《測驗學刊》
第五十五輯第二期　2008 年 8 月 435～462 頁

個人特質與背景知識對問題導向學習教學成效之影響

陸希平[1]　陳誠仁[2]　林妍如[3]　余民寧[4]

摘要

問題導向學習，是以問題為教案中心，透過以學生小組討論的方式來達成團隊學習的目標，在台灣醫學院該學習方式已行之有年。過去研究證據顯示有一些影響問題導向學習表現的因素，包括教案場景的設計、導師的特質、學生的學習努力程度等。本研究的主要動機在檢視學生的個性與知識特質如何影響其在混成式問題導向學習學程中的表現。

本研究以 124 位台灣中部某醫學院醫學生為調查樣本。個性評量使用自我評估 44 題 Big-Five 個性指標問卷進行調查，背景知識評量則使用過去四年大學必修課成績平均值，問題導向學習表現則使用經設計並在本研究中檢驗具合格信效度的評估表，使用同儕評估的方式進行。

每位學生在問題導向學習上的表現都會經過同組同儕的評估，我們根據樣本的研究，抽取出五個主成分，分別命名為領導／控制、協助／協調、遵守規則、思索旁觀，以及妥協。使用逐步迴歸法得知個性特質中的良知及知識水平與問題導向學習中的領導／控制特質呈現有意義的正相關；此外，個性特質中的交際性特質與問題導向學習中的遵守規則呈現有意義正相關。而個性中的肯定他人及良知與背景知識呈現有意義的正相關。

由本實驗得知，個性特質與背景知識可能會影響學生在問題導向學習中的表現。但為何交際性與問題導向學習中遵守規則的特質有正相關存在，則有些困惑難以解釋，不過既然問題導向學習中的「規則」，本含有開放心胸公開討論以及著重人際關係的成分，這樣的結果就不會顯得過於突兀。未來需要蒐集更多的樣本作進一步的驗證，而該研究的結果不僅對於問題導向學習的實施具有參考與管理價值，也可為建立發展未來生涯預測的模式打下基礎。

關鍵詞：背景知識、個人特質、問題導向學習、醫學院學生

---

1. 陸希平，嘉義基督教醫院暨中山醫學大學副教授
2. 陳誠仁，嘉義基督教醫院院長暨國立成功大學醫學院副教授
3. 林妍如，中國醫藥大學醫務管理學系助理教授
4. 余民寧，國立政治大學教育學系教授（通訊作者）
電子郵件：mnyu@nccu.edu.tw
收件日期：2006.11.28；完成修改：2007.4.18；正式接受：2007.6.5

Psychological Testing
August, 2008, Vol. 55 No. 2, pp. 435-462

A Study of the Personal Traits and Knowledge Base of Taiwanese Medical Students on the Instruction Effects of Problem-Based Learning

Shi-Ping Luh[1] Cheng-Ren Chen[2]
Yen-Ru Lin[3] Min-Ning Yu[4]

Abstract

Problem based learning (PBL), a pedagogic concept using problems in context through student-centered and small group discussion approach, has been adopted in varying contexts for years in all medical institutes in Taiwan. Much evidence have shown that a number of factors can seriously affect student performance in PBL courses, such as the design of PBL scenarios, characters of the tutors, or the students' attitudes and efforts. The purpose of this study is to examine how the personal traits or knowledge base of the Taiwanese medical students influence their performance on a hybrid-PBL curriculum.

A total of 124 high-school entry undergraduate medical students participated in this survey. Self-assessed personal traits were presented in a 44-item questionnaire with a Big-Five factor structures. Knowledge base was assessed by the score point average (SPA) based on their previous four-year education in the medical school. Peer-assessed performance of students in PBL curriculum was carried out using a well-developed, reliable, and validated evaluation form.)

Each student's PBL performance evaluated by peers can be extracted as five principal components, as control/lead, assist/coordinate, obey rules, observe/think, and compromise. The relationships among the personal traits, knowledge base, and PBL performance, as analyzed by stepwise regression, showed that conscientiousness and knowledge (i.e., SPA) were positively related to "control/lead" trait, and extroversion was positively related to the trait of "obey rules." Agreeableness and conscientiousness were positively related to SPA.

Knowledge base and personal traits appear to be associated with the students' performance on a hybrid-PBL curriculum. The positive correlation between the extroversion and obeying rules is puzzling, yet if might be explained in terms of the association between being sociable/assertive and the objectives of PBL spirits, which include open mindedness, and inter-personal skills. The implications of this study on the future development and the applications of this assessment tool in medical schools are proposed.

Key words: problem-based learning, personal traits, knowledge base, medical school students

1.Shi-Ping Luh, Ph.D of Medical Research, Master of Healthcare Management, Associate Professor, Chia-Yi Christian Hospital and Chung-Shan Medical University
2.Cheng-Ren Chen, Ph.D. of Medical Research, Associate Professor, Chia-Yi Christian Hospital
3.Yen-Ru Lin, Ph.D. of Healthcare Management, Assistant Professor, Chinese Medical University
4.Min-Ning Yu, Professor, Department of Education, National Chengchi University
E-mail: mnyu@nccu.edu.tw
Received: 2006.11.28 ; Revised: 2007.4.18 ; Accepted: 2007.6.5

Background

Problem based learning (PBL) is a student-centered educational approach, which encourages students to explore, inquire, explain, analyze, exchange, debate and manage information using relevant content related scenarios as triggers for learning in a small group environment (Norman & Schmidt, 1992; Savery & Duffy, 1995). While the purpose of PBL is to learn new knowledge, its spin-off benefit is the acquisition of skills of solving a problem, i.e., if the problem indeed has a workable solution. In PBL which fosters self-directed approach to learning, the students formulate their own learning objectives, propose hypotheses, integrate basic and clinical sciences, and search, review and critique the evidence from the literature (Schmidt, 1983). Therefore, a PBL tutor plays the role as a facilitator, who encourages cooperative learning and serves as a "guide on the side" rather than a "sage on the stage" (Johnson & Johnson, 2003). That is, the traditional role of the teacher who is the source of knowledge for students no longer applies.

Since its pioneering inception at McMaster University in 1969 (Berkson, 1993), PBL with its characteristic pedagogic principles has been adopted as a major driving force pushing waves of evolutionary as well as revolutionary reforms in medical education in all kinds of medical and health-care institutes across the world. Medical education in Taiwan was not spared this trend. During the past decade, one by one, all eleven medical schools in Taiwan have incorporate some forms of innovative curriculum bearing some characteristics of PBL. The newest medical school at the Catholic Fu-Jen University (starting in 1999) in Taipei has taken a bold step in implementing a broad scope of PBL curriculum and its first group of graduates just entered hospital for clinical internship this year. In Taichung city, both Chung-Shan Medical University and China Medical University have carried out PBL for more than 5 years using a hybrid PBL model, i.e., a smaller modular PBL component embedded in a traditional curriculum, which emphasize an integrative approach to teaching. In the present study, medical students of Chung-Shan Medical School were investigated to determine how personal traits and knowledge base might influence their performance. Instead of self-evaluation, which tends to elicit overestimation on self, peers were

asked to complete the questionnaires and assessment sheets.

Impregnated with the pedagogic characteristics of learning within learners' context of medical or health professions, PBL can theoretically enhance students' abilities to understand and solve real-life problems, improve interpersonal skills and reasoning ability, and motivate a sense of responsibility for self-directed learning (Albanese & Mitchell, 1993; Schmidt, Dauphinee, & Patel, 1987). Barrows et al. declared that it would be superior to the conventional subject-based lecturing in imparting medical problem-solving skills, getting knowledge more relevant to clinical practice, and self-learning skills to the students (Barrows, 1986). Briefly speaking, this new teaching approach can make the knowledge be understood, remembered, and applied better.

Nevertheless, in the practice of PBL, multiple problems or difficulties are often encountered at various levels of the stakeholders. This includes eliminating traditional resistance against innovative PBL concept, investing and distributing resources, training and maintaining of a large number of tutors, promoting group dynamics among students, improving the design of the problems and designing a host of valid and reliable evaluation methods (Colliver, 2000; Fenwick & Parsons, 1997; Jaffarey, 2001). These difficulties have indeed been reported to be important factors influencing the implementation of PBL (Barrows, 1996; Davis & Harden, 2003; General Medical Council, 1993, 2000; Harden, 1986; Harden & Davis, 1995; Wilkerson, 1998; Wood, 2003).

Thus, self-evaluation, peer opinion, and objective content-based examination have been developed to measure personal and group variables and evaluate performance (Mayes et al., 1997; Rynes, Trank, Lawson, & Ilies, 2003; Smith, 1997; Waldman & Korbar, 2004; Williams et al., 2001). The evaluation of students' performance in PBL should be based on their role play requirement in this curriculum. Studies about the role-play in small group learning have been published in previous literature (Albanese & Mitchell, 1993; Benne & Sheats, 1948; Luh, 1999; Schmidt, 1983). A typical PBL tutorial consists of a small group of students (5 to 10 students) and a tutor, who facilitates the session of learning and the collaboration among group members (Johnson & Johnson, 2003; Wood, 2003). Students usually elect a chair for each PBL scenario and a "scribe" or "recorder" to record the discussion (Wood, 2003). The ba-

sic outline of the PBL process includes the following six steps through the way of collaborative learning by group members (Barrows & Tamblyn, 1980): (1)Encountering the problem. (2)Problem solving with clinical reasoning skills. (3)Identifying learning needs in an interactive process. (4)Applying self or other resources gained knowledge to the problem. (5)Summarizing what has been learned. (6)Evaluating the values of information resources and analyzing the management plans by students (in Close loop PBL).

The implementation of PBL curricula poses many problems, one of which was the lack of objective outcome evaluation (Albanese & Mitchell, 1993; Neufeld & Barrows, 1974). Although there have been a lot many literature which delineated the roles of students in PBL or other types of small group learning (Benne & Sheats, 1948; Luh, 1999). However, there was still rare if any sheet to evaluate the students' performance in PBL, especially for the Asian medical students. Thus, the first objective in this study is to establish a valid and reliable PBL peers' evaluation sheet based on a variety of role play in this course.

As described in the above paragraph, since the implementation of PBL required not only personal ability to search, integrate and apply the related knowledge, as well as the interpersonal skills to collaborate and coordinate different view points, it would be reasonable to postulate that students' personality or knowledge characteristics would influence their performance characters in PBL. Thus, the second objective of this study was to modify a well-done, valid and reliable personality sheet, and a knowledge assessment score, to search their influences in the PBL performance. There have been many well-established and verified personality test in previous literature. The Big-Five personality test, a modified form of the Myers-Briggs Type Indicator (MBTI), was selected in this study because it has been used worldwide for over 10 years in many research fields with satisfactory reliability and validity (Hogan, Johnson, & Briggs, 1999; Hough, 1997; Howard & Howard, 2005). In literature of Euro-American institutes, grade point average (GPA) was usually used as the evaluation of students' knowledge. Since 0-100 score has been widely used in most Asian countries, the score point average (SPA) would be used in this study.

Materials and Methods

In 2003, a total of 124 undergraduate medical students (33 females and 91 males) attending PBL-based course at Chung-Shan Medical University participated in this survey. They were randomly divided into 18 groups of 6 or 7 students and arbitrarily assigned one tutor. Each group learn from written clinical cases for 2-3 hours per week over a whole school year. The process in PBL sessions included initial brainstorming to formulate questions and setting objectives, and subsequent searching for resources including the textbooks, journals, and medical websites for relevant information. Students come back in the following session to discuss the information, making a possible diagnosis (when applicable) and/or interpretation, and developing a plan for further evaluation and/or action. The tutors communicated the rules and goals of the course with their students, and played the role of facilitators or coordinators, instructing to mediate students' learning processes instead of the factual knowledge content during tutorial discussions (Barrows, 1996; Neufield, Woodward, & Mac Leod, 1989; Wilkerson, 1998). At the end of discussions prior to the end of the tutorial, the students and tutor provided feedback either verbally or as written comments on-line or in reports.

At the end of the PBL-based course, students were asked to fill out questionnaire and evaluation sheets to assess the performance of their group members and the tutor, as well as evaluate their own personal traits. Score point average (SPA) obtained during previous four consecutive years at the medical school served as a measure of students' knowledge base.

Peer evaluation of student performance

Students evaluated their peers in each group at the end of this course. The assessment had two major dimensions: first, contributions to group missions and goals and second, interpersonal skills, which have been described in the literature (Albanese & Mitchell, 1993; Benne & Sheats, 1948; Luh, 1999; Schmidt, 1983), which were verified by five tutors well-experienced in PBL before performing the survey. The achievement of missions and goals in group learning task often relates to the following

characters of content-related role-play:

1. *The initiator-contributor,* who often suggests new ideas or sorts out directions in the course of PBL discussion. For example, the *initiator* may challenge: "How do we treat pulmonary emphysema patients who are refractory to medical treatment". In response to the question, a *contributor* may suggest the flow of direction by asking: "It is reasonable to consider the lung volume reduction surgery or pulmonary transplantation".

2. *The answer seeker/giver,* who tends to seek or offer a correct answer to a question in the PBL tutorial discussion. For example, an *answer seeker* may ask simple and direct question: "What's the normal pH value of a human arterial blood sample?" The answer giver will respond directly with an answer: "7.4".

3. *The opinion seeker,* who tends to challenge and/or offer comments to add more values to the information. For example, an *opinion seeker* may comment: "Some reports in the literature emphasize the value of video-assisted thoracic surgery, in the treatment of empyema". They may also respond to further such comment: "Evaluation using evidence-based principles (level of evidence, level of recommendation) shows the level of understanding of their learning results."

4. *The elaborator,* who explain a concept by actual and adequate examples or metaphors. For example, an *elaborator* may respond to a question such as: "What is lung compliance?" by elaborating as the following "You can think of the lung as a balloon. If you can blow the balloon up easily, its compliance is said to be high."

5. *The coordinator,* who can summarize different opinions within a group to formulate a consensus. For example, during debates about treatment options for urethral stones, the *coordinator* may weigh the condition of this patient and the proposed treatment plans, and then describes a cost-effectiveness treatment strategy for the benefit of the patient.

6. *The orientator,* who can direct the pace and issues effectively to help members adequately adhering to the proper course of learning.

7. *The evaluator,* who comments on the contents and process of learning and offer feedback for further improvement as an individual or as a group.

8. *The energizer,* who showed enthusiasm and passion in the group process via facilitation and encouragement and persistently helped the group to reach consensus

within the group.

9. *The scribe*, who records the content and process of learning during the discussion. A *scribe* may also prepare reports or summaries on behalf of the group.

The items about interpersonal skills included were:

1. *Encourager.* A member who encourages and appreciates other colleagues' comments or attitudes.

2. *Harmonizer.* A member who intervenes in the conflict or disagreement between other members.

3. *Compromiser.* A member who can change his viewpoint for other group members to maintain the group harmony.

4. *Gatekeeper.* A member who controls evaluation criteria and functions as a selector.

5. *Standard setter.* A member who reminds the other members of the need to meet the goals and follow the rules. This behavior is usually observed at the feedback stage.

6. *Group observer.* A member who analyzes the interactions of the members, and this is also observed at the feedback stage.

Two points or 1.5 points were added to the score of any student rated "the best" or "second best," respectively, in a particular item. The score of each student for a particular item was the sum of the scores given by their peers. Then the group sum for each item was calculated, and the ratio of each student score for an item to the group score for that item was calculated to correct for inter-group differences in response (standardization).

Big-Five personality factors

Paper-and-pencil measures were included in our study to evaluate the personality variables. The Big-Five personality test, a modified form of the Myers-Briggs Type Indicator (MBTI), has been used worldwide for over 10 years in many research fields with satisfactory reliability and validity (Hogan et al., 1999; Hough, 1997; Howard & Howard, 2005). It includes the following five dimensions: I- extraversion *vs.* introversion. Extraversion means a person is talkative, sociable, and assertive. II- agreeableness *vs.* antagonism. Agreeableness means a person is good natured, cooperative, and trusting. III- conscientiousness *vs.* undirectedness. Conscientiousness means a

person is responsible, orderly, and dependable. IV- neuroticism *vs.* emotional stability. Neuroticism means a person is anxious, prone to depression, and worries a lot. When this score was reversed in the following analysis, it was renamed "emotional stability." V- open to experience *vs.* not open to experience. Openness means a person is imaginative, independent minded, and has ability to think divergently. A modified 44-item questionnaire was used and the items were scored on a Likert 5-point scale ranging from 5, strongly agree to 1, strongly disagree. The "negative" trait items were reverse-scored so that high scores indicate more positive traits.

Score point average (SPA)

SPA over the last 4 years at the university was used. The grades (scores) were separated on the basis of content courses (e.g., basic and clinical medical courses) and method courses involving memory (e.g., anatomy), operation (e.g., chemistry lab course), and reasoning (e.g., physics). These scores were weighted on the basis of the number of teaching hours, and the average score of the above three groups of subjects for every student was calculated for analysis (Bartels, Bommer, & Rubin, 2000; Cohen, 1983).

Study design

The study was designed to determine how personality and learning characteristics influence student's performance. It is illustrated in the Fig. 1.

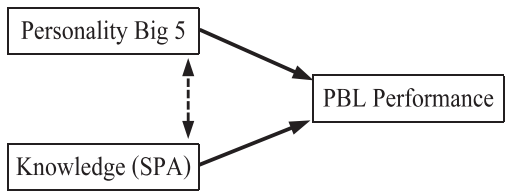

Fig. 1. Study design

Analyses and statistics

Internal consistency reliability was measured in the Big-Five personality evaluation. Initially, item-total correlations were obtained, and items yielding negative ef-

fects on the alpha values of the total evaluation were excluded. Coefficient alpha was determined by the revised evaluation sheets (Cronbach, 1951).

Content and construct validity of the PBL evaluation sheets were assessed by five experts in this field. The effectiveness of each question was assessed and scored from 5 (strongly effective) to 1 (not effective). The content validity and significance level were calculated using the method developed for ordinal data (Guion, 1978). Validity coefficient (Vi) > 0.78 was regarded as significant at the 0.05 level for 5 evaluators using a 5-point ordinal scale.

PBL performance (peers evaluation) and SPA were subjected to principal components analysis, and variables were subtracted to identify the mutually independent factors. Naming these factors depended on the original variables and the loading values of the new independent factors after varimax rotation. Factors with eigenvalue more than 1 would be retained in this analysis (Kalaian & Mullan, 1996; Kao, Lee, & Lue, 1997).

The mean and standard deviation of scores was determined. The response rate was defined as the ratio of the number of respondents to the total number of members in this group. The purpose of the ratio of the scores used in the peer evaluation, described above, was to minimize differences in response rates between groups.

Simple correlation between items of the revised evaluation sheets, between peer evaluations and Big-Five personality or SPA were obtained. Big-Five personality factors and SPA were used to predict student's performance (rated by peers and the tutor). Factors were included or excluded step-by-step in this analysis. The statistical tests were performed by using SPSS 13.0 and Excel for Windows XP.

Results

Reliability of the Big-Five personality questionnaire

The Cronbach's alpha values of the original 44-item, 5-dimension questionnaire ranged from 0.484 to 0.792. These values increased from 0.670 to 0.820 after deletion of 10 items which were shown in the Table 1. The reliability of this questionnaire was

improved after this deletion, and the revised questionnaire could be used to proceed the following correlative study with the students' PBL performance.

Table 1. Reliability (*Cronbach's Alpha*) of the Big-five personality questionnaire

(*N* = 110, 44 items with 5 dimensions)

Dimension	Original alpha	Revised alpha	Item deletion	Retained item no.
Agreeableness	0.484	0.670	27, 37	8
Openness to experiences	0.642	0.819	3, 30, 35, 41, 44	6
Emotion stability/ Neuroticism	0.734	0.820	34	6
Extroversion	0.792	0.800	13	7
Conscientious-ness	0.728	0.748	36	7

Content validity of the PBL performance evaluation sheet

The content validity (Vi) of the 15-item PBL performance evaluation sheet ranged from 0.80 to 0.95 (significantly powerful at the 0.05 level). The mean score of each item (using a Likert 5-point scale) ranged from 4.2 to 4.8 with standard deviation from 0.45 to 0.89.

The validity of the PBL performance evaluation sheet was satisfactory after five different specialists' evaluation.

Table 2. Content validity of the PBL performance evaluation sheets (N = 5)

Items	Content validity				
	Minimum	Maximum	Mean±SD	Vi	*p* value
Opinion Seeker	4	5	4.6±0.55	0.9	<0.05
Evaluator	4	5	4.8±0.45	0.95	<0.05
Standard Setter	4	5	4.4±0.55	0.85	<0.05
Initiator Contributor	4	5	4.6±0.55	0.9	<0.05
Answer Seeker/Giver	4	5	4.4±0.55	0.85	<0.05
Energizer	4	5	4.8±0.45	0.95	<0.05
Elaborator	3	5	4.6±0.89	0.9	<0.05
Coordinator	4	5	4.6±0.55	0.9	<0.05
Harmonizer	3	5	4.4±0.89	0.85	<0.05
Gate Keeper	4	5	4.8±0.45	0.95	<0.05
Orientator	4	5	4.6±0.55	0.9	<0.05
Encourager	3	5	4.2±0.84	0.8	<0.05
Group Observer	4	5	4.6±0.55	0.9	<0.05
Scribe	4	5	4.6±0.55	0.9	<0.05
Compromiser	4	5	4.8±0.45	0.95	<0.05

Note: ($Vi=\Sigma di/n(c-1)$, di: differences from the evaluated score and the score which stands for the "least" valid, n: number of the evaluators, c: the scale number=5)

Factor analysis of the PBL performance peer-evaluation sheets

First level factor analysis identified 5 mutually independent principal factors: Control/lead, assist/coordinate, obey rules, observe/think, and compromise. The factor loading of each item is listed in Table 3. Second level factor analysis revealed two mutually independent principal factors: "Control others/self directed" and "respect others/considerate." The factor loading of each item is listed in the Table 4. The summarized factor analysis is illustrated in Fig. 2. The variables of PBL performance were reduced from 15 to 5 (first level) and 2 (second level) mutually independent, as well as properly named according to their components and factor loadings, new factors after this convertion.

Table 3. Factor loadings and component names from peer-evaluated student performance sheets (First level)

Items	Components names				
	Control/lead	Assist/coordinate	Obey rules	Observe/think	Compromise
Opinion seeker	**.787**	.062	-.097	.073	-.157
Evaluator	**.762**	.089	-.004	.012	-.136
Standard setter	**.643**	.477	-.068	.138	-.175
Initiator contributor	**.622**	.110	.286	-.079	.228
Answer seeker/ giver	.311	**.682**	.180	.029	.029
Energizer	.118	**.645**	.187	.044	-.168
Elaborator	.441	**.630**	-.036	-.023	.276
Coordinator	-.127	**.621**	.401	.391	.126
Harmonizer	-.004	**.489**	.387	-.103	.317
Gate keeper	-.038	.127	**.792**	.242	.000
Orientator	.134	.102	**.776**	-.073	.074
Encourager	-.090	.242	**.480**	-.084	-.292
Group Observer	-.077	.388	.024	**.694**	-.082
Scribe	.274	-.308	.020	**.686**	.246
Compromiser	-.209	.061	-.017	.083	**.830**

Table 4. Factor loadings and component names from peer-evaluated student performance sheets (Second level)

Items of first level principal components	Second level components names	
	Control others/Self directed	Respect others/Considerate
Control/lead	**.670**	.174
Assist/coordinate	**-.566**	.074
Obey rules	**.421**	-.110
Observe/think	.127	**.747**
Compromise	-.196	**.627**

Note: The underlined values mean the principle components of these items. The nomenclature of the new variables were according to their composition and factor loadings of old variables.

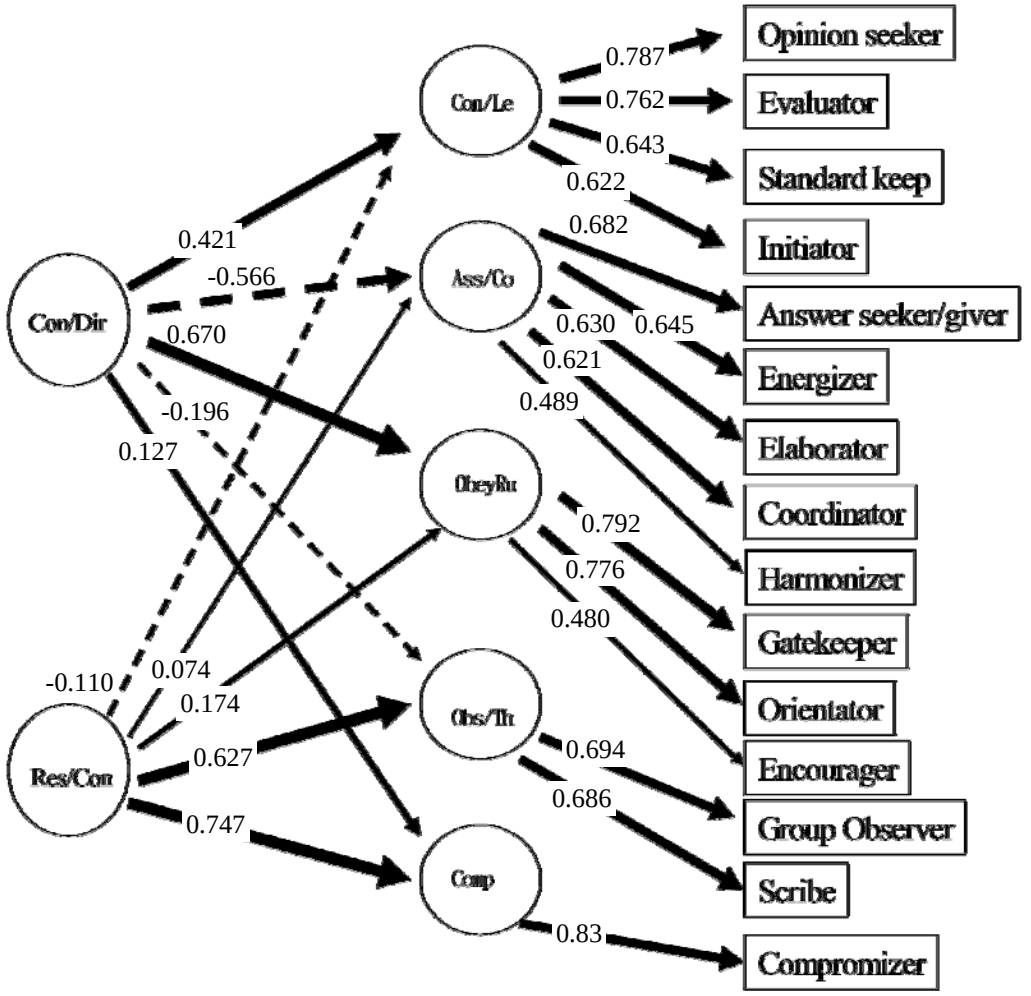

Fig. 2. Factor analysis of peer-evaluated student performance (The numbers represent factor loading, the dotted lines represent negative loadings, the thickness of arrow-line was related to the degrees of correlation. The related factors can be seen in Tables 3 and 4).

Factor analysis of the SPA

Factor analysis of SPA found only one principal component. The factor loading of each item is listed in Table 5. In Asian country, most medical schools still use the written test (which emphasize the students' ability of memory) to determine the per-

formance of their students, that made this score not properly reflect their true abilities in this subject. Thus a variety of abilities, such as the operational, reasoning, or calculation, which should be emphasized in some experimental or specific basic science (such as physics, calculus) course, cannot be measured through these tests.

Table 5. Factor loadings and component names of the SPA

Items of SPA	Component name (Integrated ability, with emphasis in the biomedical and non-operational)
Common course/memory	.195
Calculation/reasoning	.198
Common course/operational	.163
Biomedical basic/memory	.214
Biomedical basic/operational	.188
Biomedical clinical/memory	.211

Descriptive statistics of PBL performance, Big-Five personality, and SPA

Scores of peer-evaluated PBL performance were standardized and ranged from 0 to 0.63 (elaborator and compromiser) to 1.00 (information seeker, coordinator, recorder, gatekeeper, and standard setter), with the median value ranging from 0 to 0.14. Response rates for the 18 groups ranged from 0.42 (recorder) to 0.76 (opinion seeker), with the standard deviation ranging from 0.11 to 0.22. The scores of tutor-to-student evaluation of performance, which was unstandardized, ranged from 0 to 2, and response rates by the 18 tutors ranged from 0.44 (recorder and compromiser) to 0.67 (initiator/elaborator, information seeker, and opinion seeker).

One hundred and ten students (88.7%) completed the Big-Five personality questionnaire. The mean and standard deviation of each dimension (before exclusion of items) is listed in Table 6. One hundred and twenty-one students (97.5%) had SPA information, and the mean and standard deviation is listed in Table 7.

Table 6. The Big-Five personality questionnaire score distribution

(*N* = 110, response rate 88.7%)

Dimensions	Total score			No. items	Average score (range)
	Minimum	Maximum	Mean±SD		
Agreeableness	10	43	28.8±4.6	10	2.88 (1.0-4.3)
Openness to experience	23	47	35.0±4.8	11	3.18 (2.1-4.3)
Emotional stability/ Neuroticism	10	31	23.3±4.6	7	3.33 (1,4-4.4)
Extraversion	10	34	21.7±4.7	8	2.71 (1.3-4.3)
Conscientiousness	10	32	20.8±4.9	8	2.60 (1.3-4.0)

Table 7. The SPA data distribution (*N* = 121, response rate 97.5%)

Dimensions	Total score (Σ Score * credit hrs)			No. credit hrs.	Average score (range)
	Minimum	Maximum	Mean±SD		
Common/memory	511	807	697±59	9	77.4 (56.8-89.7)
Calculate/reasoning	791	1273	1061±93	14	75.7 (56.5-90.9)
Common/operation	572	721	673±29	8	84.1 (71.5-90.1)
Basic/memory	3097	4960	4128±446	53	77.9 (58.4-93.6)
Basic/operation	608	798	737±35	9	81.9 (67.6-88.7)
Clinical/memory	1504	2205	1928±148	25	77.1 (60.2-88.2)
Total	7104	10701	9148±78	118	77.5 (60.2-90.7)

Simple and stepwise regression between the personality/SPA and PBL performance

Simple correlation between personality/SPA and peer-evaluated performance (Table 8) showed that the conscientiousness and SPA were positively correlated with the "control/lead" character of performance ($p < .05$), extraversion was positively correlated with "assist/coordinate" and "obey rules" ($p < .05$), and the openness to experience was positively correlated with obeying the rules ($p < .05$). After stepwise regression, only the correlation between conscientiousness and control/lead, between SPA and control/lead, and between extraversion and obey rules remained significant (Table 9). Simple correlations between personality/SPA and tutor-to-student evaluation of performance were insignificant except for the relationship between the emo-

Table 8. Relationship between personality/SPA and peer-evaluated student performance

Personality/ SPA Items	PBL Peer-evaluation principal components				
	Control/lead	Assist/coordinate	Obey rules	Observe/think	Compromise
Agreeableness	-.097	-.018	.159	.067	.139
Openness to experience	.159	.116	**.204***	.027	-.001
Emotional stability/Neuroticism	.076	-.019	-.073	.105	-.108
Extraversion	.072	**.209***	**.237***	-.081	.062
Conscientiousness	**.349***	.118	.130	.026	.127
SPA principal components	**.443***	.161	.045	.022	-.160

Note: *correlation is significant at the .05 level (2-tailed), SPA components indicate level of integrative ability, with emphasis on the biomedical and non-operational skills (Table 5).

Table 9. Relationship between the personality/SPA and performance

Personality/SPA Items	Principal components of peer evaluations		
	Control/lead		Obey rules
	Step 1	Step 2	Step 1
Agreeableness	-	-	-
Openness to experience	-	-	-
Emotional stability/Neuroticism	-	-	-
Extraversion	-	-	**.276**
Conscientiousness	-	**.215**	-
GPA principal components	**.424**	**.338**	-

Note: Stepwise regression (beta coefficient); Variables entered at significant at the .05 level (2-tailed), no variables entered or deleted in other three components. SPA components indicate level of integrative ability, with emphasis on the biomedical and non-operational skills (Table 5).

tional stability (reverse of the neuroticism score) and flexibility, and no variables were entered into the stepwise regression analysis (Table 10).

Table 10. Relationship between the personality/SPA and the PBL performance tutor-to-student evaluation

Personality/SPA Items	PBL Tutor-to-student evaluation Principal Components	
	Insist on Rules	Flexible
Agreeableness	.195	-.082
Openness to experience	.121	-.180
Emotional stability/Neuroticism	-.015	.312*
Extraversion	.120	-.242
Conscientiousness	-.071	-.030
SPA principal components	.105	.076

Note: Simple regression [Pearson correlation coefficient]; *: correlation is significant at the .05 level (2-tailed), # of SPA components indicate level of integrative ability, with emphasis on the biomedical and non-operational skills (Table 5).

Correlation between the personality and the SPA

Simple personality-SPA correlations (Table 11) showed that neuroticism was significantly and negatively correlated with most other personality characteristics, and that SPA was positively correlated ($p < .05$) with agreeableness and conscientiousness.

Table 11. Relationship between personality and SPA

	Agreeableness	Openness	Neuroticism	Extraversion	Conscientiousness	SPA PC
Agreeableness	1					
Openness	-.037	1				
Emotional stability/Neuroticism	**-.358****	-.095	1			
Extraversion	.127	**.506****	**-.507****	1		
Conscientiousness	-.142	**.252***	**-.193***	**.398****	1	
SPA PC	**.232***	.046	.189	.045	**.402****	1

Note: Pearson correlation; **, correlation is significant at the 0.01 level (two-tailed); *, correlation is significant at the .05 level (two-tailed); PC: principal components.

Discussion

The implementation of PBL was originated at McMaster University in 1960s (Neufeld & Barrows, 1974). It's development was also related to widespread technological advances and the accelerating information growth which increased the need for the doctor to be more capable of independent and self-directed learning or reasoning (Barrows & Tamblyn, 1976; Berkson, 1993). Albanese & Mitchell (1993) define the PBL as an instructional method characterized by using patient problems as a context for students to acquire related basic and clinical knowledge, as well as to learn problem solving skills. Thus, PBL is not only about problem solving per se, but also for the purpose of increasing knowledge and understanding through this learning. The theoretical advantages of PBL, as summarized in previous literature (Albanese & Mitchell, 1993; Barrows, 1985; Coles, 1990; Schmidt et al., 1987; Vernon & Blake, 1993) are as follows: (1) The pattern of "student-centered" learning can induce active and lifelong learning attitude and skills, as well as facilitate understanding and retention of the knowledge. (2) PBL can cultivate the generic competencies of medical students for future career, such as teamwork, chairing a group, listening, recording, cooperation, respect of colleagues' views, critical evaluation of literature, self directed learning, use of resources and presentation skills. (3) PBL can facilitate the knowledge integration, the motivation of learning, and the construction of thought process. Nevertheless, in its practice problems are often encountered, such as investing money on the related resources, training and maintaining high quality and large quantity of tutors, promoting group dynamics among members, and improving the design of the problems (Colliver, 2000; Fenwick & Parsons, 1997; Jaffarey, 2001). Berkson (1993) reported that the graduate of a PBL curriculum is difficult to distinguish from his or her traditional counterpart, that PBL can be stressful for both student and faculty, and that the curriculum may be unreasonably costly. There were no substantial evidences to reveal advantages of PBL in problem-solving skills, imparting knowledge, satisfaction of students and faculty, enhancing motivation to learn or self directed learning (Neufeld et al., 1981; Newble & Entwistle, 1986). Besides, the investment of faculty development, the manpower hours, the hardware costs, and the physical space and li-

brary resources required much more in PBL than the traditional courses (Donner & Bickley, 1990; Hamad, 1985).

The paradigm shift from subject-based to problem-based learning, and from classroom unidirectional lectures to small group coordinated and cooperative learning, is not an easy one to make for tutors and students in medical schools. To implement PBL successfully depends on a lot of key factors, which can be classified as the curriculum design, writing scenarios, tutor development, evaluation method, group member characteristics and group dynamics, which included all of the goals in our present study (the PBL performance and its relationship to the personality and knowledge characteristics). About the issues curriculum design, PBL can be used either as the mainstay or as a part (hybrid mode) of the entire curriculum. In current consensus by most medical school, PBL is only part of an integrated curriculum using a systems based approach, with non-clinical material (e.g., Diabetes mellitus) delivered in the context of clinical practice (e.g., a patient with high blood sugar and related symptoms). A module based on, usually the organs or systems (circulatory or respiratory systems) rather than the traditional course system (e.g., anatomy, pathology, surgery) can be designed to include mixed teaching methods, such as the core course or critical review for basic content knowledge, PBL for cultivating reasoning, self and collaborative learning skills, and clinical skills practice on artificial models or computer simulators (General Medical Council, 1993, 2000). Writing appropriate scenarios is also very important for successful implementation of PBL. Dolmans, Wolfhagen, Scherpbier & Van der Vleuten, (2001) have described characteristics of a PBL scenarios as follows: reaching consensus about the learning objectives between the students and the faculty, problem being appropriate to the stage of the curriculum and the level of students' understanding, scenarios with sufficient intrinsic interest for the students as well as relevant to further practice, basic science being presented in the context of a clinical scenario to encourage integration of knowledge, scenarios containing open cues questions, which can stimulate discussion and encourage students to seek explanations for the presented issues, and scenarios promoting participation by the students in seeking information from various learning resources. Characteristics of the group members, such as the knowledge and personality, will also influence the outcomes of PBL implementation. Schmidt (1983) has described students with better

prior content knowledge or reasoning skills would perform better in PBL. Wilkerson (1998) also described students with better attitudes or interpersonal skills, such as actively participating in the course, or appropriate feedback would be as key factors for successful PBL implementation. Tutors also play cornerstone roles for successful implementation of PBL. Tutors were reported to be better as the guided, probed, or supporting rather than the directed or governing roles. The length of time (the number of sessions) to form good PBL group dynamics varies but usually needs long-enough time to get together. Therefore the group members in PBL would not be changed except that personality clashes or other dysfunctional behavior emerges (Wood, 2003).

Our studies modified the role play in the small group learning in previous literature (Benne & Sheats, 1948) to design a new evaluation sheet of students' PBL performance in the medical school. Although there have been a lot many literature which delineated the roles of students in PBL or other types of small group learning (Albanese & Mitchell, 1993; Benne & Sheats, 1948; Luh, 1999; Schmidt, 1983; Wood, 2003). However, there was still no related quantified studies in previous literature. In our present study, the 15-item evaluation sheet has been verified by five specialists in the field of medical education. Then we performed factor analysis about these 15 role play item to extract five first-level, and two second-level, mutually independent principal components (PCs). These PCs can be properly named according to their factors components and loadings as described in the Fig. 2, Table 3, and Table 4. In our proceeding studies, we have collected much more samples for similar analysis and noted that the previous classification and nomenclature of these PCs was consistent and reliable. Our results disclose the multidimensional factor structure of PBL performance. We think that this carefully constructed evaluation sheet is not only a tool for conducting an objective and multidimensional assessment but also a means of reminding the members in this course to regulate their roles. The other important benefit of PC analysis is the subtraction and mutually independent variables will make the subsequent comparison between their correlations with many other variables, such as personality or knowledge characteristics, simpler and more reliable. Furthermore, we found that (not described in this paper) peer evaluation provides more valuable and discriminative information about student performance than our previous literature about the tutor evaluation. Tutors, and to a lesser extent peers, in PBL curricula are

usually reluctant to give low scores to students and thus tend to give higher, less discriminative scores than is justified.

The other benefit of establishing this PBL performance evaluation is achieving feedback from self and group members. Reviewing in literature, students in the PBL can not only learn the concepts of PBL through feedback evaluation using this evaluation sheet after the course, but also learn more objective evaluation methods in this course (Barrows & Tamblyn, 1980; Berkson, 1993; Colliver, 2000).

Research has shown a linkage between personality and performance (Barrows, 1986; Hough, 1997) and between knowledge and performance of pre- and post-graduates (Cohen, 1983; Waldman & Korbar, 2004). Personality evaluation had been popularly used in many academic or business institutes for many years, because it can significantly influence one's behaviors, which are related to the professionalism of medical students in the future career (Loveland, Lounsbury, Welsh, & Buboltz, 2007; Oswald et al., 2004; Tett & Burnett, 2003). Our results described how to modify the personality (Big-Five) evaluation sheets and their correlations with the PBL performance. In this study we used the investigated sample for items selection/deletion in the same dimension. We delete only a very small number of "discordant" items to get better consistent reliability (the higher Cronbach's alpha value in the Table 1). In this study we also found that some personality characteristics, such as conscientiousness and extraversion, can influence performance. The positive correlation between the extraversion and obeying rules is puzzling, yet may be explained by the association between being sociable / assertive and the purpose of PBL, which requires having an open mind, and talking and interacting with others. Through this and our ongoing studies, we can establish and compare these databases and realize the influences of personality not only in the individual student's performance of the PBL, but also the group dynamics and their future career development. These results can provide us guidelines to help the students not only in the PBL courses but also in other aspects of their learning in the school.

There were still some study limitations in this study. Grade point average (GPA) has been widely applied as the students' knowledge indicator in previous literature (Bartels et al., 2000; Cohen, 1983). In this study we used the score point average (SPA) to replace the GPA because there were cultural differences between the Asian

and Euro-American countries. We realized the differences between the subjects, some of them emphasize the ability of reasoning and calculation (such as calculus and physics), some others emphasize the ability of memory (anatomy), and some others emphasize the ability of operation (experiment or bedside practice). However, since most of the course in the Asian country still use written test as one of the important methods to evaluate the students' performance, thus the PCs would be difficult to extract not because of the contents of the courses themselves, but the methods of evaluation. In our school, the curriculum reform has been undergoing, including the reform of evaluation method. Content knowledge would not be the only determinant to evaluate the ability of a student, but also the ability of search, integration, application and actual operation, which would be replace the former as the main criteria for evaluation. The other limitations in this study are the number and the representatives of these samples are insufficient. Now we have proceed a 3 year medical education research project supported by the National Science Council in Taiwan and has recruited this study as one of the important missions in these years. We collaborate with two other medical schools in Taiwan and investigate more medical students for the future survey. To test the α-value stability of these evaluation sheets, we have proceed a test-retest reliability evaluation since this year, and the preliminary results were satisfactory. Furthermore, in our proceeding study we also added the tutor and self evaluation to compare the reliability of the peers' evaluation.

In this study, we developed a new evaluation sheet for PBL performance. Five mutually independent and definable components can be extracted. The relationships among the personal traits, knowledge base, and PBL performance showed that conscientiousness and knowledge were positively related to "control/lead" trait, and extroversion was positively related to the trait of "obey rules". Agreeableness and conscientiousness were positively related to SPA. Knowledge base and personal traits appear to be associated with the students' performance on a hybrid-PBL curriculum. The positive correlation between the extroversion and obeying rules is puzzling, yet if might be explained in terms of the association between being sociable/assertive and the objectives of PBL spirits, which include open mindedness, and inter-personal skills. In the future, we should perform related activities. (1) Administer this survey at the beginning and end of this course (or even more than two times) to the same gro-

ups, to compare their differences at different time points and to estimate the test-retest reliability. (2) Compare results between different PBL curricula (focused on basic, clinical, or other topics). (3) Collect more samples from other students taking the same course. (4) Collect samples from other medical schools and compare their differences. (5) Develop methods to evaluate inter-group differences. Group dynamics (such as leaderless group discussion [LGD] dynamics) or demonstrations of individual abilities (such as ability to analyze cases and simulate interviews) (Wood, 2003) should be recorded for evaluation by third-party specialists. We believe that a reliable and valid method of evaluation of PBL as well as predictive models of individual performance or future career success can be developed in the future with the use of personality, knowledge, and other variables such as the tutor characteristics. Through these models, group composition can be optimized so as to lead to the most effective group dynamics.

References

Albanese, M., & Mitchell, S. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academy of Medicine, 68,* 52-81.

Barrows, H. S. (1985). *How to design a problem-based curriculum for the preclinical year.* New York: Springer.

Barrows, H. S. (1986). A taxonomy of problem-based learning methods. *Medical Education, 20,* 481-486.

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. In L. Wilkerson & W. H. Gijselaers (Eds.), *Bringing problem-based learning to higher education: Theory and practice.* San Francisco, CA: Jossey-Bass.

Barrows, H. S., & Tamblyn, R. M. (1976). An evaluation of problem-based learning in small group utilizing a simulated patient. *Journal of Medical Education, 51,* 52-54.

Barrows, H. S., & Tamblyn, R. M. (1980). *Problem-based learning: An approach to medical education.* New York: Springer.

Bartels, L. K., Bommer, W. H., & Rubin, R. S. (2000). Student performance: Assessment centers versus traditional classroom evaluation techniques. *Journal of Education for Business, 75,* 198-201.

Benne, K. D., & Sheats, P. (1948). Functional roles of group members. *Journal of Social Issues, 2,* 42-47.

Berkson, L. (1993). Problem based learning: Have the expectations been met? *Academy of Medicine, 68,* 79-88.

Cohen, P. A. (1983). College grades and adult achievement: A research synthesis. *Research in Higher Education, 20,* 281-283.

Coles, C. R. (1990). Evaluating the effects curricula have on student learning: Toward more competent theory for medical education. In Z. E. Nooman, H. G. Schmidt & E. S. Ezuss (Eds.), *Innovation in medical education: An evaluation of its present status* (pp. 76-93). New York: Springer.

Colliver, J. A. (2000). Effectiveness of problem-based learning curricula: Research

and theory. *Academy of Medicine, 75,* 259-266.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297-334.

Davis, M. H., & Harden, R. M. (2003). Planning and implementing an undergraduate medical curriculum: The lessons learned. *Medical Teacher, 25,* 596-608.

Dolmans, D. H. J. M., Wolfhagen, I. H. A. P., Scherpbier, A. J. J. A., & Van der Vleuten, C. P. M. (2001). Relationship of tutors' group dynamics skills to their performance ratings in problem based learning. *Academic Medicine, 76,* 473-476.

Donner, R. S., & Bickley, H. (1990). Problem-based learning: An assessment of its feasibility and cost. *Human Pathology, 21,* 881-885.

Fenwick, T. J., & Parsons, J. (1997). *A critical investigation of the problems with problem-based learning* (Research Report No.143). US Department of Education (ERIC Document Reproduction Service No. ED 409 272).

General Medical Council (1993). *Tomorrow's doctors: Recommendations on undergraduate medical education.* London: The Author.

General Medical Council (2000). *Report on visit to Dundee Medical School.* London: The Author.

Guion, R. (1978). "Content validity" in moderation. *Personnel Psychology, 31,* 205-214.

Hamad, B. (1985). Problem-based education in Gezira, Sudan. *Medical Education, 19,* 57-363.

Harden, R. M. (1986). Approaches to curriculum planning. *Medical Education, 20,* 458-466.

Harden, R. M., & Davis, M. H. (1995). The continuum of problem-based learning. *Medical Teacher, 17,* 125-148.

Hogan, R., Johnson, J., & Briggs, S. (1999). *Handbook of personality psychology.* New York: Academic Press.

Hough, L. M. (1997). The millennium for personality psychology: New horizons or good old daze. *Applied Psychology: An International Review, 47,* 233-261.

Howard, P. J., & Howard, J. M. (2005). *The Big-Five Quickstart: An introduction to the five factor model of personality.* Retrieved from http://www.centacs.com/

quickstart.htm

Jaffarey, N. A. (2001). Problem-based learning. *Journal Pakiston Medical Association, 51,* 266-267.

Johnson, D. W., & Johnson, F. P. (2003). *Jointing together: Group theory and group skills.* Boston, MA: Allyn & Bacon.

Kalaian, H. A., & Mullan, P. B. (1996). Exploratory factor analysis of students' ratings of a problem-based learning curriculum. *Academy of Medicine, 71,* 390-392.

Kao, M. Y., Lee, Y. J., & Lue, B. H. (1997). Assessment of the group learning factor scale used in small-group tutorial mode. *Journal of Medical Education, 1,* 397-410 (in Chinese).

Loveland, J. M., Lounsbury, J. W., Welsh, D., & Buboltz, W. C. (2007). The validity of physical aggression in predicting adolescent academic performance. *British Journal of Educational Psychology, 77*(Pt 1), 167-176.

Luh, S. P. (1999). The creation of small group teaching and the roles of its members. *Journal of Medical Education, 3,* 416-418 (in Chinese).

Mayes, B. T., Belloli, C. A., Riggio, R. E., Aguirre, M., et al. (1997). Assessment centers for course evaluations: A demonstration. *Journal of Social Behavior and Personality, 12,* 303-320.

Neufeld, V. R., & Barrows, H. S. (1974). The "McMaster Philosophy": An approach to medical education. *Medical Education, 49,* 1040-1050.

Neufeld, V. R., Norman, G. R., Feightner, J. W., Barrows, H. S., et al. (1981). Clinical problem solving by medical students. A cross-sectional and longitudinal analysis. *Medical Education, 15,* 315-322.

Neufield, V. R., Woodward, C. A., & MacLeod, S. M. (1989). The McMaster MD program: A case study of renewal in medical education. *Academy of Medicine, 64,* 423-432.

Newble, D. I., & Entwistle, N. J. (1986). Learning styles and approaches: Implications for medical education. *Medical Education, 20,* 162-175.

Norman, G. R., & Schmidt, H. G. (1992). The physiological basis of problem-based learning: A review of the evidence. *Academy of Medicine, 67,* 557-565.

Oswald, F. L., Schmitt, N., Kim, B. H., Ramsay, L. J., Gillespie, M. A., et al. (2004).

Developing a biodata measure and situational judgment inventory as predictors of college student performance. *Journal of Apply Psychology, 89*(2), 187-207.

Rynes, S. L., Trank, C. Q., Lawson, A. M., & Ilies, R. (2003). Behavioral coursework in business education: Growing evidence at a legitimacy crisis. *Academy of Management Learning & Education, 2*, 269-283.

Savery, J. R., & Duffy, T. M. (1995). Problem-based learning: An instructional model and its constructivist framework. *Educational Technique, 35*, 31-35.

Schmidt, H. G. (1983). Problem-based learning: Rationale and description. *Medical Education, 17*, 11-16.

Schmidt, H. G., Dauphinee, W. D., & Patel, V. L. (1987). Comparing the effects of problem-based and conventional curricula in an international sample. *Medical Education, 62*, 305-315.

Smith, C. M. (1997). Using student feedback on examination questions to promote fairness, item validity and learning. *Journal of Clinical Pharmacology, 37*, 379-387.

Tett, R. P., & Burnett, D. D. (2003). A personality trait-based interactionist model of job performance. *Journal of Apply Psychology, 88*(3), 500-517.

Vernon, D. T. A., & Blake, R. L. (1993). Does problem-based learning work? A meta-analysis of evaluative research. *Academy of Medicine, 68*, 550-663.

Waldman, D. A., & Korbar, T. (2004). Student assessment center performance in the prediction of early career success. *Academy of Management Learning and Education, 3*, 151-167.

Wilkerson, L. (1998). Tutors and small groups in problem-based learning: Lessons from the curricula. *Annals of Internal Medicine, 129*, 734-797.

Williams, P. B., Lathers, C. M., Smith, C. M., Payer, A., Volle, R. L., et al. (2001). Evaluation of student achievement and educational outcomes. *Journal of Clinical Pharmacology, 41*, 1259-1270.

Wood, D. F. (2003). ABC of learning and teaching in medicine: Problem based learning. *British Medical Journal, 326*, 328-330.