

# Validation of an Instrument to Measure Dental Students' Use of, Knowledge About, and Attitudes Towards Computers

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*Abstract:* Currently, no validated survey instrument exists to measure dental students' use of, knowledge about, and attitudes towards computers. Several studies have surveyed students about their knowledge and opinions regarding computers, but none of them has established the reliability and validity of the instrument(s) used. A measurement study to validate a preliminary survey for dental students was conducted. The preliminary instrument contained five scales: computer use, information resource use, computer knowledge, capabilities of computer systems, and effects of computers on dental practice. Selected variables were summarized descriptively, and a factor analysis for each scale was performed. In addition, construct validity was assessed through correlational analyses among several variables. Three hundred seventy surveys distributed to students at nine dental schools generated 156 responses (42 percent response rate). Sixty-four percent of respondents were male, 36 percent female. Respondents used computers an average approximately four hours per week, and most had begun using computers in 1991. All survey scales except computer use were unidimensional. Computer use required a two-factor solution that distinguished between clinical and nonclinical uses of computers. The instrument can be used for a demonstration study, but should be continuously refined and validated.

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Educational programs in dentistry are rapidly increasing in the use of computers in many areas.<sup>1-4</sup> However, to date no validated instrument exists to measure students' use of, knowledge about, and attitudes towards computers. This is a problem because without such an instrument we cannot reliably assess baseline values for variables of interest, nor can we quantify changes over time. Faculty and administration often drive computing priorities, such as the implementation and use of computer-based learning materials, clinical information systems, and courses in computing and informatics. Meaningful evaluation research becomes difficult without reliable instruments to measure variables in the population toward which such interventions are targeted at, that is, our students.

The purpose of this project was to conduct a measurement study for a new survey designed to measure dental students' use of, knowledge about, and attitudes towards computers. Readers unfamiliar with the basic terminology of evaluation research

are referred to the text by Friedman and Wyatt.<sup>5</sup> The most pertinent aspects of measurement studies are reviewed below.

Measurement studies determine the degree of reliability and validity with which an instrument measures the variable(s) of interest.<sup>5,6</sup> They help researchers understand whether an instrument results in reproducible measurements (=reliability) and how well it measures the variable(s) of interest (=validity). Reliability is assessed in one of two ways: through a test-retest, in which the same instrument is administered repeatedly (which is rarely practical or advisable in surveys); or by employing multiple simultaneous observations of the same variable. The latter approach is commonly used to construct psychometric scales, in which multiple questions address the same attribute in a slightly different way. Reliability is an important aspect of validity.

The concept of "validity" of a test or an assessment has evolved over time. Earlier, validity was typically subdivided into content validity, criterion-

related validity, and construct validity. Today, validity is seen as a more unified concept encompassing additional aspects, such as the verification of domain processes to be revealed by an assessment, the generalizability of the assessment, and the positive and negative consequences of score interpretation.<sup>7</sup> Despite the evolution of the concept, we applied the earlier approach in this study for two reasons. First, the analyses are somewhat simpler to perform because of the more limited definition of validity (and therefore are more easily replicated), and second, current validity theory uses many of the same statistical approaches. Content-related aspects of validity involve a judgment of whether an instrument likely measures the variable(s) of interest in the opinion of domain experts. External factors can help “triangulate” validity by considering measurements derived from other, unrelated sources. If those measurements correlate well with the results of the assessment, the presumption of validity is strengthened. Structural aspects of validity explore correlations between the measurements of different, but likely related, variables within the same instrument. For instance, if respondents with intensive computer use also exhibit high knowledge scores in computing, the structural aspects of the assessment are likely to be valid.

A few studies have attempted to quantify at least some aspects of students’ use of and attitudes towards computers. Unfortunately, none of them used an instrument that was validated by a measurement study. However, it is instructive to review these studies briefly. A survey of first-year and fourth-year classes of dental students at the University of Michigan in 1990 and 1993<sup>8</sup> assessed trends in students’ knowledge, opinions, and experience regarding dental informatics and computer applications. Knowledge and opinions of both first-year classes were similar, but the fourth-year students in 1993 increased their knowledge of informatics applications during dental school. Gender-specific knowledge differences disappeared in the same class. Surveys of three classes of dental students at the University of Pennsylvania (classes of 1989, 1991, and 1993) in 1988 and 1990<sup>9</sup> determined experience with and perceptions of computer technology. The study found little difference in knowledge ratings and perceptions of usefulness of computers between classes.

The objective of this study was to validate a preliminary instrument to determine students’ use of, knowledge about, and attitudes towards computers by conducting a rigorous measurement study. Such

an instrument is needed because it offers a method to assess several computer-related variables in dental student populations in a reliable and valid fashion. Validated instruments are essential as outcomes become more important in dental education.<sup>10,11</sup>

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## Methods

The questionnaire in this study was derived from a survey developed for physicians in 1995.<sup>12</sup> This survey was designed to assess physicians’ use of, knowledge about, and attitudes towards computers. The 1995 questionnaire—“Computers in Medical Care”—comprised four scales: computer use, computer knowledge, computer optimism, and computer-feature demand. Analysis of 771 responses from full-time academic physicians at five academic medical centers in the United States determined that the first three scales were unidimensional and had high reliabilities (0.79, 0.91, and 0.86, respectively). The computer-feature demand attribute was two-dimensional, differentiating between demand for high-level functionality (reliability 0.81) and demand for usability (reliability 0.69). The study found significant positive correlations between the computer use, computer knowledge, and computer optimism attribute scores and respondents’ hands-on computer use, computer training, and self-reported computer sophistication. The original survey is available at <http://www.med.virginia.edu/~wmd4n/medsurvey.html>.

The current study adapted the 1995 Computers in Medical Care survey to assess the same attributes in dental student populations. The four attributes of the earlier survey were retained, but several items in each scale were added, changed, or deleted. Those changes removed or updated outdated items and made each scale specific for the dental environment. A fifth attribute, Information Resource Use, was added, and a corresponding scale was created. Of the fifty items that were part of the five scales, twenty were retained from the original survey, twenty-four were modified, and six were added.

Deriving the current instrument from this survey made it likely that much higher reliability and validity could be achieved on the first try compared to starting *de novo* or with an unvalidated instrument. An interesting peripheral observation was how and to what degree the instrument had to be changed to adapt it to dentistry and technological innovations.

These changes are referenced briefly in the description of the instrument.

A working group of two faculty, one intern, and two graduate students in dental informatics and one faculty member in medical informatics adapted the instrument over a five-week period. The first scale, "Computer Use" (Table 1), consisted of six items in total (three were retained from the original instrument), such as "recording/accessing comprehensive patient information (e.g., progress notes, digital radiographs)" and "writing (e.g., taking notes, homework)." Respondents rated to what extent they used a computer for these tasks on a scale of "never," "sometimes," "often," and "always." The new scale, Information Resource Use (Table 2) asked respondents how often they used computing resources, such as e-mail, WWW, MEDLINE, and an intranet on a five-point scale ranging from "never" to "daily." This scale included six items. The scale "Computer Use" was task-oriented, and the scale "Information Resource Use" resource-oriented.

The third scale, "Computer Knowledge" (Table 3), presented paired computer terms and asked respondents to what degree they could define the distinction between them on a three-point scale. This question construct, as well as nine of the sixteen items, was retained from the original survey. Generic, currently applicable items, such as "hardware vs. software" and "relational database vs. flat-file database," were kept, while outdated ("mainframe computer vs. personal computer") items and items not applicable to dentistry ("ICD9-CM vs. SNOMED") were replaced. New items included "MEDLINE vs. Internet search engine" and "voice input vs. digital recording." Each item was classified as easy, intermediate, or difficult in order to test the hypothesis that the average score for the more difficult items would be lower. Confirmation of this hypothesis would support the assumption that this scale was valid. Asking participants to rate their ability to distinguish between paired computer items was intended to remove the emotive qualities of an actual test to some degree and provide a less threatening survey (with a consequently higher completion rate).

The fourth scale, "Capabilities of Computer Systems" (Table 4), assessed the degree of perceived need for computing applications among respondents. Of the seventeen items in the original medical survey, many focused on some aspect of expert or decision support systems. A more generic scale was needed, and thus four items were retained and six

were added for the dental student survey. Examples of items include "The system is always functioning (no 'down-time')" and "The system alerts me about certain patient conditions (such as premedication requirements or drug interactions)." Four answer choices ranged from "vitaly necessary" to "not necessary," and a fifth one provided a "not applicable" option.

The fifth and last scale, "Effects on Practice" (Table 5), was designed to measure the degree of optimism regarding the impact of computers on dental practice. Of the twelve items, four were retained from the original instrument. Examples include "practice efficiency," "dentists' access to up-to-date dental knowledge," and "patient privacy." The five answer choices ranged from "highly detrimental" to "highly beneficial."

Questions about training and experience with computers, as well as self-rated sophistication with computers, remained essentially the same as in the original instrument. Demographic and general questions were made specific to dental students. In total, the instrument included sixty-one questions. Fifty of those were part of the five scales, and the remainder covered demographics and several other items unrelated to the variables of interest.

The survey was then pilot-tested with a random sample of twenty students who were not part of the final sample. As a result of this pilot-test, the wording of some question items was adjusted, and the expected time it would take to complete the survey was determined.

For survey distribution, student representatives for the American Dental Student Association (ASDA) at approximately twenty dental schools were contacted. The intent was to determine whether the local ASDA chapter wanted to participate in the survey and how many surveys would be needed. Nine schools agreed to participate, and administered the questionnaire during one of their monthly ASDA chapter meetings. This method was chosen because the student pilot testers advised against a mail survey that would likely result in a very low response rate. The distribution method reached a reasonably large sample with little effort and low cost. In addition, distribution did not bias the sample with respect to the variables under study. IRB approval for this survey was not sought since the project was exempt under CFR §46.101 (b) (2).

After the completed surveys were received, the responses were entered into a spreadsheet, and de-

scriptive statistics for selected variables were calculated. For all scales, a factor analysis with varimax rotation was conducted. One- and two-factor solutions were tested. (Factor analysis is a form of data reduction that examines the dimensionality of a scale, that is, how many “factors” the values of a group of values is associated with.) The sorted factor loadings, eigenvalues, and scree plots were examined to determine the dimensionality of each scale. Only responses for which all items of a scale had been answered were included in the analysis. After determining the dimensionality of each scale, the factor loadings were examined to assess whether all items were associated with the attribute of interest. Items with a factor loading of less than 0.40 were deleted. Then, the reliability (Cronbach’s  $\alpha$ ) for each resultant scale was calculated.

The validity of the instrument was also assessed. Content validity was supported by the fact that the instrument was grounded in a related and validated survey. In addition, it was developed by a group of individuals experienced in dental informatics. Construct validity was established partially through the results of the factor analysis. Construct validity was also assessed by examination of attributes likely related to each other. After weighted (factor loading  $\chi$  score) sums for all scales had been calculated, Pearson’s  $r$  was used to compute correlations. For instance, hours of weekly computer use, prior computer training, and sophistication with computers were expected to be positively correlated with the attribute scores for computer use, information resource use, and computer knowledge. The items of the scale “Computer Knowledge” were classified by difficulty. Lower mean scores for items less difficult would indicate construct validity for this scale. Both Kruskal-Wallis and repeated measures ANOVA tests were used to evaluate this hypothesis. Construct validity was also assessed by analyzing correlations among attribute scales. If measured constructs are truly independent, these correlations are expected to be moderate to low. Unfortunately, there was no opportunity to explore criterion-related validity.

The complete survey, slightly modified based on the results of this study, is available at the Web address [www.temple.edu/dentistry/di/stsurvey](http://www.temple.edu/dentistry/di/stsurvey).

## Results

Three hundred seventy surveys distributed to students at nine dental schools generated 156 re-

sponses (42 percent response rate). Dental students from each class were represented (first year: fifteen [11 percent]; second year: fifty-eight [42 percent]; third year: forty-nine [36 percent]; and fourth year: sixteen [12 percent]). One hundred (64 percent) of the respondents were male, and fifty-six (36 percent) female. One hundred thirty-one respondents (84 percent) had a computer available at home, and twenty-five (16 percent) did not. The mean of hours of computer use for school-related purposes per week was 4.1 hrs (Figure 1). Over half of the respondents used the computers two hours or less per week.

The self-rated sophistication in computer use was relatively evenly distributed about the mean of “neither sophisticated nor unsophisticated” (very sophisticated: twelve [8 percent]; sophisticated: thirty-eight [25 percent]; neither: seventy-six [49 percent]; unsophisticated: twenty-two [14 percent]; and very unsophisticated: six [4 percent]).

For the scale “Computer Use,” the questionnaire listed six common school-related tasks, and asked respondents about the extent to which they used a computer for each of them. Response options ranged from “never” (=1) to “always” (=4). Responses for which not all items of the scale had been answered, or where respondents indicated that they never used a computer in a previous question, were excluded. Table 1 shows the results of the analysis of the remaining 148 responses. The scale was two-dimensional and comprised the factors “Clinical Use” and “Nonclinical Use.” Scree plot analysis supported the two-factor solution, with Factor 1 explaining 30 percent of the total variance and Factor 2 17 percent. Examining the factor loadings demonstrated that all items contributed to their respective subscale with loading of 0.73 or greater. Reliability for the subscale “Clinical Use” was 0.76, while reliability for the subscale “Nonclinical Use” was 0.63.

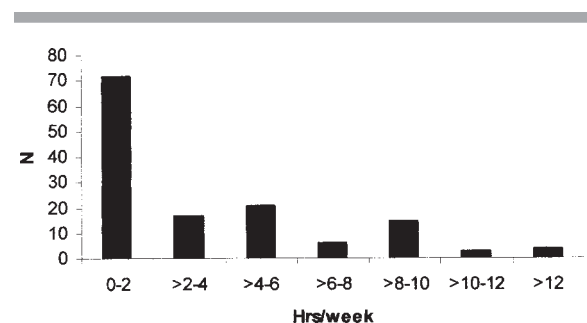


Figure 1. School-related computer use of respondents in hours/week

**Table 1. Two-factor scale “Computer Use” as determined by factor analysis (items sorted by factor loading)**

To what extent do you use a computer for each of the following school-related tasks? Answer choices: never = 1; sometimes = 2; often = 3; always = 4.

	Mean	SD	factor loading
<b>Clinical use</b>			
Recording/accessing basic patient information (e.g., patient demographics, ADA codes)	1.67	0.99	0.88
Scheduling patient appointments	1.98	1.34	0.84
Recording/accessing comprehensive patient information (e.g., progress notes, digital radiographs)	1.29	0.67	0.77
<b>Non-clinical use</b>			
Writing (e.g., taking notes, homework)	2.00	0.92	0.80
Preparing slides or overheads	1.53	0.84	0.73
Accessing/studying learning and teaching materials (e.g., course handouts, textbooks)	2.28	0.83	0.73

Table 2 lists the results for the analysis of the scale “Information Resource Use.” Possible answers ranged from “never” (=1) to “daily” (=5). Analyzing 146 responses yielded a one-factor solution. Two items (“World Wide Web” and “e-mail to communicate with patients”) loaded less < 0.4 and were eliminated from the resultant scale (reliability: 0.57). The single factor of the resulting scale explained 40 percent of the total variance.

For the scale “Computer Knowledge,” respondents rated their ability to define the distinction between sixteen paired computer terms. Answer choices ranged from “I don’t understand the distinction at all” (=1) to “I can define the distinction precisely” (=3). One hundred forty-one responses were included in the analysis. Factor and scree plot analysis supported a one-factor solution, with all items loading greater than 0.5 for the single factor (Table 3). The

**Table 2: Scale “Information Resource Use” with associated factor loadings (items sorted by factor loading)**

Please indicate how often you use the following computing resources for school-related purposes? Answer choices: never = 1; once a month or less = 2; weekly = 3; 3-4 times per week = 4, daily = 5.

	Mean	SD	factor loading
Dial-up from home to use the school’s information resources	2.97	1.55	0.57
MEDLINE/online library catalogs	2.06	0.99	0.53
The school’s intranet	3.09	1.61	0.47
E-mail to communicate with faculty and students	3.82	1.35	0.41
World Wide Web	4.03	1.25	0.39
E-mail to communicate with patients	1.32	0.80	0.38

**Table 3. Scale “Computer Knowledge” (items sorted by factor loading)**

Below is a set of paired terms that relate to computers. Please score your knowledge of the distinction between the terms in each pair, using the following scale. Answer choices: I don’t understand the distinction at all = 1; I have a general appreciation of the distinction but couldn’t define it = 2; I can define the distinction precisely = 3. Difficulty: E = easy; I = intermediate; D = difficult.

	Difficulty	Mean	SD	factor loading
Modem vs. network connection	D	2.25	0.78	0.81
Operating system vs. application program	I	2.18	0.81	0.77
Client vs. server	D	2.19	0.72	0.73
Internet vs. WWW	I	1.99	0.77	0.72
Images vs. graphics	I	2.04	0.66	0.71
MEDLINE vs. Internet search engine	I	2.38	0.71	0.71
Voice-input vs. digital recording	D	1.74	0.70	0.70
Digital vs. analog	E	2.15	0.77	0.68
Electronic mail vs. discussion list	I	2.26	0.72	0.66
Hardware vs. software	E	2.60	0.57	0.63
Full-text database vs. bibliographic database	I	1.65	0.77	0.63
Digital radiography vs. radiograph digitalization	D	1.84	0.79	0.63
Field vs. record	I	1.52	0.67	0.61
Data in memory vs. data on disk	E	2.58	0.58	0.60
Touchscreen vs. touchpad	I	2.33	0.74	0.56
Relational database vs. flat-file database	D	1.23	0.52	0.51

factor explained 45 percent of the total variance. The reliability of the scale was 0.92.

The scale “Capabilities of Computer Systems” consisted of a list of features and characteristics of dental computer systems. Respondents rated how each capability would be necessary for them in their practice. The answer scale ranged from “vitality” (=1) to “not at all” (=4). Analysis of the 144 valid responses to this question yielded a one-factor solution, with 34 percent of the total variance explained by the factor (Table 4). All ten items loaded greater than 0.42 on this factor. The reliability of the resultant scale was 0.84.

The last scale, “Effects on Practice,” listed twelve areas on which computers could have a potential effect. Respondents evaluated those expected effects on a scale ranging from “highly detrimental” (=1) to “highly beneficial” (=5). Evaluation of 149 valid responses determined a one-factor solution that explained 65 percent of the total variance (Table 5).

All items loaded greater than 0.71 on this factor. The reliability of the scale was 0.95.

As indicated previously, content validity for the instrument was addressed by basing the questionnaire development on a validated and related survey and by review through an expert panel. The factor analyses provided a partial measure of construct validity, because they assessed to which degree each item of a scale contributed to the attribute the scale measured. Items that did not display adequate factor loadings were eliminated. In addition, certain correlations between different, but related, variables measured by the instrument were hypothesized. For instance, hours of weekly computer use, prior computer training, and sophistication with computers were expected to be positively correlated with computer use, information resource use, and computer knowledge. Table 6 shows the correlations between those variables and the attribute scores measured by scales. The attribute “Computer Knowledge” showed

**Table 4. Scale “Capabilities of Computer Systems” (items sorted by factor loading)**

If you were considering the use of a computer system in your practice, how necessary would the following capabilities be? Answer choices: vitality = 1; generally = 2; somewhat = 3; not at all = 4; N/A = 5.

	Mean	SD	factor loading
The system alerts me about certain patient conditions (such as premedication requirements or drug interactions).	1.60	0.71	0.71
I can access the system in the dental operator.	1.80	0.86	0.65
The system provides assistance regarding patient diagnosis and treatment.	2.26	0.95	0.65
I can interact with the computer using methods other than the keyboard and mouse (e.g. voice, touchscreen).	2.31	1.07	0.65
The system allows me to exchange patient information with other dentists for diagnosis and treatment consultations.	2.06	0.87	0.55
Help on how to use the program is available within the system.	1.60	0.68	0.55
The system allows me to access information relevant to patient care, such as online journal articles and diagnostic/treatment information.	1.91	0.84	0.55
The system allows me to manage all patient information (administrative and clinical information, including radiographs, etc.).	1.56	0.74	0.54
The system is always functioning (no “down-time”).	1.64	0.80	0.49
The system is easy to learn on my own for myself and my staff.	1.34	0.62	0.43

**Table 5. Scale “Effects on Practice” (items sorted by factor loading).**

Given below are some effects that the implementation of computer applications may have on your practice. For each, indicate whether you believe the effect will be beneficial or detrimental. Answer choices: highly detrimental = 1; detrimental on the whole = 2; neither detrimental nor beneficial = 3; beneficial on the whole = 4; highly beneficial = 5.

	Mean	SD	factor loading
Practice efficiency	4.18	1.00	0.85
Accuracy and quality of patient documentation	3.91	0.99	0.84
Quality of patient care	3.62	0.99	0.84
Dentists’ access to up-to-date dental knowledge	3.91	0.99	0.84
Finding information in the patient record	4.14	1.06	0.82
Communication with patients between office visits	3.53	0.91	0.82
Patients’ satisfaction with the quality of care they receive	3.54	0.95	0.81
Communicating with other dentists for patient care	3.70	1.01	0.80
Rapport established between dentists and patients during the patient visit	3.46	0.98	0.80
Patient privacy	3.28	1.02	0.78
Time required for documentation, such as progress notes	3.78	1.02	0.75
Ability to negotiate managed care contracts	3.58	0.88	0.72

**Table 6. Correlations between selected variables and attribute scores**

	Computer Use- Clinical	Computer Use- Nonclinical	Information Resource Use	Computer Knowledge	Capabilities of Computer Systems	Effects on Practice
Computer Use (hrs/week)	0.096	0.092	0.135	0.219*	-0.170*	-0.040
Computer Training	0.009	-0.001	0.034	0.269**	0.086	0.087
Computer Sophistication	-0.135	-0.024	-0.003	-0.549**	-0.082	-0.165

\*p<0.05 \*\*p<0.01

significant and substantive correlations to computer use, training, and sophistication. A perplexing finding was that computer knowledge was negatively correlated with self-rated computer sophistication. A small, negative correlation between the scale “Capabilities of Computer Systems” and “Computer Use” was significant.

For the computer knowledge items (Table 3), each item had been rated as either “easy,” “intermediate,” or “difficult” by the questionnaire developers. A measure of construct validity was whether the respondents rated themselves less knowledgeable on the more difficult items. The mean ( $\pm$ SD) for the “easy” items was 2.36 ( $\pm$ 0.72); for the “intermediate” items, 2.00 ( $\pm$ 0.79); and for the “difficult” items, 1.69 ( $\pm$ 0.78). A Kruskal-Wallis test ( $df = 2$ ;  $H$  value = 128.3) confirmed that the three averages were significantly different ( $p < 0.001$ ). A repeated measures ANOVA test yielded the same result. The fact that item difficulty correlated negatively with respondents’ self-assessed ability to answer could be an indicator that this scale assessed knowledge rather than confidence in the ability to answer. Intuitively, confidence in the ability to answer an item should be independent of its level of difficulty.

Correlations among attribute scores were examined to assess whether they were independent. Only “Information Resource Use” was moderately correlated with “Computer Use-Nonclinical” ( $r = .023$ ,  $p = 0.004$ ). No other attributes were correlated with each other.

## Discussion

This study determined reliability and validity of a preliminary instrument to measure dental students’ use of, knowledge about, and attitudes toward computers. The instrument was derived from a closely related instrument for physicians. The survey was thus quite similar to the original one, but was better adapted to dental students.

A potential source of bias was the method of survey administration. The best choice would have been to distribute the survey to a random sample of the approximately 17,000 dental students in the United States. However, the students involved in the development of this survey strongly advised against this method because of the expected low return rate. The survey results indicate that students most likely did not self-select because of their computer knowledge or use. Respondents used computers between zero and more than twelve hours per week, and self-rated computer sophistication ranged across all categories. The response rate of 42 percent was smaller than desirable, but acceptable for purposes of a measurement study.

The scale “Computer Use” was conceived as measuring a single attribute, but data analysis favored the two-factor solution which divided the scale into clinical and nonclinical components. The reliability of the subscale “Computer Use-Clinical” was above the commonly accepted threshold level of 0.70, but the subscale “Computer Use-Nonclinical” exhibited somewhat lower reliability of 0.63. The reliability of the scale “Information Resource Use” also was below the threshold level of 0.70. Lower reliability implies less confidence in the measured value. However, since reliability of these scales was not unacceptably low, several additional items for each of those scales should be generated in future studies, and reliability should be reexamined. For the scale “Information Resource Use,” two of the six items loaded less than the threshold level of 0.4 on the single factor solution. Dimensionality and factor loadings should be reexamined in future studies. The scale “Computer Knowledge” exhibited high reliability and construct validity. How well this scale measures real as opposed to perceived computer knowledge is open to discussion. A supportive argument is the fact that this self-test was presented in a nonthreatening way, and the survey itself provided no incentive to be untruthful. A true test of this hypothesis, however, would be a comparison with an external measurement of computer knowledge, such

as a standardized test. The scales “Capabilities of Computer Systems” and “Effects on Practice” both exhibited high reliability. This observation is typical for scales with many items that perform at an acceptable level in measuring the target attribute.

Measures of construct validity by correlation analysis were not as strong or unequivocal as desirable. As opposed to the results of the measurement study with physicians,<sup>12</sup> several of the hypothesized correlations could not be demonstrated. “Computer Knowledge” was positively correlated with computer use in hours per week and computer training, but exhibited a significant negative correlation with self-rated computer sophistication. One possible explanation is that experienced and knowledgeable computer users simply rated themselves more strictly than others. Another is that the item “Computer Sophistication” does not measure the intended construct adequately, that is, it is subject to significant measurement error. This would also explain the absence of correlations between “Computer Sophistication” and other variables (Table 6). The absence of any strong and significant correlations among the three computer use scales (“Computer Use-Nonclinical,” “Computer Use-Clinical,” and “Information Resource Use”) and “Computer Use” (hrs/week), “Computer Training,” and “Computer Sophistication” may be the result of attenuation. Attenuation can occur when the reliability of variables’ measurements is relatively low, as was the case with the three scales. Attenuation makes correlations appear weaker than they actually are. The absence of strong correlations could also be due to the fact that the variables are actually independent. The only other significant correlation was a small, negative correlation between hours of computer use/week and “Capabilities of Computer Systems.” Individuals who use computers more frequently could actually have lower demands on the capabilities of computer systems, for instance, because they may be more realistic about what such systems can actually deliver. The absence of some expected correlations does not automatically render the survey invalid. This circumstance simply points to the need to continue to refine the instrument.

This study has established initial estimates for the validity and reliability of the instrument. The scales “Computer Knowledge,” “Capabilities of Computer Systems,” and “Effects on Practice” exhibited acceptable measurement performance. The “Computer Use” and “Information Resource Use” scales should be refined before they are used in dem-

onstration studies. In addition, the measurement properties of the variables “Computer Use” (hrs/week), “Computer Training,” and “Computer Sophistication” and their relationship to the scales should be reexamined.

After appropriate modifications, all or part of the instrument could be used for one or more demonstration studies. Such demonstration studies measure one or more attribute(s) and assess changes, especially after interventions. For example, a demonstration study could assess computer use and computer knowledge of students to ensure they can take full advantage of computer-related or -dependent components of the curriculum. Or, the instrument could be administered both before and after a computer course to measure changes in variables of interest. The instrument could also be used to assess student-related outcomes of implementing computer applications (such as clinical information systems). Importantly, the instrument does not have to be used in its entirety. Investigators can eliminate scales that are of no interest, as long as each remaining scale is left intact.

It should be noted that no measurement study can provide a final judgment on the performance of an instrument. Samples in subsequent studies may generate different measures of reliability and validity. Therefore, even in the course of demonstration studies, measures of reliability and validity should be analyzed and reported.

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