

A multiple regression analysis (Table 3), including factors that were significantly correlated with AU, could explain 31% of the variation (R-square = 0.31). Regarding the overall AU (R-square = 0.31), the explanatory factor with the highest partial correlation was social norm (part r = 0.33, P < .001), followed by performance (part r = 0.24 P = .007) and organization (part r = 0.23, P = .011).

For overall AU, as shown in Table 3, all factors are significant. However, the significance varies, depending on the subindex being studied. For the AU mixed, social norm (part r = 0.26, P < .001) and organization (part r = 0.24, P = .009) are significant, whereas PE is not. For AU collaboration, there is no significant correlation to social norm, but organization (part r = 0.22, P = .013) and PE (part r = 0.21, P = .023) are significant. For AU-learning, the factors social norm (part r = 0.40, P < .001) and performance (part r = 0.20, P = .027) are significant, but not organization.

Individual and ED and Their Mediators

Our model assumes that ED and ID influence AU through mediating variables, ie, effort and PE, and e-health attitude. ED shows no direct correlation with AU (r = 0.02); when EE is added in a linear regression model, the partial correlation is even lower (partial r = 0.0). ID does show a direct correlation with AU (r = 0.30); adding e-health attitude to a regression model produces a similar partial correlation (r = 0.28). But when PE is added to the regression model, the partial correlation for ID is reduced and loses significance (partial r = 0.11). In sum, this suggests that ID influences AU through PE as a mediator, whereas ED influences AU through EE as mediator.

Tested Hypotheses and Conclusions

In sum, seven hypothetical relationships, including sub-hypotheses, were tested using the generated model. A summary of tested hypotheses and conclusions is presented in Table 4, and significant hypothetical relationships correlations are included in Supplemental Digital Content 1 (see Appendix III, http://links.lww.com/JCEHP/A92). The main findings, implications, and suggestions for future research are discussed below.

DISCUSSION

This article examined factors influencing physicians' usage of ICT in general and for learning. Social norm was most important, suggesting that the medical community is a key factor for ICT use.[54,62] PE (perceived usefulness of ICT) was another important factor. By adding contextualized items related to ease of use (EE) and usefulness (PE), the study found that physicians' degree of ID and the characteristics of different ICTs affect PE and AU. This has important implications.

From a learning perspective, ICTs have focused on tools and technical skills rather than on integration of technology to broader practice.[28–31] In this study, ID, beyond technical IT skills, was correlated with factors other than formal education. This supports prior findings that physicians who use ICTs in everyday life (ie, have a high degree of ID) also adopt work-related ICT and find ICTs easier to use.[4,52,53] The negative correlation between ID and health-specific EE was unexpected, but may be explained as dissatisfaction with health-specific systems, which increases with ID. A respondent who normally finds systems easy to use may be more critical of specific health systems than a less digitalized respondent.

TABLE 4.

Summary of Tested Hypotheses and Conclusions

Hypothesis	Conclusion
H1a: ED is related to EE	Partly confirmed. No correlation with overall EE or generic EE, but a positive correlation of medium strength with health-specific EE.
H1b: ED is related to PE	Not confirmed, no significant correlation with neither overall nor subindices.
H1c: ED is related to e-health attitude (A)	Not confirmed, no significant correlation.
H2a: ID is related to EE	Partly confirmed. Weak positive correlation with generic EE and weak negative correlation with health-specific EE. However, no correlation with overall EE.
H2b: ID is related to PE	Confirmed. Strong correlation with overall index and subindices as well.
H2c: ID is related to e-health attitude (A)	Confirmed. Medium correlation.
H3: EE is related to AU	Not confirmed, no correlations obtained, neither for overall index nor subindices.
H4: PE is related to AU	Confirmed. Overall index and WIL subindex showed medium positive correlation, whereas generic PE showed a weak positive correlation.
H5: E-health attitude (A) is related to AU	Not confirmed, no significant correlation.
H6: Organizational context is related to AU	Confirmed. Overall index and subindices showed medium correlations with AU.
H7: Social norm is related to AU	Confirmed. A medium positive correlation.

AU indicates actual uses; ED, educational digitalization; EE, effort expectancy; ID, individual digitalization; PE, performance expectancy; WIL, work-integrated learning.

Item phrasing was retrospectively analyzed, showing an overlap between generic items from TAM and items on WIL in the actual context. The weak positive correlation between ID and generic EE suggests that perceived ease of use increases with an increased degree of ID. The correlation between the overall index and ID, however, is nonsignificant. This may be because when merged into an overall index of EE, the two subindices cancel each other out, although the correlation between them was weak (r = 0.2, P = .026). Organizational context is important both for understanding the benefits of ICT (value) and the ability to use (technical support). This confirms the need to incorporate digitalization into clinical work and lifelong learning.[10,15,16] Although physicians express positive views toward ICT's potential based on digital individualization, skills may not translate from private to professional context.

Findings from the analysis of the subindices specifically focused on learning highlight the influence of medical community and collegial collaboration. The correlations for AU collaboration and AU individual learning (Table 2) suggest that organizational support is important for collegial learning and digital collaboration, consistent with prior studies.[15,68] However, correlation analysis showed no collegial expectation to collaborate using ICT, despite collegial expectations to use ICT individually for everyday work and learning, perhaps because collegial learning and collaboration takes place within small face-to-face workgroups rather than across extended (digital) networks. Because collegial expectations is a key factor for ICT use for collaboration, this gap highlights the need to support expectations to collaborate beyond organizational boundaries.

Findings from this study have theoretical and methodological implications. Previous technology-determined models may not explain adoption of future health care information technologies.[39] Prior models reverse priorities by presuming that systems are right, and problems arise from individual psychology rather than the design process, built-in assumptions, or conflict between management and practitioner goals. To identify barriers and enablers for ICT adoption in clinical practice, contextual factors and social consequences of new technologies must be included in models.[55] This study contributes to theory by empirically testing new factors specific to learning in health care.

LIMITATIONS AND FUTURE RESEARCH

TAM research focuses on intention to use as a dependent variable, often with respect to one digital artefact in pre-implementation. This study focused on existing, mostly mandatory ICTs. Therefore, rather than assess intention to use, we judged frequency of usage ("How often do you..."), a more adequate dependent variable.[65] Furthermore, we added different aspects of use, ie, learning, collaboration, and mixed tasks. Because the questionnaire was extensive, and systems are mostly mandatory, we removed questions about intention to use ICT for multiple purposes. For mandatory systems, an alternative endpoint would be to measure "acceptance of ICT" or "intention to collaborate" with ICT. Acceptance and frequency of use may seem related, but this is unconfirmed. Because self-reported usage frequency can be biased by perceived social desirability, measuring AU through log-files may provide greater validity.

TAMs are considered robust, having been tested and replicated; therefore, we included generic TAM questions from previous research in the survey, and then added health-specific questions to improve response quality by increasing relevance. The correlation between the two groups of items, generic and health-related, was significant. The correlation of the variable EE was weak, which could be because the generic questions focus on "ease of use," whereas the health care-specific questions focused on ICT usage in terms of system adaption to daily practice, ie, ease of use from functional perspectives (time and access).

This study did not address notions of responsibility (eg, accuracy of online health information, legality, and integrity). The findings indicate a digitalization-related change in role and core tasks for physicians. Collaboration may be limited by confidentiality concerns arising from the extension of the role into digital channels. The level of model explanation shown in Table 3 was generally 0.31 except for the subindex AU-collaboration (R = 0.17). Thus, the R-square for the AU-overall (R = 0.31) could be explained by the R-square for the subindices AU-learning and AU-mixed tasks rather than the subindex AU-collaboration. AU for collaboration was lower (mean = 2.1) than for learning (mean = 3.3). Future research might explore variances and correlations related to physicians' attitudes toward digitally engaged patients and peers, and the increased flow of (patient-generated) health data into clinical settings.

Our questions and response alternatives have comparatively high validity and reliability, and our questionnaire seems relevant to the sector. The study is replicable, but the present questionnaire is long. The positive values of reliability and correlations between subindices indicate consistency; therefore, it may be possible to shorten the questionnaire by deleting generic questions and/or excluding redundant items. The study of ICT and learning in health care needs a standardized instrument in support of organizational strategies to increase the usefulness of ICT for learning. We hope these suggested amendments contribute to such an instrument.

CONCLUSION

This study extends findings from prior qualitative research, by quantitatively studying ICT usage for learning in health care. The findings show that physicians' AU of ICT is related to perceived performance, social influence, and organizational context. Furthermore, an individual's degree of digitalization affects performance, which in turn affects AU. Social norm was the most important factor for AU in general; PE was an important factor for AU of ICT for WIL.

The findings have implications for research and practice. The model includes alternative and health-specific items, contributing to theory by contextualizing standard TAM dimensions and extending the use of attitude as a predictor for ICT usage. It broadens established views on usage, by moving beyond digitization of routine tasks (eg, patient records) toward effects such as continuous learning. A practical implication is to incorporate ICT into CPD programs to encourage collaboration. Consistent with prior research, we argue that beyond training and support for specific systems, there should be more focus on understanding digitalization in practice, specifically for contributing to communities of practice around learning and care. It is crucial to account for the influence of ED and ID. Finally, it is important to adapt social norms and organizational support for information integrity and security to increase collaboration and blend private and professional use of ICT.

Lessons for Practice

- Physicians' use of ICT in general and for learning depends on factors such as social influence, individual digitalization, and the extent to which ICT is perceived as useful.
- Besides formal training and support in how to use specific systems, more focus is required on incorporating ICT into CPD and clinical work, to develop a better understanding of the usefulness of digitalization in practice.
- ICT is a growing element of physicians' professional development and learning at work but is not yet fully integrated into practice. Increasing collegial expectations for digital collaboration could enhance practitioner experience and learning in the digital age.

REFERENCES

1. Sackett DL, Rosenberg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. *BMJ*. 1996;312:71–72.
2. Georgiou A. Health informatics and evidence-based medicine-more than a marriage of convenience? *Health Inform J*. 2001;7:127–130.
3. Vallo Hult H, Hansson A, Svensson L, et al. Flipped healthcare for better or worse. *Health Informatics J*. 2019;25:587–597.
4. Vallo Hult H, Byström K, Gellerstedt M. ICT and learning usability at work: challenges and opportunities for physicians in everyday practice. In: Lundh Snis U, eds. *Nordic Contributions in IS Research SCIS 2016*. Cham: Springer, 2016:176–190.
5. Kritz M, Gschwandtner M, Stefanov V, et al. Utilization and perceived problems of online medical resources and search tools among different groups of european physicians. *J Med Internet Res*. 2013;15:e122.
6. Lykke M, Price S, Delcambre L. How doctors search: a study of query behaviour and the impact on search results. *Inf Process Manag*. 2012;48: 1151–1170.
7. Villalba-Mora E, Casas I, Lupiañez-Villanueva F, et al. Adoption of health information technologies by physicians for clinical practice: the Andalusian case. *Int J Med Inform*. 2015;84:477–485.
8. Vallo Hult H, Wynn E. Information integrity and human infrastructure in digital health care. In: *25th Americas Conference on Information Systems, AMCIS 2019. Cancún, Mexico*: Association for Information Systems; 2019
9. Grajales FJS III, Samuel S, Ho K, et al. Social media: a review and tutorial of applications in medicine and health care. *J Med Internet Res*. 2014;16: e13.
10. Islind AS, Snis UL, Lindroth T, et al. The virtual clinic: two-sided affordances in consultation practice. *Comput Supported Coop Work*. 2019;28:435–468.
11. Ball MJ, Lillis J. E-health: transforming the physician/patient relationship. *Int J Med Inform*. 2001;61:1–10.
12. Lupton D. The digitally engaged patient: self-monitoring and self-care in the digital health era. *Soc Theory Health*. 2013;11:256–270.
13. Househ M, Grainger R, Petersen C, et al. Balancing between privacy and patient needs for health information in the age of participatory health and social media: a scoping review. *Yearb Med Inform*. 2018;27:029–036.
14. Islind AS, Lindroth T, Lundin J, et al. Shift in translations: data work with patient-generated health data in clinical practice. *Health Inform J*. 2019; 25:577–586.
15. Konttila J, Siira H, Kyngäs H, et al. Healthcare professionals' competence in digitalisation: a systematic review. *J Clin Nurs*. 2019;28:745–761.
16. Curran V, Fleet L, Simmons K, et al. Adoption and use of mobile learning in continuing professional development by health and human services professionals. *J Contin Educ Health Prof*. 2019;39:76–85.
17. Nguyen XV, Adams SJ, Hobbs SK, et al. Radiologist as lifelong learner: strategies for ongoing education. *Acad Radiol*. 2019;26:1120–1126.
18. Isah EE, Byström K. Physicians' learning at work through everyday access to information. *J Assoc Inf Sci Tech*. 2016;67:318–332.
19. Van De Wiel MW, Van den Bossche P, Janssen S, et al. Exploring deliberate practice in medicine: how do physicians learn in the workplace? *Adv Health Sci Educ*. 2011;16:81–95.
20. Dornan T. Workplace learning. *Perspect Med Educ*. 2012;1:15–23.
21. Nikolova I, Van Ruysseveldt J, De Witte H, et al. Work-based learning: development and validation of a scale measuring the learning potential of the workplace (LPW). *J Vocat Behav*. 2014;84:1–10.
22. Östlund C. *Design for e-Training [Doctoral Thesis, Monograph]*. Köpenhamn, Denmark: Doctoral School of Business and Management, PhD Series, Copenhagen Business School Press; 2017.
23. Fu J. Complexity of ICT in education: a critical literature review and its implications. *Int J Educ Dev ICT*. 2013;9:112–125.
24. Forsgren E, Byström K. Multiple social media in the workplace: contradictions and congruencies. *Inf Syst J*. 2018;28:442–464.
25. Gellerstedt M, Gellerstedt V, Bernhard I, et al. Work-integrated learning: impact of individual and organizational digitalization on knowledge management and expertise sharing. In: INTED2019, 13th annual International Technology, Education and Development Conference. Valencia; 2019.
26. Kind T, Evans Y. Social media for lifelong learning. *Int Rev Psychiatry*. 2015;27:124–132.
27. Alsobayel H. Use of social media for professional development by health care professionals: a cross-sectional web-based survey. *JMIR Med Educ*. 2016;2:e15.
28. Niehaus W. Informatics and technology in resident education. *PM R*. 2017;9:S118–S126.
29. Tierney MJ, Pageler NM, Kahana M, et al. Medical education in the electronic medical record (EMR) era: benefits, challenges, and future directions. *Acad Med*. 2013;88:748–752.
30. Shachak A, Randhawa GK, Crampton NH. Educational approaches for improving physicians' use of health information technology. *Healthc Manage Forum*. 2019;32:188–191.
31. Armstrong AD, Jarvis-Selinger S. I feel disconnected: learning technologies in resident education. *Instr Course Lect*. 2013;62:577–585.
32. Reis J, Amorim M, Melão N, et al. *Digital Transformation: A Literature Review and Guidelines for Future Research*. Cham, Switzerland: Trends and Advances in Information Systems and Technologies; 2018:411–421.
33. Gagnon MP, Desmartis M, Labrecque M, et al. Systematic review of factors influencing the adoption of information and communication technologies by healthcare professionals. *J Med Syst*. 2012;36:241–277.
34. Ventola CL. Mobile devices and apps for health care professionals: uses and benefits. *P T*. 2014;39:356–364.
35. Sclafani J, Tirrell TF, Franko OI. Mobile tablet use among academic physicians and trainees. *J Med Syst*. 2013;37:9903–9906.
36. Venkatesh VL, Thong JY, Xu X. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Q*. 2012;36:157–178.
37. Venkatesh V, Morris MG, Davis FD, et al. User acceptance of information technology: toward a unified view. *MIS Q*. 2003;27:425–478.
38. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q*. 1989;13:319–340.
39. Sharma R, Mishra R. A review of evolution of theories and models of technology adoption. *Indore Manag J*. 2014;6:17–29.
40. Cockcroft S. *Exploring the Impact of IS Theory on Health Informatics*. Hawaii, HI: 48th Hawaii International Conference on System Sciences (HICSS); 2015.
41. Bagozzi RP. The legacy of the technology acceptance model and a proposal for a paradigm shift. *J Assoc Inf Syst*. 2007;8:3.
42. Markus ML. Power, politics, and MIS implementation. *Commun ACM*. 1983;26:430–444.
43. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process*. 1991;50:179–211.
44. Fishbein M, Ajzen I. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison-Wesley; 1977.
45. Vallo Hult H, Byström K. The workplace in transition: exploring emerging challenges and demands for new competence. In: *10th*

International conference on Reseaching work and learning, 68 December 2017. Grahamstown, South Africa: Rhodes University; 2017.
46. Georgiou A, Whetton S. Broadening the socio-technical horizons of health informatics. *Open Med Inform J*. 2010;4:179–180.
47. Venkatesh V, Zhang X, Sykes TA. “Doctors do too little technology”: a longitudinal field study of an electronic healthcare system implementation. *Inf Syst Res*. 2011;22:523–546.
48. Jussupow E, Spohrer K, Heinzl A, et al. *I Am; We Are-Conceptualizing Professional Identity Threats from Information Technology*. Proceedings of the International Conference on Information Systems, ICIS 2018, San Francisco, CA: Association for Information Systems (AIS), 2018.
49. Sligo J, Gauld R, Roberts V, et al. A literature review for large-scale health information system project planning, implementation and evaluation. *Int J Med Inform*. 2017;97:86–97.
50. McClellan SR, Casalino LP, Shortell SM, et al. When does adoption of health information technology by physician practices lead to use by physicians within the practice? *J Am Med Inform Assoc*. 2013;20:e26–e32.
51. Fiander M, McGowan J, Grad R, et al. Interventions to increase the use of electronic health information by healthcare practitioners to improve clinical practice and patient outcomes. *Cochrane Database Syst Rev*. 2015:CD004749.
52. Mohammadyari S, Singh H. Understanding the effect of e-learning on individual performance: the role of digital literacy. *Comput Educ*. 2015;82:11–25.
53. Gellerstedt M, Babaheidari SM, Svensson L. A first step towards a model for teachers' adoption of ICT pedagogy in schools. Heliyon. 2018;4: e00786.
54. Abouzahra M, Guenter D, Tan J. *Integrating Information Systems and Healthcare Research to Understand Physicians' Use of Health Information Systems: A Literature Review*. Proceedings of the 36th International Conference on Information Systems (ICIS), Fort Worth, TX: Association for Information Systems (AIS), 2015.
55. Holden RJ, Karsh BT. The technology acceptance model: its past and its future in health care. *J Biomed Inform*. 2010;43:159–172.
56. Chauhan S A meta-analysis of e-health applications acceptance. *J Enterprise Inf Manag*. 2017;30:295–319.
57. Keyworth C, Hart J, Armitage CJ, et al. What maximizes the effectiveness and implementation of technology-based interventions to support healthcare professional practice? A systematic literature review. *BMC*. 2018;18:1–21.
58. Ackerman MS, Dachtera J, Pipek V, et al. Sharing knowledge and expertise: the CSCW view of knowledge management. *Comput Supported Coop Work*. 2013;22:531–573.
59. Fitzpatrick G, Ellingsen G. A review of 25 years of CSCW research in healthcare: contributions, challenges and future agendas. *Comput Supported Coop Work*. 2013;22:609–665.
60. Wynn E. *Office Conversation as an Information Medium [PhD, thesis]*. Berkeley, CA: University of California, PhD Thesis; 1979.
61. Gellerstedt M, Johansson K, Winman T. Work integrated learning: a marriage between academia and working life. J Systemics Cybernetics Inform. 2015;13:38–46.
62. Fan W, Liu J, Zhu S, et al. Investigating the impacting factors for the healthcare professionals to adopt artificial intelligence-based medical diagnosis support system (AIMDSS). *Ann Oper Res*. 2018.
63. Hadadgar A, Changiz T, Dehghani Z, et al. A theory-based study of factors explaining general practitioners' intention to use and participation in electronic continuing medical education. *J Contin Educ Health Prof*. 2016;36:290–294.
64. Willermark S. *Digital Didaktisk Design: Att utveckla undervisning i och för en digitaliserad skola [Digital Didactical Design: To develop teaching in and for a digitalised school] [Dissertation]*. Trollhättan, Sweden: University West; 2018.
65. Brown SA, Massey AP, Montoya-weiss MM, et al. Do I really have to? User acceptance of mandated technology. *Eur J Inf Syst*. 2002;11:283–295.
66. Turner M, Kitchenham B, Brereton P, et al. Does the technology acceptance model predict actual use? A systematic literature review. *Inf Softw Technol*. 2010;52:463–479.
67. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Cambridge, MA: Academic press; 2013.
68. Vallo Hult, Helena; Islind, Anna Sigríður, et al. Sociotechnical co-design with general pediatricians: ripple effects through collaboration in action. AMCIS. 2020. In: 26th Americas Conference on Information Systems, AMCIS 2020. Virtual Conference: Association for Information Systems; 2020.