Effects of personality traits on collaborative performance in problem-based learning tutorials

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ABSTRACT

الأهداف: دراسة العلاقة بين الأداء التعاوني للطلاب في بيئة التعلم المتمركز حول المشكلة وسماتهم الشخصية.

الطريقة: أجريت هذه الدراسة الاستعادية المقطعية باستخدام بيانات طلاب برنامج PBL خلال الفترة من 2013م إلى 2014م في جامعة سونغ كنكوان، كلية الطب، كوريا الجنوبية. اشتملت هذه الدراسة على 80 طالب. استخدمت بيانات الطلاب من اختبار المزاج والشخصية لقياس سماتهم الشخصية ودرجات تقييم أقرانهم خلال PBL لقياس التعاون للطلاب.

النتائج: أشار تحليل الانحدار البسيط أن المشاركة ارتبطت بشكل سلبي مع تجنب الأذى وإيجابي للثبات، في حين ارتبط الاستعداد لعمل مجموعة بشكل سلبي على مكافأة الاعتماد. وفي تحليل الانحدار المتعدد، ويعد انخفاض الاعتماد على المكافئة من مؤشرات القوية من الاستعداد. ارتبط GPA بشكل سلبي مع السعي الجاد والتعاون وايجابي مع الاستمرارية.

الخاتمة: تشير النتائج التي توصلنا إليها أن طلاب الطب الذين هم أقل اعتماد على المكافأة الاجتماعية أكثر قابلية لاستكمال العمل المستقل للتحضير لدروس PBL. يمكن أن تساعد نتائج هذه الدراسة على فهم ودعم طلاب الطب بشكل أفضل والذين يعانون من بيئة التعلم التعاوني.

Objectives: To examine the relationship between students' collaborative performance in a problem-based learning (PBL) environment and their personality traits.

Methods: This retrospective, cross-sectional study was conducted using student data of a PBL program between 2013 and 2014 at Sungkyunkwan University School of Medicine, Seoul, South Korea. Eighty students were included in the study. Student data from the Temperament and Character Inventory were used as a measure of their personality traits. Peer evaluation scores during PBL were used as a measure of students' collaborative performance.

Results: Simple regression analyses indicated that participation was negatively related to harm avoidance and positively related to persistence, whereas preparedness for the group work was negatively related to reward dependence. On multiple regression analyses, low reward dependence remained a significant predictor of preparedness. Grade-point average (GPA) was negatively associated with novelty seeking and cooperativeness and was positively associated with persistence.

Conclusion: Medical students who are less dependent on social reward are more likely to complete assigned independent work to prepare for the PBL tutorials. The findings of this study can help educators better understand and support medical students who are at risk of struggling in collaborative learning environments.

Collaborative competency is an important outcome for medical school graduates.[1,2] As today's health care environment involves interdisciplinary health care teams, effective teamwork skills are essential for all health care professionals. Nevertheless, trainee interns can struggle when working collaboratively and can frequently make medical errors owing to problems in communication and coordination with the health care team.[3,4] To prepare for a team-based work environment, medical students need to develop and refine collaborative and communication skills.

Many medical schools have adopted problem-based learning (PBL), in which students are engaged in collaborative learning processes. Working in small groups, students build a common knowledge base by completing group discussions and assignments during PBL.[5,6] The productivity of PBL groups depends on individual students' cognitive skills and the collaborative and interpersonal functioning of student groups.[7,8] Students need to actively participate in group discussions, demonstrate effective communication, and make a significant contribution to group work to achieve successful learning during PBL tutorials. Although one of the goals of PBL is to foster students' collaboration skills,[6] PBL studies have focused mostly on aspects related to cognitive skills. Little attention has been paid to the development of collaborative learning skills.

Student personalities can play a substantial role in developing collaborative competence. Personality characteristics have been recognized as significant correlates of academic performance in medical school. For example, medical students who tend to be conscientious achieve higher tests scores during their preclinical years.[9] Personality attributes have also been associated with medical students' academic competencies other than test scores.[10,11] For example, loneliness or social isolation has been negatively correlated with medical students' clinical competence, in particular their interpersonal relations and attitudes, during clerkships.[12] Students' communication skills have correlated with personality characteristics of being extraverted and critical.[13] These studies imply that personality attributes predict medical students' interpersonal skills, a component of collaborative competency.

Cloninger et al[14] proposed a theory of personality, including 4 dimensions of temperament and 3 dimensions of character. Unlike the 5-factor model, which is an empirically based model of personality, the theory of temperament and character was developed based on the underlying biological and psychological determinants of individual differences. The 4 dimensions of temperament include novelty seeking, harm avoidance, reward dependence, and persistence; the 3 character dimensions comprise self-directedness, cooperativeness, and self-transcendence.[14] Temperament is assumed to

involve inherited neurological dispositions to emotions and their related automatic behavior reactions; character is hypothesized to involve individual differences in self-concepts about goals and values and mature with age. Among the 7 dimensions of personality, high persistence and low novelty seeking have been reported to correlate with medical students' academic achievement.[15,16] Little is known of the effects of temperament and character on students' collaboration skills.

The primary purpose of the study was to examine the association between medical students' collaborative performance during PBL tutorials and their personality. Also, the study assessed whether medical students with personality traits supportive of collaboration skills would demonstrate superior academic achievement. Thus, the study examined the temperament and character dimensions that correlated with academic achievement (namely, grade point average) and compared them with the personality dimensions related to students' collaborative performance during PBL tutorials. Understanding the relationships between student personality traits and collaborative performance will enable instructors to better understand students who are likely to lack collaboration skills and offer appropriate guidance for these students when working in PBL groups.

Methods. This retrospective, cross-sectional study was conducted using student data generated during a PBL program in 2013 and 2014 at Sungkyunkwan University School of Medicine in South Korea. At Sungkyunkwan University School of Medicine, second-year students engaged in a year long program of PBL, which comprised 11 units. Each PBL unit lasted for 3 weeks on average; students as a group held 2 tutorials per week to discuss a clinical case. Each group consisted of 6-8 students; they remained together over the course of 2 units (approximately 6 weeks). After every 2 units, new groups with different students were formed. In contrast, the tutor for each group was altered in every unit. In accordance with the principles of Helsinki Declaration, the research protocol of this study was reviewed and approved by an Institutional Review Board.

Inclusion criteria for study participants were limited to second-year medical students enrolled at Sungkyunkwan University School of Medicine in South Korea in 2013 and 2014. A total of 80 students met the criteria, which included 39 students from 2013 and 41 students from 2014. Half of the participants (n=40) were graduate entry-level students with Bachelor's

degrees in Life Sciences or related fields. The majority (n=59) were male. The mean ± standard deviation age of participants was 22.85 ± 2.04 years.

Sources of data. Student data from a Korean version of the Temperament and Character Inventory-Revised Short (TCI-RS) was used as a measure of their personality traits.[17] Students completed the instrument during a week-long introductory PBL course at the beginning of the second year, which was part of the course activities to help them better understand themselves before engaging in a collaborative learning environment (PBL). The survey instrument measures 4 dimensions of temperament (novelty seeking, harm avoidance, reward dependence, and persistence) and 3 dimensions of character (self-directedness, cooperativeness, and self-transcendence).[14] According to the theory, novelty seeking refers to a tendency towards exhilaration in response to novel stimuli or cues, and harm avoidance relates to inhibition of behaviors in response to signals of punishment or non-reward. Reward dependence involves maintaining or pursuing behaviors previously associated with reinforcement, and persistence refers to perseverance in behavior despite frustration and fatigue. Self-directedness reflects an ability to regulate behavior in line with personal goals; cooperativeness involves identification with and acceptance of others; and self-transcendence is related to spiritual maturity and self-forgetfulness.

The entire instrument comprises a total of 140 items. Each item was answered on a 5-point Likert scale ranging from absolutely false (0) to absolutely true (4). The validity and reliability of the Korean version of the TCI-RS has been proven to be satisfactory in previous research.[18] This study also found high scale reliability with a Cronbach's alpha ranging from 0.82 to 0.89.

Table 1 summarizes the number of items in each subscale and validity was calculated using Cronbach's

Table 1 - Internal consistency of Temperament and Character Inventory-Revised Short.

Scales	Item n	Cronbach's alpha
Novelty seeking	20	0.82
Harm avoidance	21	0.89
Reward dependence	20	0.82
Persistence	20	0.86
Self-directedness	20	0.89
Cooperativeness	22	0.87
Self-transcendence	17	0.88

alphas. T-scores of each personality dimension in the analyses were used.

We used peer evaluation scores to assess students' collaborative performance during PBL tutorials. It is believed that peer evaluation is an appropriate method for assessing areas of student performance, such as communication skills, that are not readily measured by traditional forms of assessment.[19] Although tutors often find it difficult to judge the contribution of an individual student to the group product, peers evaluation scores, on the other hand, could make better evaluative judgments owing to their multiple observations of peer performance.[20] In addition, past studies[21,22] has reported that university students were capable of evaluating their peers in a reliable and valid way.

Peer evaluation in our PBL program assessed 4 aspects of collaborative learning behaviors: 1) participation in group discussions, 2) preparedness for the group work by completing independent study assigned to individual students, 3) effective communication during the group work, and 4) contribution to the productive tutorials and a shared knowledge base. At the end of each PBL unit, students rated every group member on a 4-point Likert scale regarding these 4 aspects of collaborative learning behaviors. Peer evaluation scores of individual students were obtained by averaging the scores as rated by the group members. Students received 4 mean scores in each unit corresponding to their performance on the 4 aspects of collaborative learning. We used a sum score across the 11 units in the analyses for each collaborative performance criterion, with potential scores ranging from 11-44.

Finally, grade-point average (GPA) scores at the end of the second year of medical school were obtained as a measure of overall academic achievement of the students.

Statistical analyses. In order to identify TCI dimensions associated with students' collaborative performance and academic achievement, simple regression analyses were performed. Then, we conducted hierarchical multiple regression analyses to examine how personality dimensions separately predicted each of the 4 collaboration outcomes and academic achievement (GPA). With the possibility of any influence of demographic variables (gender and educational background) on the outcome variables, the 2 demographic variables were entered in the first step of each multiple regression analysis. We used the Statistical Package for Social Sciences version 22 for Windows (Armonk, NY: IBM Corp) for all statistical analyses. All significance was tested at the 95% confidence level.

Results. Table 2 summarizes descriptive statistics of the study variables. Female students demonstrated a tendency to have lower traits of novelty seeking and reward dependence and higher traits of harm avoidance, and persistence as compared to male students. Also, female students showed a tendency of higher self-transcendence than male students. Undergraduate entry-level students showed a significantly higher trait of novelty seeking ($p<0.05$) and a tendency of lower persistence, self-directedness, cooperativeness, and self-transcendence as compared to graduate entry-level students.

Correlates of collaborative outcomes. No significant differences were found in the collaboration outcomes between female and male students. Also, undergraduate entry-level students showed a similar level of collaborative performance to that of graduate entry-level students. On the simple regression analyses, participation scores negatively correlated with harm avoidance (r=-0.25, $p=0.024$) and positively with persistence (r=0.28, $p=0.011$). Preparedness had a significant negative relationship with reward dependence (r=-0.34, $p=0.002$). Students who tended to be reward dependent were less likely to complete the assigned independent work. Neither communication nor contribution scores were significantly related to any of the personality traits. Table 3 summarizes the regression analyses. In the multiple regression analysis predicting participation, none of the personality variables were

found to be significant after accounting for gender and educational background, although persistence showed a trend of approaching significance (β=0.27, $p=0.060$). In the regression analysis predicting preparedness, reward dependence was the only significant individual predictor (β=-0.29, $p=0.022$). We did not find any personality traits that significantly predicted either communication or contribution.

Correlates of GPA. Female students achieved a significantly higher GPA than male students ($p=0.020$). Undergraduate entry-level students showed a slightly higher GPA than graduate entry-level students, but the difference was not statistically significant ($p=0.273$). Bivariate correlation analyses indicated that GPA was negatively related to the traits of novelty seeking (r=-0.26, $p=0.019$) and reward dependence (r=-0.23, $p=0.040$). In the multiple regression analysis, GPA was significantly predicted by temperament and character dimensions of novelty seeking (β=-0.31, $p=0.029$), persistence (β=0.27, $p=0.041$), and cooperativeness (β=-0.23, $p=0.047$). Students with high persistence, low novelty seeking, and cooperativeness were more likely to achieve a high GPA.

Discussion. Collaborative learning is a crucial element of PBL. The success of PBL depends on how well individual students work together toward common goals and build a shared understanding of knowledge. However, there is a lack of research on critical factors

Table 2 - Descriptive statistics of study variables of 80 students' data generated during a problem-based learning program between 2013 and 2014 at Sungkyunkwan University School of Medicine, Sungkyunkwan, South Korea.

Descriptive statistics	Male (n=59)		Female (n=21)		Undergraduate (n=40)		Graduate (n=40)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Temperament and Character Inventory								
Novelty seeking	45.75	30.74	33.38	25.98	50.04	31.38	34.96	26.67
Harm avoidance	45.06	29.48	55.13	21.00	46.16	28.97	49.25	26.74
Reward dependence	40.25	29.02	34.96	25.73	39.15	28.34	38.58	28.27
Persistence	47.53	31.37	53.17	29.47	45.02	31.08	53.01	30.38
Self-directedness	58.09	26.69	58.96	27.19	54.03	26.67	62.61	26.66
Cooperativeness	51.58	30.81	51.63	32.77	47.08	29.59	56.11	32.32
Self-transcendence	34.68	27.67	40.97	28.64	34.70	26.64	37.96	29.32
Collaborative performance								
Participation	36.52	2.57	36.51	2.72	36.50	2.76	36.53	2.45
Preparedness	36.66	2.47	37.57	2.03	36.40	2.55	37.40	2.14
Communication	35.71	2.17	35.42	3.11	35.66	2.09	35.62	2.75
Contribution	36.31	2.07	36.61	2.72	36.35	2.41	36.43	2.09
Grade-point average	3.32	0.56	3.66	0.57	3.48	0.56	3.34	0.59

Table 3 - Simple and multiple regression analyses for predicting 4 dimensions of collaborative performance (n=80).

Variables	Participation		Preparedness		Communication		Contribution		Grade-point average	
	Simple	Multiple	Simple	Multiple	Simple	Multiple	Simple	Multiple	Simple	Multiple
Gender (male=1, female=2)	0.000	-0.021	0.170	0.047	-0.053	-0.035	0.058	0.021	0.261*	0.183
Educational background (U=1, G=2)	0.007	-0.051	0.211	0.131	-0.008	-0.020	0.019	-0.021	-0.124	-0.297**
Temperament dimensions										
Novelty seeking	-0.023	-0.200	-0.208	-0.123	0.000	0.029	-0.071	-0.062	-0.261*	-0.308*
Harm avoidance	-0.252	-0.217	0.162	0.118	-0.064	0.028	0.044	0.021	0.115	0.245
Reward dependence	0.009	-0.031	-0.345**	-0.294*	0.123	0.074	-0.109	-0.104	-0.230*	-0.067
Persistence	0.282*	0.276	0.082	0.161	-0.017	-0.086	-0.008	-0.023	0.132	0.276*
Character dimensions										
Self-directedness	0.201	-0.064	0.005	0.052	0.113	0.134	0.016	0.070	0.126	0.220
Cooperativeness	-0.006	-0.039	-0.067	-0.068	0.150	0.113	0.029	-0.012	-0.204	-0.232*
Self-transcendence	0.039	0.056	0.131	0.174	0.002	-0.019	0.154	0.191	-0.018	0.103
R^2		0.127		0.222		0.043		0.048		0.318

The data presented are bivariate correlation coefficients for simple regression analysis and standard regression coefficients for multiple regression analysis, *$p<0.05$, **$p<0.01$, U - undergraduate, G - graduate

that contribute to successful collaborative learning. Past research has focused on group-level factors such as the sociocognitive processes of group interaction (for example, interdependence) that lead to better collaborative learning outcomes.[23,24] Not much is known about the effects of individual characteristics, such as personality, on collaborative learning. This study examined how personality characteristics are related to medical students' collaborative performance during PBL tutorials. We also focused on how these relationships differ from the relationship patterns between personality and academic achievement (namely, GPA).

In this study, 4 elements of collaborative learning in PBL were examined: participation in group discussions, preparedness for the group work, communication, and contribution to the group work. Both the correlation and regression analyses indicated that participation in group discussions was positively related to a temperament dimension of persistence. That is, students who tended to persevere in a challenging learning context were more likely to actively participate in group discussions. Students with high persistence are often ambitious.[25] Thus, they could be proactive in participating in learning activities. At the same time, the findings suggest that active participation in group discussions may require extra effort from students. Asian students' reticence in discussions during PBL tutorials has been noted and suggested to be due to cultural attributes.[26] Asian culture generally values collectivism and discourages

individual self-expression.[27] Also, Asian culture values public image; being outspoken runs the risk of making mistakes that can damage public image.[27] Reflecting this cultural behavior, Korean students in this study could have been reluctant to speak out during group discussion; nevertheless, those with strong persistence temperament may have endeavored to lead and actively participate in discussions.

Preparedness for the group work was significantly predicted by reward dependence after controlling for gender and educational background. Students with low reward dependence were more likely to complete the independent work assigned to them in PBL. Previous studies[15,16] have rarely reported a relationship between reward dependence and academic performance. According to the theory, individuals with low tendency of reward dependence are those who maintain behaviors independent of social reward. These individuals are often described as practical, cold, and socially insensitive.[14] Our results suggest that students who are tough-minded and less dependent on social reward are more likely to comply with assigned independent work in a collaborative PBL environment.

In medical school, students are required to acquire a vast amount of knowledge in a limited time. Consequently, medical students are expected to devote much of their time to study. However, students with a disposition to seek social support and approval are likely to spend more time in social activities and commit less time to independent work than those less attached to social relationships. Providing the unique circumstance

of medical school, a temperament of social detachment may be advantageous for dedicating a greater amount of time in preparing for collaborative learning by completing independent study.

It was expected that collaborative learning would correlate with cooperativeness. However, there was no association between cooperativeness and the 4 elements of collaborative learning. Highly cooperative people are generally described as empathetic, compassionate, and supportive individuals who like to serve others and try to cooperate with others as much as possible.[28] These individuals are expected to be capable of mixing and working together with others. Nevertheless, our findings suggest that being considerate and friendly are not related to learning behaviors in a collaborative environment.

Our findings further indicate that the personality traits associated with collaborative performance are not necessarily related to the academic achievement of students. Consistent with the results of previous studies,[15] GPA was negatively associated with the temperament and character variables of novelty seeking and cooperativeness and was positively associated with persistence after accounting for gender and educational background. However, the personality traits associated with collaborative learning, such as harm avoidance and reward dependence, did not correlate with GPA in our analysis. These findings suggest that students who possess personality characteristics conducive to academic achievement may not necessarily perform well in a collaborative PBL environment. Distinct personality dimensions seem to contribute to collaborative performance and overall academic achievement.

There are a few notable limitations in the study. First, the study included a small number of participants who were representative of students at a single institute. As a result, the study findings may not be generalizable unless the current methodology is repeated in future research with a larger sample. In addition, although a regression analysis was carried out to understand the relationships between personality and academic performance, qualitative data would have been helpful for further understanding of the underlying mechanisms of the reported relationships. Also, the way collaborative performance was measured in the study (namely, peer evaluation) may be subject to peer bias because students interacted with their group members outside of the PBL environment. However, we believe that such bias was minimal as PBL groups were changed after completing every 2 units, and students were specifically instructed to evaluate their peers based on peer performance during PBL tutorials. Finally, it

should be noted that the current study was conducted in a hybrid type of PBL environment in which students were required to prepare for lecture classes. Students may demonstrate different collaborative behaviors in a pure PBL environment as they would focus on and devote most of their time for the PBL activities.

Despite these limitations, our study is meaningful in that it explores individual characteristics favorable to collaborative learning and provides an empirical base for understanding the associations between personality traits and students' collaborative performance in a medical school setting. It is particularly worthwhile to note that personality dimensions associated with collaborative performance are not the same dimensions that are related to students' overall academic achievement, or GPA. Many students are still accustomed to teacher-centered, lecture-style classes, they may have had difficulty in adapting to a new way of learning (PBL) that requires effective collaboration and communication with peer students regardless of their level of academic achievement. The findings of this study can help educators better understand medical students who may be at risk of struggling in collaborative learning environments and provide them with appropriate guidance. Future research is warranted to examine whether similar patterns are observed with different participants and to explain how personality factors support or prevent effective collaborative learning in PBL environments.

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