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A Survey of Academic and Industry Professionals Regarding the Preferred Skillset of Graduates of Medical Informatics Programs

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Abstract

Identification of the skills needed by graduates of medical informatics masters degree programs is needed so that students will know what is desired in the workplace and curriculum designers can assure that courses cover relevant areas. We conducted a mail survey of representatives of the informatics job market to discover what they think is most important. A survey instrument was designed after analyses of job ads and curricula in the U.S. and interviews with representative employers. The survey was mailed to 1000 randomly selected members of AMIA and HIMMS plus EMR vendors. Respondents were asked to rank skills and groups of skills according to perceived utility. The results indicate higher rankings for organizational and interpersonal skills than for more technical credentials. Statistical analysis indicates the existence of relatively few underlying constructs to the skill list.

Keywords:

Medical Informatics; Data Collection; Data Interpretation, Statistical; Education; Factor Analysis, Statistical

Introduction

Lorenzi et al. have stated: "The time has come for health care organizations of all types to invest in people skilled in medical informatics" [1]. The determination of the set of abilities that constitutes "skill in medical informatics" is one of the central concerns of academic medical informatics programs, as curriculum designers strive to meet the needs of a diverse and expanding marketplace. If it were possible to describe a group of core competencies, academic curricula could be designed to impart the needed skills.

The objective of this project was to describe the skills needed by informatics master's degree graduates who enter either academia or industry. The primary data collection vehicle for this job market survey was a paper survey mailed to 1000 individuals considered potential employers of holders of MS degrees in medical informatics.

Materials and methods

Survey Creation

The survey's skill list was compiled with information collected from three sources: interviews with local medical informatics professionals, a review of all available curricula of medical informatics programs in North America, and relevant employment advertisements obtained from various sources.

The interviews were conducted in the Fall of 1997 with a chief information officer at an academic health sciences center, with a chief medical information officer at a health maintenance organization, and the senior vice president of a medical software company. Data from these interviews were analyzed by two researchers and formed the basis for the list of skills.

Web-based sources for medical informatics education programs were identified and course descriptions were analyzed to expand the skill list. The task of extricating skills from published curricula proved difficult, as others have noted [2].

There were three tasks for each respondent to complete. First, the list of 69 skills was divided and grouped into thirteen categories. Respondents were asked to rank each skill according to the perceived level of importance of the respective ability or knowledge domain. A Likert scale was used, with a one through five numerical assignment representing an ascending level of importance. Second, each skill also had a separate assignment category that allowed the skill to be included in a list of the "top five" most important medical informatics skills. This task was part of the closing section that also included space for free text answers to open-ended questions, and questions that provided a profile of the hiring tendencies along with anonymous personal data of the respondents. Third, the

survey also contained a section for respondents to take broad skill categories, similar to the subheadings that divided the skill list, and assign them weighted values according to the extent of that capacity that they would like to see in the ideal job candidate. The final version of the survey, due primarily to its extensive list of skills, was four pages in length. The survey's contents were transferred to a software package that allows the creation of computer "scannable" forms for ease of data entry upon receipt of returned surveys [3].

Survey Distribution

The recipient list consisted of a total of 1000 prospective employers randomly sampled in approximately equal parts from three sources: the 1998 versions of the HIMSS and AMIA directories, and a list of electronic medical record (EMR) vendors [4,5,6]. Follow-up was done two weeks after the initial distribution by sending reminders with instructions for requesting a second copy of the survey if the first was lost.

Results

One hundred and forty eight of the original 1000 surveys sent out were completed and returned.

Descriptive

The survey included a task in which respondents were asked to select their choices from the skill list for the top five skills. Figure 1 below, accompanied by a legend in Table 2,
shows the frequency with which the twenty (20) most-chosen skills were nominated to this list in the 148 responses, in descending order.

Respondents were asked to create the ideal candidate by assigning dollar values to a list of ten skill domains using a USD1000 budget. The results are shown in Table 1.

Table 1- Skills ranked by mean USD spent

Rank	Survey Skill	USD
1	Interpersonal, Organizational and Relational Skills	190
2	Clinical experience or Training	170
3	Written and Oral Communication	160
4	Database Creation and Management	155
5	Programming languages and Coding	130
6	Administrative and Business Functions	125
7	Statistical and Epidemiological Outcomes, Applications	125
8	Training, Teaching and Educational	125
9	Basic and Clinical Research	100
10	Computer Network and Connection Protocols	100

Statistical

In accordance with principles described by Dillman [7], several initiatives were undertaken to try to maximize our survey response rate. However, because the response rate remained low even after reminders were sent, and because handwritten comments on completed surveys indicated that length was a problem, we decided to use the data to help develop a shorter survey instrument and simultaneously delve more deeply into any existing relationships between skills. Therefore, exploratory factor analysis was done. The returned values for the skill set assigned along a Likert scale were first entered into an Excel worksheet, and then loaded into the SPSS statistical package [8]. Data reduction methods were chosen to explore the meaning behind given

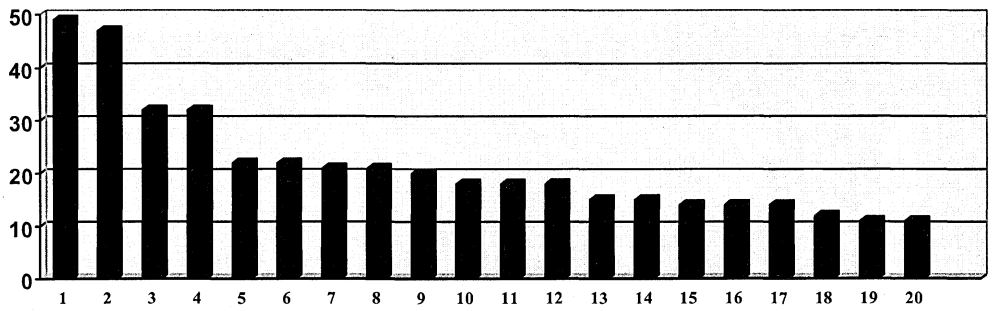

Figure 1 - Skills Ranked by Frequency of Assignment to "Top Five" List. N = 148

Table 2 – Legend for Figure 1

Rank	Survey Skill
1	Knowledge of the types of information used in clinical care and how such information is generated and utilized
2	Demonstrated interpersonal skills
3	Change management
4	Relational databases / data structures
5	Project management
6	Evaluation of health care information systems
7	Electronic medical record (EMR) development
8	File-based data management, query languages and modern database implementation standards (SQL/ODBC)
9	Oral presentation and/or conference participation
10	User interface design
11	Clinical hardware and software integration standards (e.g. HL7)
12	Development of internet-based information sources
13	Evaluation and improvement of data quality
14	Knowledge of the roles of the different providers in the health care system, including observation of a clinician in a practice setting
15	Appropriate use and interpretation of statistical data
16	Team building and participation
17	Work team organization
18	HTML, SGML
19	Quality management
20	Data structures and their collection methods and uses for research

responses, and to show whether relationships between responses existed.

Background

The survey's list of 69 skills was believed to be comprehensive, and to cover distinct abilities with a minimum of overlap. Nevertheless, they were organized into 13 subheadings according to underlying knowledge and experience constructs.

These assignments were the result of the authors' determination of common domains underlying some skills. A statistical procedure such as factor analysis could affirm the validity of these domains by showing that the respondent's attitudes regarding the value of each skill were related by common factors.

Factor Analysis

Principal component analysis was applied to the values returned under each subheading. For each subheading, the intent was to extract multiple factors as components, describe the variance in responses by Eigenvalues for each component, and then use a Rotated Component Matrix to align skills with components. Within the parameters of the SPSS program, the type of rotation used was "Varimax Rotation with Kaiser Normalization." The strength and direction of association between skill and component would then be described within a range of values between –1.00 and +1.00.

With the exception of one subheading, labeled "Business and Administrative Functions," the extraction procedure resulted in only a single component for each subheading. This was taken to mean that the total variance within each of 12 subheadings could be explained by the tendency towards 12 individual concepts. This direct relationship was taken to validate the rendering of a single domain to cover all subsumed skill descriptions. The next step was to put an appropriate label on this domain and design a skill description to match that embracing concept.

Six subheading combinations were attempted in further factor analysis. These combinations were made in accordance with semantic similarity in their subheading labels. Examples include "Medical Decision Making" with "Clinical Medicine Practices," as well as "Epidemiology and Public Health" with "Statistical Processes."

All of these pairings yielded only two factors that aligned themselves strongly with the skills from their respective original groups (mean +0.751). This was presumed to mean that there was no overlap in underlying constructs.

Organizational Group

Semantic judgements along with component analysis were applied to reorganize and fine-tune associations of factors with skills. The "Business and Administrative Functions" subheading was relabeled "Organizational Issues and Behaviors" in order to more accurately reflect the skills contained therein.

This single subheading yielded a total of four factors. According to their Eigenvalues, 61.2% of the total variance among the responses to all skills within the subheading was explained by these four factors. The Rotated Component Matrix, which assigns weights and direction to the component associations, showed that three of these factors had relatively strong relationships (+0.414

to +0.847) with all but one particular "outlier" skill, labeled "Practice guideline creation." A fourth factor had a strong association (+0.738) with *only* this skill.

Initially, the "Practice guideline creation" skill had been inserted into this group according to the status or position of the physician who usually executes this function, which would put this person into the managerial or administrative ranks. Given these associations and the fact that the medical background required for this function was addressed in two other subheadings, this skill was relocated into a more appropriate group. The reorganized subheadings were revisited with factor analysis. Subsequently, the newly inserted "Practice guideline development" skill aligned itself strongly (+0.672) with the single component previously extracted from "Clinical Medicine Practices" subheading.

The Organizational group, with "Practice guidelines" removed, and with 16 skills remaining, now yielded only three factors; down from the original four. A reading of these skills favored communication and "people" skills, which prompted the insertion of "Oral presentation and/or conference participation" from elsewhere in the survey. Interestingly, although three factors remained, this new skill aligned weakly (+0.347, +0.389) with two factors, and relatively opposite (-0.507) the third.

Further factor reduction in this skill group was by achieved the removal of four skills with weak component associations in the Rotated Component Matrix. Those excluded were three whose wording associated them with medical education, and another amorphously titled "Change management". The remaining 12 skills yielded only two factors, with relative strong associations (+0.576 to +0.776) between factors and skills. In contrast, the addition of two skills from other subheadings to the original 17-skill group yielded as many additional factors as added skills.
In effect, these inclusions blurred associations between underlying factors, despite their references to organizational issues. These results support the idea that a few governing concepts control the choices made by survey respondents within this organizational group [9]. The results of the factor analysis will be used to develop a shorter survey instrument that will hopefully lead to a higher response rate.

Discussion

In his editorial comments in an issue of JAMIA in early 1999, Stead opined that "...the key to the future is education and training programs that can produce people who know how to develop effective information-enabled work processes. Despite (this), informatics groups based in academic medical centers have had minimal impact on the health system and the health information technology industry" [10]. Covvey, MacNeill and Angus have written that "Reviewing medical and healthcare informatics programs reveals that most target the development of theoretical healthcare informaticians," whom they describe as "...fundamentally scientists, conceivers of new knowledge and creators of new tools, often driven by their own interests." They contrast these people to the "applied healthcare informaticians," who must be "...able to understand the problem...and deliver the (optimal) solution that addresses the need," and "whose primary measure of success is the production of quality deliverables" [11].

Given the choice to rate "people skills" relative to more specialized aspects of the medical informatics profession; respondents elevated proficiency in organizational issues to a level equal to or greater than the one assigned to technical competence. The importance of interpersonal and communication skills as selected by our survey respondents is a sign that these capacities are considered critical for professional success. This emphasis touches upon issues regarding formal education versus experiential learning in our field, and further asks whether it is a traditional lack of organizational abilities in technologically savvy individuals that has spawned this reaction. An analogy can be drawn between the programmer absorbed with the language of the computer and the clinician likewise absorbed in the physiology of a patient. Divergent philosophies meet in the conception and application of medical technology. The conflicts created by this convergence can surface in significant discord that is often at the root of failures of information systems in medicine [12,13].

Lorenzi et al. wrote: "Medical informatics professionals are trained to understand both the objective of the work process and the capability of the information technology. This dual background, together with their experience as change agents, positions them to design optimal processes and to set a course by which an organization can move from old processes to new ones" [1]. Perhaps a qualification such as "practiced" could have preceded Lorenzi's definition of the medical informatics professional. The opportunity exists for the expansion of curricula into the arena of real-world applications. This could result in a graduate whose preparation will more closely resemble Lorenzi's definition of the model professional.

Conclusion

Our work, and that of others [1,10,13,14], indicates that being equally well versed in both academic and practical skills is essential to success in medical informaticians. As a primary source for well trained and versatile informaticians, academic institutions and degree programs will be challenged to both nurture their traditional classroom formats and to devise new methods to encourage the development of more experiential skills expected of the future developers and managers of health care systems.

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