Relationship Among Scores of Medical Student Assessments in a New Integrated Curriculum

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Purpose. The medical curriculum at the China Medical University, Taiwan was reformed in 2001. A new integrated curriculum (New-IC) that includes organ-based block, problem-based learning (PBL) and clinical skills and communication (CSC) courses has replaced the traditional discipline-based, lecture-intensive coursework. Multiple assessment instruments including multiple-choice questions, direct observation and preceptor ratings were used accordingly. This study describes our new curriculum, examines the results of student assessments and tries to explore the relationship among these assessments.

Methods. The scores of two student cohorts obtained from written exams, PBL and CSC including history taking, physical examination and clinical procedure were calculated during one academic year. The relationship among these scores within each organ-based block was analyzed by Pearson correlation.

Results. A total of 243 students who completed 12 blocks were assessed during the 2003 to 2004 academic year. Although there were some statistically significant correlations between the scores of different assessments, in general, the correlation coefficients in most cases were quite low, ranging from –0.233 to 0.377.

Conclusions. Assessments used to evaluate knowledge, skill, self-directed learning and attitude in our New Integrated Curriculum were not correlated with each other. All instruments have their own strengths and weaknesses; therefore a good assessment program requires a variety of assessment instruments, with each one designed to discover something unique. **(Mid Taiwan J Med 2006;11:20-7)**

Key words

clinical skill, medical education, problem-based learning, student assessment

Undergraduate medical education in Taiwan was revised after the World Federation for Medical Education (WFME) released the International Standards in Medical Education [1]. A national regulatory body, the Taiwan Medical Accreditation Council (TMAC), was set up to perform the formal accreditation process that includes self-study exercise and external on-site visit. With the impacts of WFME standards and TMAC accreditation, changes of educational

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Table 1. Block names and duration, numbers of test and case, and contents of clinical skills session in the New Integrated Curriculum in China Medical University (2003-2004)

Blocks	Contents	Block weeks	MCQ tests	PBL cases	Clinical skills and communication (CSC)		
					History taking	Physical examination	Clinical procedure
4101	General introduction	3	1	1	1	Vital signs and blood pressure	General protection and aseptic procedures
4102	Cardiovascular diseases	8	2	3	1	Heart and circulation	Venipuncture and intravenous catheter
4103	Respiratory diseases	6	2	3	1	Lung and respiration	Endotracheal intubation and airway care
4204	Gastrointestinal disease	6	2	2	1	Abdomen	Nasogastric tubing
4205	Social and family medicine	6	2	1	–	–	–
4206	Immunology and infection	5	1	2	–	–	–
5107	Renal and urology	5	1	2	1	Digital rectal and prostate exam	Foley catheterization
5108	Muscle and bone diseases	6	2	2	1	Musculoskeletal exam	Casting and splinting
5109	Head and neck-related disease	6	2	2	1	Checking vision, eardrum and tuning fork exam	Throat swab
5210	Neurology and psychiatry	10	3	3	1	Neurological exam	Lumbar puncture
5211	Metabolic and endocrine-related disease	3	1	1	–	–	–
5212	Hematology and oncology	4	2	1	1	Lymph node, thyroid and breast	Basic life support

MCQ = multiple-choice questions; PBL = problem-based learning.

programs took place in almost every medical school in Taiwan. Traditional discipline-based, lecture-intensive curricula are transited to more focus on professional attitude and skill as well as knowledge [2]. In addition to adapting the organ-based block, problem-based learning [3-5], standardized patients [6], medical informatics [7], and faculty development [8] are now part of medical school curricula in Taiwan. Consequently, the accurate assessment of the performance of medical students has become a challenging issue.

The China Medical University School of Medicine, established in 1956, is a private medical school in Taiwan. Each year it matriculates about 120 high school graduates for a seven-year educational program. The traditional curriculum before reform was predominantly lecture-based and discipline-oriented, and written exams were the most common methods for assessment. After undertaking a self-study using the WFME Global Standards [9], our school implemented a New Integrated Curriculum (New-IC) in the fall of 2001 [10]. The learning objectives of the New-IC are to train students to provide efficient primary health care service, to communicate better with patients, to be critical thinkers and life-long learners, and to be members of a multidisciplinary team for the benefit of the community. During the process of curriculum reform, we believe that students need to be observed and assessed across a broad range of situations and procedures, not just by written exams, to draw reasonable conclusions about overall clinical competence. This study reports the design of our new curriculum and the assessment results from two cohorts of students. Furthermore, we attempted to explore the correlation among these assessments.

MATERIALS AND METHODS

The first two years of the New-IC at the China Medical University provided general education focused on professionalism, humanism and medical ethics. After anatomy, biochemistry, physiology and other basic medical courses in the third-year, there were 12 organ-based blocks in the fourth- and fifth-years. Each block consisted of problem-based learning (PBL) courses in addition to traditional didactic lectures. Clinical skills and communication (CSC) courses were included in 9 out of the 12 blocks in the New-IC. The details of the 12 blocks are summarized in Table 1. The sixth- and seventh-years are for clerkship and rotating internship focused on hands-on and teamwork practice. The implementation of the New-IC started simultaneously at the first-, third-, and sixth-year levels in 2001. The fifth-year students in 2003 comprised the first class, which had completed three years of the New-IC.

Each block has up to 3 written multiple-choice question (MCQ) tests, during or at the end of a given block. The faculty members who taught the course gave the test items. The numbers of test items were proportional to the lecture hours. The block coordinator had reviewed the test items for clarity, ambiguity and other common item flaws before the test was administered. Students' test scores in each block were averaged and converted to percentages.

One to three PBL cases relevant to the organ-system were studied in each block. With cases overlapping, each case was spread in a weekly base over 3 sessions. Students were randomly assigned to groups of nine to ten during each semester. At the end of each case, tutors were asked to rate the students using a 10-point scale on 5 items. The five items of student performance were: 1) critical appraisal, 2) data-gathering and processing, 3) interpersonal skills, 4) group participation, and 5) attendance and attitudes. For fairness in grading, there was consensus amonog tutors that no more than 2 students (20%) will be rated more than 9 or less than 6 in the PBL group. Narrative description on specific areas of student strengths and deficiencies was encouraged. If the grade was 9, 10 or less than 6, a written justification had to be provided. Within each block, PBL scores as percentages of the maximum score were averaged. All tutors attended a 4-hour PBL training program and tutors' meetings with the case authors before each session. Tutors who participated in this study had tutored PBL sessions for at least one year.

The CSC course included three sessions: interview and history taking (CSC-HT), physical examination (CSC-PE), and clinical procedure (CSC-CP) skills relevant to the subject matter of the block. Students rotated through the three sessions of the CSC course at the same time. In the CSC-HT session, 2-3 students were assigned a clinical preceptor and one of the preceptor's patients from the in-patient department of the university hospital. At bedside, students were observed while they were interviewing a real, untrained patient. The student was required to write a medical note to document the information gathered during the interview and present the patient to the preceptor. The preceptor gave direct feedback concerning the performance on interview, oral case presentation, clinical reasoning, and write-up, and assessed each student using a standard rating form, which was provided to the students at the beginning of the session.

In the CSC-PE session, 15-16 students were grouped with a clinical preceptor. After completing a 30-minute formal training session consisting of videotapes and hands-on demonstration, students practiced physical examination on each other of the same gender. After giving immediate feedback in the examination room, the preceptor assessed the student with a 100-point global rating scale consisting of three descriptors of the students' knowledge, skill and attitude. All preceptors were experienced staff members from the hospital departments related to the organ-based block and had been trained in proper use of the assessment form in order to achieve a similar standard in all groups.

Ten to eleven students were grouped in a

Table 2. Descriptive statistics of students' scores in the five assessments (2003-2004)

Blocks	Assessments				
	MCQ	PBL	CSC-HT	CSC-PE	CSC-CP
4101	73.2 ± 6.8*	86.5 ± 3.8	81.4 ± 4.9	86.2 ± 2.7	84.9 ± 3.9
4102	74.8 ± 8.2	87.0 ± 3.0	83.3 ± 4.1	87.3 ± 1.7	84.3 ± 3.7
4103	75.7 ± 6.4	87.2 ± 3.3	82.4 ± 4.5	85.5 ± 1.4	84.2 ± 2.9
4204	77.3 ± 6.8	86.9 ± 2.3	85.0 ± 3.6	85.6 ± 3.3	89.8 ± 4.4
4205	83.0 ± 4.6	87.0 ± 3.5	-	-	-
4206	69.9 ± 7.6	87.6 ± 2.9	-	-	-
5107	71.3 ± 10.3	85.9 ± 4.4	83.5 ± 3.9	84.3 ± 1.4	84.4 ± 2.8
5108	82.2 ± 8.4	86.8 ± 3.2	84.0 ± 3.7	85.9 ± 1.7	86.6 ± 2.7
5109	74.0 ± 8.7	87.2 ± 3.3	85.9 ± 1.7	87.4 ± 1.7	88.9 ± 2.8
5210	87.6 ± 4.8	86.1 ± 3.5	84.6 ± 3.6	86.9 ± 1.0	88.2 ± 1.6
5211	74.9 ± 9.7	86.9 ± 3.1	-	-	-
5212	76.3 ± 7.8	87.6 ± 3.5	82.1 ± 5.8	86.4 ± 3.3	86.6 ± 3.1

*Mean ± standard deviation. MCQ = multiple-choice questions; PBL = problem-based learning; CSC = clinical skills and communication; HT = history taking; PE = physical examination; CP = clinical procedure.

Table 3. Correlation coefficients for the assessment scores in each block marked with parenthesis

	MCQ		PBL		CSC-HT		CSC-PE		CSC-CP	
MCQ			(4101)	(4204)	(4101)	(4204)	(4101)	(4204)	(4101)	(4204)
			0.096	0.085	0.135	−0.002	−0.036	0.004	0.084	0.023
			(4102)	(4205)	(4102)	(4205)	(4102)	(4205)	(4102)	(4205)
			0.223	0.215	0.109	–	0.170	–	0.022	–
			(4103)	(4206)	(4103)	(4206)	(4103)	(4206)	(4103)	(4206)
			0.146	0.284*	0.091	–	0.055	–	0.029	–
PBL	(5107)	(5210)			(4101)	(4204)	(4101)	(4204)	(4101)	(4204)
	0.183	0.269*			0.141	0.227	0.136	−0.047	0.011	0.219
	(5108)	(5211)			(4102)	(4205)	(4102)	(4205)	(4102)	(4205)
	0.192	0.192			0.271*	–	0.128	–	0.010	–
	(5109)	(5212)			(4103)	(4206)	(4103)	(4206)	(4103)	(4206)
	0.268*	0.332*			0.266*	–	0.088	0.284*	0.033	–
CSC-HT	(5107)	(5210)	(5107)	(5210)			(4101)	(4204)	(4101)	(4204)
	0.134	0.143	0.110	0.103			−0.016	−0.064	0.021	0.075
	(5108)	(5211)	(5108)	(5211)			(4102)	(4205)	(4102)	(4205)
	−0.036	–	0.060	–			0.042	–	−0.014	–
	(5109)	(5212)	(5109)	(5212)			(4103)	(4206)	(4103)	(4206)
	−0.043	0.112	−0.087	−0.001			−0.003	–	0.018	–
CSC-PE	(5107)	(5210)	(5107)	(5210)	(5107)	(5210)			(4101)	(4204)
	0.377*	−0.035	0.278*	−0.056	0.089	−0.039			−0.233	0.051
	(5108)	(5211)	(5108)	(5211)	(5108)	(5211)			(4102)	(4205)
	0.094	–	0.231	–	0.234*	–			0.207	–
	(5109)	(5212)	(5109)	(5212)	(5109)	(5212)			(4103)	(4206)
	−0.012	−0.011	−0.231	−0.022	0.067	−0.067			0.146	–
CSC-CP	(5107)	(5210)	(5107)	(5210)	(5107)	(5210)	(5107)	(5210)		
	0.031	0.055	0.045	−0.056	0.060	−0.148	0.125	0.042		
	(5108)	(5211)	(5108)	(5211)	(5108)	(5211)	(5108)	(5211)		
	0.182	–	0.140	–	0.047	–	0.067	–		
	(5109)	(5212)	(5109)	(5212)	(5109)	(5212)	(5109)	(5212)		
	−0.040	−0.036	−0.109	−0.023	−0.035	0.072	0.127	0.165		

*$p < 0.01$. MCQ = multiple-choice questions; PBL = problem-based learning; CSC = clinical skills and communication; HT = history taking; PE = physical examination; CP = clinical procedure.

CSC-CP session. Clinical procedures related to the organ-based block were taught with models or simulators. The students were observed and assessed during their repetition sessions. The preceptors graded the students' performance after each session with the same 100-point global

rating scale used in CSC-PE. The same consensus that no more than 20% of students in the two extremes for the PBL course, was applied to the CSC-PE and CSC-CP courses too. In order to combat preceptor severity or leniency error, we used the handicapping method to adjust the final scores [11].

For each block, a mean score of MCQ and PBL, and mean scores of the three CSC sessions were determined for each student. We calculated the mean and standard deviation of results for each assessment in the block and compared these scores with each other for all fourth- and fifth-year students during the 2003-4 academic year. The internal consistency estimate of reliability for the MCQ assessment was calculated by the Cronbach's alpha test. Pearson correlation coefficient was used to determine the relationship among MCQ score and the scores assigned by preceptors for PBL and CSC in a given block. Analyses were performed using the SPSS software (SPSS Inc., Chicago, IL). Statistical tests were two-tailed. Since multiple tests were performed, a more conservative level of α significance was set at 0.01.

RESULTS

A total of 243 students were assessed (121 fourth- year and 122 fifth-year students) from August 2003 to July 2004. Absentees in MCQ (n = 2), PBL (n = 7), and CSC (n = 7) were noted during the academic year, and their make-up scores were not included in the calculation.

Reliability of the MCQ test, as measured by Cronbach's alpha, averaged 0.772 ±0.047 (range, 0.715 to 0.838) for the fifth-year, and 0.694 ± 0.055 (range, 0.627 to 0.771) for the fourth-year. Nine out of twelve, or 75%, MCQ tests had Cronbach's alpha levels above 0.7 for reliability. Several methods were used to improve our assessment's face and content validity: the examination contents were matched with course content, the faculty members expert in content were used to develop items, and the items were reviewed by another expert, the block coordinator.

Descriptive statistics for the results of five assessments in each block are listed in Table 2. The correlation coefficients for each block of the curriculum are listed in Table 3. The significant correlations ($p < 0.01$) are highlighted (*) in the table. Although there were some statistically significant correlations between the scores in the different blocks, in most cases the correlation coefficients were quite low, ranging from –0.233 to 0.377.

DISCUSSION

Assessment of students is one of the nine areas in WFME Global Standards. To meet the basic standards, medical schools must develop and implement instruments to assess its students. The primary purpose of an assessment is to achieve the educational objectives and to promote student learning [9]. The well-recognized Miller's pyramid provides a clear and reproducible focus for assessment. A model with four levels, designated “knows”, “knows how”, “shows how” and “does”, is very useful in educational settings. The four levels can easily be used to build a framework that begins with pure knowledge and progresses through problem solving and clinical skills and ends with real performance [12]. These levels are not readily assessable as a whole and there is general agreement that multiple instruments are needed to capture at least some of the levels of clinical competence. A 1998 survey of assessment methods used in US medical schools showed that more than 80% of schools reported using almost all of the 14 specific assessment methods included in the survey [13]. School-based multiple-choice question (MCQ) examinations were used by almost two thirds of the schools in the pre-clinical curriculum, and National Board of Medical Examiners (NBME) subject examinations were used by one third of schools. At the time of the survey, preceptor or faculty ratings and various methods of live observations were reported throughout the curriculum for most schools.

Although there are many assessment tools available, each of them has strengths and weaknesses. The traditional MCQ can test large content area quickly with a high degree of

reliability and consistency, but focues on assessing knowledge (knows) only. The use of PBL as a learning strategy has increased in recent years, although it requires more comprehensive faculty development and training. Assessment of students in a small group has also become a common practice that focuses on knowledge (knows), competence (knows how), and performance (shows how). Direct observation of the student's ability to gather data from the patient through history taking, physical examination, and to practice clinical procedural skills reflects the student's knowledge, competence, and performance, rather than action (does) [14]. In this study we have examined five assessment instruments to determine knowledge, competence and performance of medical students. These assessments provided students with learning opportunities to gain the skills and, with successful passage, ensured them get competence during their clinical years. Action, the highest level of competence in the pyramid, will be assessed by other measures, e.g. log book, passport or medical record audit, in clerkship and internship.

The qualities of the MCQ tests were evidenced by their high Cronbach's alpha level and that each item was created and reviewed by the experts in the disciplines. The validity of the tests was further evidenced by the proportionate weighting of test content to the actual emphasis of the courses taught.

The random grouping of students in PBL and CSC courses ensured that the subjectively scored assessments were fair. Other measures, such as that faculty's ratings of student performances were being restricted in range and that handicapping method was used, also supported the fairness in our study. Furthermore, as the New-IC was implemented over three years, the ability of subjective assessment subsequently improved. The important issue of predictive validity was not addressed in this study and warrants further investigation and documentation.

The low correlations found between the subjective scores and the more objective written test scores are similar to findings reported in the literature. Keynan et al found the Pearson's correlation coefficients between the MCQ scores and the subjective assessment of oral examinations and global rating of students' performance during the clerkship were 0.35 and 0.25 respectively [15]. The authors recommended that the clinical performance of medical students should be assessed by a combination of subjective and objective measures. Poor correlation was noted between the NBME surgery subtest scores and physical exam skills (r = 0.19), physician-patient interaction skills (r = 0.15), and patient write-up skills (r = 0.2) in a surgical clerkship by Dunnington et al [16]. The very poor level of correlation found was interpreted as a result of testing completely different domains. In a correlation study on the scores between PBL and written exams, Whitfield et al revealed that the coefficients of determination (r^2) ranged from 0 to 0.387 for all blocks, with a mean of 0.145, and concluded that tutor assessment of student knowledge base is not useful [17]. Awad et al also found a poor correlation between the subjective perception of the faculty of student surgical knowledge and objective measures obtained through written exam scores (r = 0.12) [18]. The poor correlations between different measures of subjective assessments have also been reported [15,18-20]. From all these reported works, the conclusion is that multiple assessment methods should be used to evaluate the performances of individual students.

On the basis of these findings, it might be appropriate to conclude that all five instruments for assessing students in our New-IC are independent and are not related to each other. Although the global rating scales are believed to be subjective and unreliable, they are few existing measures for assessing the qualities of skills like physical examination and clinical procedures. All instruments have their own strengths and weaknesses and are useful for limited purposes only. A good assessment program requires using a variety of assessment instruments, each designed to discover something the other kinds do not. In our current hybrid curriculum, we have decided to add objective structured clinical examination

(OSCE) and standardized patient (SP) as a summative assessment. A pilot program with 8 five-minute OSCE/SP stations was conducted in June 2004 [21]. It is expected that the planned combination of these assessments will have a major impact on the future development of our curriculum, not only to meet the basic standard but also to achieve quality development of WFME Global Standards.

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新整合課程之醫學生評量成績與其間之相關性

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目的 中國醫藥學大學醫學系於2001年進行醫學教育改革，新整合課程以器官系統爲模組，取代過去以學科及授課爲主的傳統課程，並導入問題導向學習(problem-based learning)和臨床技能與溝通(clinical skills and communication)等課程，同時採用包括選擇測驗題、教師直接觀察及評分等多元的教學評量。本研究除了描述新整合課程之特色、各種教學評量的結果外，並嘗試探討各類評量間之相關性。

方法 統計一學年內兩屆學生於臨床醫學模組中，在筆試、問題導向學習及三項臨床技能與溝通(包括醫療面談、身體檢查及操作技能)之評量分數，並以Pearson correlation分析各種評量分數之相關性。

結果 於2003至2004年間，共有兩屆243名學生，分別完成12個模組，各種評量分數雖然在少數模組中有統計意義之相關性，整體而言各種評量分數間之相關係數皆十分低，介於-0.233到0.377的範圍內。

結論 新整合課程中針對知識、技能、自我學習及態度的教學評量，各自評量獨特的學習目標且相互間無明顯相關，顯示各種評量方法有其優點和弱點，因此，好的教學評量計畫需要使用多元化的評量方法。（中台灣醫誌 **2006;11:20-7**）

關鍵詞

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