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ABSTRACT

This study was undertaken to determine the factor analytic structure of patient management problems (PMPs) and to determine whether such factors are stable for different groups taking the same examination and for the same group over time. PMPs attempt to simulate, in written form, the process that a physician goes through in managing a patient. Two examinations were administered to a group of medical students, the first during their junior year and the second during their senior year. The second test was also administered to a second class of students during their junior year. Factor analysis results indicated there are two components to medical problem solving as measured by PMPs--data gathering and management. Both factors were stable over groups and over time. (Author/MV)

A FACTOR ANALYTIC STUDY OF BRANCHING PATIENT MANAGEMENT PROBLEMS

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Branching patient management problems (PMPs) as described by McGuire, Solomon, and Bashook (1) were developed to simulate on paper the physician's encounter with a patient and have been widely used to assess medical problem-solving ability. This study was undertaken to further examine the nature of the factors underlying performance on PMPs and to determine whether such factors are stable for different groups taking the same examination and for the same group over time.

LITERATURE REVIEW

In a study undertaken at the University of Illinois College of Medicine to analyze performance on PMPs, the authors (2) concluded that medical problem-solving was highly content specific because there was a great deal of intra-individual variability in performance within and across different PMPs. Results of the Michigan State University Medical Inquiry Project (3) also indicated that there was a lack of consistency in performance across problems.

Bashook (4) argues that this variability in performance is because there are different domains of clinical problem-solving. A domain is defined by three components--stage of the problem-solving process (sensing, defining,

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resolving), clinical discipline, and the context of care (e.g., emergency, acute, chronic, health maintenance). PMPs often focus on a single domain; hence, performance is not generalizable from one problem to the next.

However, Donnelly, et al. (5) demonstrated that there was some consistency in performance across problems. Ten PMPs and an average across all problems were individually factor analyzed, and two factors emerged--information gathering and decision making. The two factors were not highly related within problems or across problems. The high reliabilities of the information gathering variables and the low reliabilities of the decision making variables led the authors to conclude that information gathering is a general ability and that decision making is content specific because it varies from problem to problem.

The research, although limited, does suggest that PMPs do not measure a general medical problem-solving ability. There is some evidence that performance may be content specific, and one study indicates there may be two components involved--information gathering and decision making.

METHOD

As indicated earlier, PMPs are an attempt to simulate in written form the process that a physician goes through in managing a patient. They generally consist of a short introduction to the patient followed by a series of sections devoted to gathering history and physical exam data, ordering diagnostic procedures, and treating the patient. Within each section the examinee selects from a list of options those which he feels are appropriate. He records his decisions by erasing the opaque overlay or developing the latent image with a special pen to reveal the outcome of his choices. The responses

are presented in as realistic a manner as possible. History questions are answered in terms the patient would be expected to use. If x-rays, EKGs, and the like are ordered, appropriate photographic reproductions are provided. In addition, no interpretation of results is given unless such information is normally provided or consultation is specifically requested.

Each examinee determines the order in which he goes through the problem based on his judgment of optimal management of the patient. Therefore, not all examinees are exposed to the same sections of the problem nor to the same sequence of sections. For example, selecting an incorrect medication might cause the patient to have an adverse reaction, and the examinee must then deal with that complication. Selection of the proper medication, on the other hand, would have led to satisfactory recovery.

Two examinations that included PMPs were administered to 191 University of Illinois College of Medicine students (Class I), one during their junior year and the other during their senior year, as part of the ongoing appraisal program. The first exam (Exam I), taken when the students were juniors, contained 24 PMPs, and the second (Exam II), taken when they were seniors, had 26. Exam II was also administered to a different group of 214 junior students (Class II). Both tests were designed to assess clinical competence in a number of different disciplines, settings (e.g., emergency room, outpatient clinic, private office, hospital service), and types of problems (e.g. emergency, chronic). Although the specific content of the problems varied from year to year, the patients had relatively common problems that third and fourth year medical students were expected to be able to manage.

Because earlier research indicated that there was a great deal of

variability in individual performance across problems, it was concluded that it would not be fruitful to analyze each problem separately. Rather, it was hypothesized that given a sufficiently large and varied sample of PMPs, examinees would exhibit consistent patterns of performance over time. It was further hypothesized that different groups of examinees would exhibit similar patterns of performance on the same exam.

In order to analyze performance across problems each of the items in the exams was classified into one of the six following categories.

History: Information gained from patient history

Physical: Information gained from physical exam of the patient

Diagnostic procedures: Information gained from laboratory tests, x-rays, EKGs, etc.

Pathway: Decision points at which the next stage in management is selected

Treatment: The care given the patient; includes medications, operations, counseling, etc.

Diagnosis: Specific identification of the patient's problem(s)

Table 1 contains a percentage breakdown by category of the two exams.

Insert Table 1 about here

Each of the items was assigned a weight on a nine-point scale ranging from +8 (clearly indicated) to -8 (contraindicated) by an interdisciplinary committee of medical school faculty. Scores for the six categories were computed for each student. These scores were the algebraic sum of the weights of the positive items and the negative items selected in each category across

all problems divided by the maximum number of points possible in that category.

Principal-factor analyses with iteration were performed separately on the correlation matrices of the three exam administrations to identify factors underlying performance on PMPs. Initial estimates of communalities were the squared multiple correlations of each variable with the remaining five variables, and the significant factors of the three analyses were rotated obliquely by the direct oblimin rotation method. In order to determine if performance was similar for different groups taking the same exam, the factor patterns for the Class I seniors and the Class II juniors were compared. In order to determine stability over time, a principal-factor analysis was performed on the correlation matrix of the 12 variables from the exams administered to Class I in the junior and senior years.

RESULTS

The results of the separate factor analyses performed on the correlation matrices of the three exam administrations are shown in Table 2. Loadings (factor pattern coefficients) greater than .30 are underlined for emphasis. For each of the three analyses two distinct factors emerged that were associated with principal components whose eigenvalues were greater than one and that jointly accounted for 71% or 72% of the total variance in the initial principal components analyses. History, physical, and diagnostic procedures loaded on one factor which was labelled "data gathering". Pathway, treatment, diagnosis, and diagnostic procedures loaded on the second factor which was labelled "management". It should be noted that diagnostic procedures loaded on both factors. The correlations between the two factors were .42

for the Class II juniors who took Exam I, .53 for the Class I seniors who took Exam II, and .44 for the Class II juniors who took Exam II.

Insert Table 2 about here

Inspection of the Class II junior factor pattern revealed that it was very similar to the Class I senior factor pattern, and further rotation to maximize congruence was not necessary. The similarity of the matrices indicated that the factors were stable for different groups taking the same exam.

The results of the factor analysis performed on the correlation matrix of the 12 variables from the two exams that were administered to Class I are shown in Table 3. Four factors emerged whose initial eigenvalues accounted for 72% of the total variance. These were junior and senior data gathering and junior and senior management. Junior diagnostic procedures loaded on junior data gathering and junior management. Senior diagnostic procedures loaded on senior data gathering and senior management, although less heavily on the management factor.

The highest factor correlations in Table 3 were between junior and senior data gathering (.49), junior and senior management (.60), and senior data gathering and senior management (.51).

Insert Table 3 about here

DISCUSSION

The results of this study indicate that there are two components to medical problem-solving as measured by PMPs--skill in data gathering and skill in management. Both factors were stable for different groups who

took the same exam and over time for one group who took two different exams. The stability of the factors over time is further emphasized by the relatively high correlations between junior and senior data gathering (.49) and junior and senior management (.60) as reported in Table 3.

Donnelly and his colleagues identified the same two dimensions. However, in the present study the data gathering and management factors within each exam were positively correlated suggesting that the factors are not independent. This finding is in contrast to the Donnelly study which concluded on the basis of low obtained canonical correlations between the variables comprising each factor that the factors were unrelated. It seems likely that appropriate management of a patient is to a certain extent dependent on the adequacy of the data base developed from the history, physical, and diagnostic procedures. However, an examinee might ask all the right questions but not be able to integrate the information to arrive at an appropriate resolution to the problem, or he might arrive at the appropriate resolution from a sketchy data base.

The selection of diagnostic procedures appears to be a significant point in this process of integration. Diagnostic procedures may have loaded on both factors because that is the point at which information obtained from the history and physical must be integrated in order to select correct diagnostic procedures. The results of the procedures then influence the subsequent management decisions made by the examinee.

The results of this study also provide some evidence of construct validity of PMPs. The correlation between data gathering and management factors as reported in Table 2 was higher for the seniors (.53) than for the juniors (.42 for the group that took Exam I and .44 for the group that took

Exam II). This suggests that students at the senior level who usually have had more clinical experience are better able to apply data gathering information to management decisions.

The mean scores and standard deviations for the six categories for the juniors and seniors who took Exam II appear in Table 4. A one-way multivariate analysis of variance performed on the means of the six variables for the two classes produced a significant multivariate F-ratio ($F = 13.06$; $df = 6,398$; $p < .001$), indicating that test performance is related to year in medical school--seniors performed significantly better than juniors. It might be argued that the improvement was due to increased familiarity with the testing technique. However, the students are given careful instructions prior to the exam, and many have encountered PMPs on previous exams and through using such texts as Clinical Simulations (6) which contain PMPs.

Insert Table 4 about here

In summary, the results of this study support the findings of a previous study that suggested PMPs measure two factors--data gathering and management--and that at least two subscores are necessary to describe performance. In addition, it was found that these two factors were stable across time and across groups given a large and varied sample of PMPs. It is advisable, therefore, to sample broadly when using PMPs in order to obtain a stable measure of an individual's ability. Evidence supporting the construct validity of written simulations also emerged.

TABLE 1

COMPOSITION OF EXAMS I AND II BY CATEGORY

EXAM I

Disciplines represented: Medicine, Neurology, Obstetrics-Gynecology, Pediatrics, Psychiatry, Surgery (24 problems total)

CATEGORY	PERCENT OF EXAM
History	10.6
Physical	9.6
Diagnostic Procedures	27.4
Pathway	16.6
Treatment	28.6
Diagnosis	7.2
	100.0%

Administered to Class I as juniors (N = 191)

EXAM II

Disciplines represented: Medicine, Neurology, Obstetrics-Gynecology, Otolaryngology, Pediatrics, Psychiatry, Surgery (26 problems total)

CATEGORY	PERCENT OF EXAM
History	13.6
Physical	11.2
Diagnostic Procedures	28.4
Pathway	13.0
Treatment	30.2
Diagnosis	3.6
	100.0%

Administered to Class I as seniors (N = 191) and Class II as juniors (N = 214)

TABLE 2

DIRECT OBLIMIN FACTOR PATTERNS FOR CLASSES I AND II

	CLASS I, JUNIOR YEAR EXAM I (N=191)		CLASS I, SENIOR YEAR EXAM II (N=191)		CLASS II, JUNIOR YEAR EXAM II (N=214)	
CATEGORY	FACTOR I DATA GATHERING	FACTOR II MANAGE-MENT	FACTOR I DATA GATHERING	FACTOR II MANAGE-MENT	FACTOR I DATA GATHERING	FACTOR II MANAGE-MENT
History	0.63	0.12	0.85	0.04	0.85	0.00
Physical	0.93	-0.13	0.98	-0.09	0.97	-0.09
Diagnostic Procedures	0.47	0.46	0.51	0.38	0.55	0.32
Pathway	0.24	0.56	0.10	0.57	0.03	0.70
Treatment	-0.01	0.78	-0.03	0.65	0.07	0.63
Diagnosis	-0.11	0.75	-0.05	0.71	-0.07	0.68
Factor Correlations	0.42		0.53		0.44	

TABLE 3

DIRECT OBLIMIN FACTOR PATTERN FOR CLASS I ON EXAMS I AND II

CATEGORY	FACTOR I JUNIOR DATA GATHERING	FACTOR II SENIOR DATA GATHERING	FACTOR III JUNIOR MANAGEMENT	FACTOR IV SENIOR MANAGEMENT
Jr. History	0.60	0.06	0.13	0.05
Sr. History	0.08	0.82	-0.05	0.05
Jr. Physical	0.80	0.12	-0.10	0.08
Sr. Physical	0.04	0.97	0.00	-0.11
Jr. Diagnostic Procedures	0.40	0.14	0.48	0.00
Sr. Diagnostic Procedures	-0.04	0.59	0.10	0.28
Jr. Pathway	0.27	-0.06	0.53	0.10
Sr. Pathway	0.06	0.09	-0.02	0.57
Jr. Treatment	0.04	-0.02	0.78	-0.01
Sr. Treatment	-0.13	0.07	0.30	0.45
Jr. Diagnosis	-0.14	0.08	0.69	0.07
Sr. Diagnosis	-0.05	-0.04	-0.01	0.71

FACTOR CORRELATIONS

	FACTOR I	FACTOR II	FACTOR III	FACTOR IV
FACTOR I	1.00	0.49	0.29	0.30
FACTOR II		1.00	0.33	0.51
FACTOR III			1.00	0.60
FACTOR IV				1.00

TABLE 4

CLASS I AND CLASS II SCORES ON EXAM II

	CLASS I, SENIOR YEAR (N=191)		CLASS II, JUNIOR YEAR (N=214)	
CATEGORY	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
History	67.75	10.26	61.93	11.06
Physical	73.78	9.93	68.39	10.87
Diagnostic Procedures	57.35	7.35	52.26	8.26
Pathway	75.73	8.83	69.53	10.07
Treatment	38.27	7.79	32.94	7.50
Diagnosis	56.91	8.53	51.35	9.55

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