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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA

Do students' styles of learning affect how they adapt to learning methods and to the learning environment?

Öğrencilerin öğrenme stilleri, öğrenme yöntemleri ve öğrenme ortamlarına uyum sağlamalarını etkiler mi?

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ABSTRACT

Objectives: The process of development and evaluation of undergraduate medical education programs should include analysis of learners' characteristics, needs, and perceptions about learning methods. This study aims to evaluate medical students' perceptions about problem-based learning methods and to compare these results with their individual learning styles.

Materials and Methods: The survey was conducted at Marmara University Medical School where problem-based learning was implemented in the curriculum for the first three years of the medical education. An evaluative questionnaire about a student-centered learning environment and an "Inventory of Learning Styles" were completed by the students. One-way ANOVA and Kruskal Wallis tests were used for statistical analyses of the study.

Results: It was found that personally interested students who need external regulation strategies and who were prone to learn by stepwise processing were less satisfied with problem-based learning and other active learning methods than students who were less dependent on these learning styles. Thus, the former students did not benefit much from the organization, content, acquired knowledge and skills of problem-based learning.

Conclusion: It is important for the students to develop their self-regulated learning skills so that they can benefit from problem-based learning and student–centered learning activities. Curriculum development and program evaluation studies should consider improving the students' development of self-regulation and professional skills.

Keywords: Medical education, Problem-based learning, Learning styles, Curriculum development

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ÖZET

Amaç: Program geliştirme ve değerlendirme süreci öğrencilerin öğrenme stillerini, gereksinimlerini ve algılarının analizlerini içermelidir. Bu çalışmanın amacı, probleme dayalı öğrenme yöntemleri ve ortamı ile ilgili öğrencilerin değerlendirmelerini öğrenmek ve elde edilen sonuçları kendi öğrenme stilleriyle karşılaştırmaktır.

Gereç ve Yöntem: Bu araştırma, mezuniyet öncesi eğitimin ilk üç yılında probleme dayalı öğrenim yönteminin uygulandığı Marmara Üniversitesi Tıp Fakültesinde yapıldı. Öğrencilere, öğrenci merkezli öğrenim ortamı ile ilgili bir değerlendirme anketi ve Öğrenme Biçimleri Ölçeği (Inventory of Learning Styles) uygulandı. İstatistik analizlerler için One-way ANOVA ve Kruskal-Wallis testleri kullanıldı.

Bulgular: Bireysel ilgi yönelimli, öğrenme stratejilerinin dışarıdan düzenlenmesine ihtiyaç duyan, bilgiyi adım adım işleyerek öğrenmeye daha çok ve orta düzeyde eğilimli olan öğrenciler, bu öğrenme stillerine, daha az bağımlı öğrencilere göre probleme dayalı öğrenme ve diğer öğrenci merkezli yöntemlerden daha az memnun kaldılar. Dolayısıyla, bu öğrenciler aynı zamanda probleme dayalı öğrenim sisteminin organizasyonundan, içeriğinden, kazandırdığı bilgi ve becerilerden de daha az yararlanmaktaydılar.

Sonuç: Öğrencilerin probleme dayalı öğrenim ve diğer öğrenci merkezli öğrenim aktivitelerinden daha fazla yararlanabilmeleri için kendi kendine öğrenmeyi düzenleme becerilerinin gelişmesi önemlidir. Aktif öğrenme stratejilerine uygun müfredat geliştirme ve program değerlendirme çalışmaları, öğrencilerin, kendi kendine düzenleme ve profesyonel beceri gelişimini dikkate almalıdır.

Anahtar kelimeler: Tıp eğitimi, Probleme dayalı öğrenme, Öğrenme stilleri, Program değerlendirme

Introduction

A curriculum on problem-based learning (PBL) was first used in medical education at McMaster University in Canada 40 years ago [1]. Through the widely accepted Edinburgh Declaration (1988), the World Federation for Medical Education recommended that medical schools must arrange their curriculum according to the needs of the community, combining basic sciences with clinical practice so as to

bring the competencies of the students to the forefront and establish an educational environment where learners were actively involved [2]. Many medical schools around the world have since then partly or fully adopted this innovative learning method in their curriculum [3]. Although, the number of medical schools that are implementing hybrid education by adding student-centered PBL sessions in their programs is increasing, many medical schools and faculty are resistant to this change. The Turkish Medical Association recently published an Undergraduate Medical Education Report and found that 31 medical schools have implemented a hybrid educational model (66%), 12 have implemented a traditional and teacher-centered model (25.5%) and only 4 have implemented a student-centered model (8.5%) [4]. Marmara University, School of Medicine have been using student-centered PBL methods since 1999.

Through PBL, students learn by analyzing and solving representative problems. The basic characteristic features of PBL have been described by Barrows: learning needs to be student-centered and has to occur in small student groups under the guidance of a tutor as a facilitator [1]. The problems encountered in the learning sequence are used as a tool to achieve the required knowledge and the problem-solving skills necessary to eventually solve problems. New information needs to be acquired through self-directed learning [5]. In summary, acquisition of essential knowledge, use of knowledge in clinical contexts and self-directed learning are the objectives of PBL. Students learn efficient problem solving, independent learning, and learn to monitor themselves as well as by teamwork [6].

Our objective was to obtain students opinions on the basic variables of the student-centered PBL environment that we have championed for 10 years. In addition, we have applied the "Inventory of Learning Styles" (ILS) [7] to understand how students go about their studies and how they perceive their own learning. This inventory consists of a list of statements on study strategies, motives and attitudes and aims to measure components of student learning, such as cognitive processing strategies, meta-cognitive regulation strategies, and conceptions of learning and learning orientations [7-9]. Measuring learning styles has provided some valuable insights into learning in academic settings, and there is a general acceptance that the manner in which individuals approach a learning situation has an impact on performance and achievement of learning outcomes [10].

Materials and Methods

Aims of the study and research questions

This study aims to evaluate the undergraduate medical school program through students' perceptions regarding teaching and learning methods, learning environments, also to reveal the relationships between student-centered teaching and learning activities and students' activities. The research questions of this study are as follows: 1. To what extent are the students satisfied with the student-centered PBL method? 2. How do students perceive basic variables of PBL and other student-centered learning activities? 3. What correlations do students see between student-centered teaching strategies and learning styles?

Context and participants

PBL modules are implemented at a preclinical stage in the first three years at Marmara University, School of Medicine. Each module consists of two or three sessions, usually lasts for two weeks, and ends with an assessment of the tutor and an exam. PBL sessions are placed at the central focus of the modules; other learning activities, such as laboratory skills, clinical skills and complementary presentations, are structured around the scenarios of the PBL sessions. Communication skills and professional values and ethics are also a part of the modules.

Training in laboratory skills allows students to learn by working on real or simulated materials in multidisciplinary basic science laboratories. Training in laboratory skills continues on different topics in parallel with the contents of the modules for three years. The purpose of this training is to contribute to students' understanding of evidence-based medicine.

Marmara Medical School adopted a competency-based approach to the early introduction of clinical skills to medical students. The basic attributes that a medical student should possess at the time of graduation have been expressed by the National Core Medical Curriculum (NCMC) in Turkey since 2001 [11]. Marmara Medical School uses the content of NCMC on clinical skills training.

The curriculum includes the development of communication skills to interact with patients and health professionals. Learning activities, such as role-play and psychodrama techniques, are used for this purpose.

Instruments for evaluation of the program

In the first phase, an evaluative questionnaire related to the student-centered learning environment and teaching and learning methods was given to the first, second and third year students (n= 177) of Marmara Medical School at the end of the 2009 academic year. Then, at the beginning of 2010 academic year a Turkish version of ILS was given to the same group which were, then the second, third and fourth year students (n=149) [12].

Questionnaire for program evaluation: The first part of the questionnaire for program evaluation consisted of questions about students' satisfaction levels with the student-centered program and the contributions of PBL to their individual learning and development. In the second part of the questionnaire, there were questions about student-centered learning activities, such as an introduction to clinical skills, complementary presentations, basic laboratory skills, clinical practice and communication skills. Participants rated their perceptions on a 3-point Likert scale that ranged from disagree to agree. The points on the scale were evaluated as 1 to 3 (1 = minimum, 3 = maximum).

*Inventory of learning style (ILS):*Students' learning styles were determined by applying Vermunt's Inventory of Learning Style at the beginning of 2010 to the same group of students that responded to the program evaluation questionnaire at the end of the previous year [7]. ILS consisted of a total of 100 items in 4 sub categories. These items were the following: processing strategies [D11-deep (10 items), D12-stepwise (10 items), D13-concrete (5 items)], regulation strategies [D21-self-regulation (10 items), D22-external-regulations (10 items), D23-lack of regulation (5 items)], learning orientations [D31-personally interested (5 items), D32-certificate directed (5 items), D33-self-test directed (5 items), D34-vocation directed (5 items), D35-ambivalent (5 items)] and mental models of learning [D41-construction of knowledge (5 items), D42-intake of knowledge (5 items), D43-use of knowledge (5 items), D44-stimulating education (5 items), D45-co-operation (5 items) [12]. The Turkish version of ILS adapted by Kalaca was used in the study [12]. In the Kalaca study; a learning style scale for Turkish medical students was modeled on the ILS in Marmara University Medical School [7]. Their results show that the Turkish version of ILS possesses reasonable internal consistency.

Ethical requirement: Marmara University School of Medicine Ethics Committee approval was obtained for this study. All students were informed about the aims of the study and it was explicitly stated that not participating in the study would not affect the position of the students.

Data Analyses

A one-way ANOVA was used to assess the difference between the average scores of student evaluations on the student-centered program. The point interval coefficient was calculated as 0.67 by using the formula [(number of options - 1) / Number of options] to convert coded variables (1 = minimum, 2 = moderate, 3 = maximum) to continuous variables. In this way, these variables were recoded as follows: (1.00 – 1.67) = minimum, (1.68 – 2.35) = moderate and (2.36 – 3.00) = maximum. A Kruskal Wallis test was used once more to evaluate the differences between students' evaluations on the student-centered program and the scores of the learning style subscale.

Results

Students' perceptions on the basic variables of student-centered PBL

A total of 177 students participated in the first phase of the study (first year: 74, second year: 49 and third year: 54); the participation rate was more than 95 percent. The results of the study indicated that students are moderately satisfied with the student-centered PBL program; there were no statistically significant differences between each year. Students stated that PBL considerably improved interpersonal relationships and their ability to explain and transfer knowledge. Students generally believed that PBL improved their practical skills and helped them to 'feel like a doctor'. Scores for this last item were low for second year students when compared with the first and third year students, and the difference is statistically significant ($p < 0.01$, Table I).

The average scores of students concerning the efficacy of complementary conferences given by lecturers with the objective of providing more information on the issues that students had difficulty in understanding were found near the lower limit in all categories (Table II).

The difference between students' average scores about these didactic complementary conferences and other student-centered learning activities were statistically significant ($p < 0.01$, Table III).

The average scores for other complementary educational activities, which were not didactic, were found at moderate levels. The highest average scores were obtained for content adequacy of clinical skills training. The average scores for the overall evaluation of first-year students were higher than for students of the other two years. The average scores for overall evaluation decreased as education years progressed (Table III).

Students' learning styles

In the second phase of the study, the Turkish version of ILS was used to measure the learning styles of the students who had passed to the second, third and fourth years at the start of 2010 academic year [12]. A total of 149 students

Table I. Students' average scores for the student-centered PBL program and the contributions of PBL to their learning and personal development

Topics	1st year students' average score*± SD	2nd year students' average score*± SD	3rd year students' average score*± SD	Total average score * ± SD	F	P
Are you satisfied with the student-centered PBL program?	2.20 ± 0.8	2.09 ± 0.6	1.91 ± 0.7	2.08 ± 0.7	2.740	0.067
Are you satisfied with PBL sessions?	2.19 ± 0.8	2.09 ± 0.6	2.02 ± 0.7	2.11 ± 0.7	0.895	0.410
PBL helps students to build good personal relationships.	2.59 ± 0.7	2.61 ± 0.7	2.50 ± 0.7	2.57 ± 0.7	0.427	0.653
PBL helps students to develop good teamwork.	2.26 ± 0.7	2.36 ± 0.7	2.37 ± 0.8	2.32 ± 0.7	0.470	0.626
PBL improve students' ability to explain and transfer knowledge.	2.46 ± 0.6	2.45 ± 0.7	2.46 ± 0.6	2.46 ± 0.6	0.002	0.998
PBL enhances the problem solving skills of the students.	2.27 ± 0.7	2.32 ± 0.7	2.28 ± 0.6	2.28 ± 0.7	0.074	0.929
PBL helps students to 'feel like a doctor'.	2.12 ± 0.7	1.70 ± 0.7	2.28 ± 0.7	2.06 ± 0.8	7.723	0.001†

*(1.00 – 1.67) = minimum, (1.68 – 2.35) = moderate and (2.36 – 3.00) = maximum; † $p < 0.001$

participated in the second phase of the study study (51 students for second year, 56 students for third year and 42 students for fourth year). Assessments were done on 140 students because nine students did not complete the ILS.

Results showed that first-year students were using the 'deep processing', 'self regulation' and 'external regulation' strategies more than other components and that their learning orientation and learning model were 'vocation oriented' and 'intake of knowledge', respectively. The second-year students were using 'concrete processing' and 'lack of regulation' strategies more often and their learning orientation and learning model were 'vocation oriented' and 'use of knowledge', respectively. The third-year students were using 'deep processing' and 'external regulation' strategies more often and mostly students have 'vocation orientation' and 'intake of knowledge' with regards to mental models of learning (Table IV). There was no statistically significant difference between students according to scores for ILS sub scale. We compared students' perceptions about student-centered learning activities with their learning styles.

Comparison of students' perceptions of the basic variables of student-centered problem-based education and their learning styles

Relationships between the outcomes of problem-based learning sessions and learning styles

The results of Kruskal Wallis analyses of students' perceptions about student-centered learning activities and learning styles are summarized in Table V. The results showed that there is a statistically significant difference between the development of problem solving skills in the PBL session and external regulation strategies (X^2=7.18, $p<0.05$) (Table V).

According the average score of 'external regulation' was 2.44 ± 0.5 for students who benefited little from PBL in terms of problem-solving skills, 2.37 ± 0.6 for students who benefited moderately and 2.16 ± 0.8 for students who benefited the most ($p<0.05$, Table IV). There was a statistically significant relationship between developing the ability to explain and transfer knowledge (reporting skills) in PBL sessions and external regulation strategies (X^2=6.40,

Table II. Average scores of students concerning lecture based complementary conferences

Lecture based complementary conferences	1st year students' average score*± SD	2nd year students' average score*± SD	3rd year students' average score*± SD	Total average score * ± SD	F	P
Well planned and organized	1.85 ± 0.6	1.77 ± 0.6	1.61 ± 0.7	1.76 ± 0.7	2.263	0.107
Offer sufficient content	1.81 ± 0.7	1.84 ± 0.5	1.70 ± 0.7	1.78 ± 0.7	0.617	0.541
Interesting application and presentation	1.64 ± 0.6	1.48 ± 0.6	1.41 ± 0.7	1.52 ± 0.6	2.262	0.107
Complementary conferences support the content learned in PBL sessions	1.93 ± 0.6	2.00 ± 0.5	1.78 ± 1.4	1.90 ± 0.9	0.766	0.466

*(1.00 – 1.67) = minimum, (1.68 – 2.35) = moderate and (2.36 – 3.00) = maximum.

Table III. Average student scores for other complementary educational activities (not didactic)

Evaluations	Basic laboratory skills and clinical practice	Introduction to clinical skills	Communication skills
Well planned and organized			
1st year students' average score*± SD	2.30 ± 0.7	2.41 ± 0.7	2.20 ± 0.7
2nd year students' average score*± SD	2.11 ± 0.7	2.20 ± 0.7	2.02 ± 0.7
3rd year students' average score*± SD	2.04 ± 0.6	2.19 ± 0.6	1.91 ± 0.7
Total average score * ± SD	2.17 ± 0.7	2.28 ± 0.7	2.06 ± 0.7
One-Way ANOVA- F (p-value)	2.625 (0.075)	2.024(0.135)	2.727(0.068)
Offer sufficient content			
1st year students' average score*± SD	2.41 ± 0.7	2.58 ± 0.6	2.26 ± 0.7
2nd year students' average score*± SD	2.41 ± 0.5	2.32 ± 0.6	2.07 ± 0.7
3rd year students' average score*± SD	2.17 ± 0.7	2.19 ± 0.6	1.98 ± 0.7
Total average score * ± SD	2.33 ± 0.6	2.39± 0.6	2.12 ± 0.7
One-Way ANOVA- F(p-value)	2.656 (0.073)	6.889(0.001†)	2.439(0.090)
Objective Assessment			
1st year students' average score*± SD	2.20 ± 0.7	2.16 ± 0.8	2.20 ± 0.7
2nd year students' average score*± SD	2.25 ± 0.7	1.91± 0.6	1.93 ± 0.7
3rd year students' average score*± SD	1.80 ± 0.7	1.74 ± 0.8	1.81 ± 0.8
Total average score * ± SD	2.09 ± 0.7	1.97 ± 0.7	2.01 ± 0.7
One-Way ANOVA- F(p-value)	6.847(0.001†)	5.376(0.005†)	4.822(0.009†)
Helps to gain sufficient knowledge and skills			
1st year students' average score*± SD	2.19 ± 0.6	2.45 ± 0.6	2.19 ± 0.8
2nd year students' average score*± SD	2.11 ± 0.6	2.25 ± 0.6	1.95 ± 0.6
3rd year students' average score*± SD	1.98 ± 0.7	2.11 ± 0.7	1.91 ± 0.7
Total average score * ± SD	2.10 ± 0.6	2.29 ± 0.7	2.04 ± 0.7
One-Way ANOVA- F (p-value)	1.820(0.165)	4.352(0.014**)	3.014(0.052)

*(1.00 – 1.67) = minimum, (1.68 – 2.35) = moderate and (2.36 – 3.00) = maximum. †$p < 0.01$, **$p < 0.05$

$p<0.05$). The average score of having external regulation strategies was 2.65±0.4 for the students who benefited little from PBL in terms of developing reporting skills and 2.05±0.8 for students who benefited the most (Table V).

Relationships between opinions about the organization, planning and content competency of PBL modules and learning styles

The students' learning styles and their opinions about the organization and planning of PBL modules was related to learning orientations and knowledge processing strategies. The average scores for 'personally interested' were 2.20 and 2.20 (respectively) for students who found the assessment and acquired knowledge and skills of PBL modules unsatisfactory, 2.50 and 2.27 for those who found them moderately satisfactory, 2.09 and 1.97 for those who found them satisfactory; the difference was significant (X^2=9.82, $p<0.01$; X^2=6.42, $p<0.05$ respectively, Table V).

The students' learning styles and their opinions about the outcomes of PBL modules was related to processing strategies. The average scores for 'stepwise processing' were 1.90, 1.86 and 1.72 (respectively) for students who found the organization and planning, contents, assessment and acquired knowledge and skills of PBL sufficient, 2.29, 2.35, 2.50 and 2.31 (respectively) for those who found them moderately sufficient and 2.12, 2.26, 2.36 and 2.19 (respectively) for those who found them insufficient; the difference was significant (X^2=7.37, $p<0.05$; X^2=7.96, $p<0.05$; X^2=15.09, $p<0.01$; X^2=14.13, $p<0.01$ respectively, Table V).

Relationships between the outcomes of basic laboratory skills and clinical practice and learning styles

We examined the relationship between students' learning styles with opinions on clinical skills laboratory practice and learning styles. The average scores of 'stepwise processing' strategies were 2.17, 2.41 and 2.24 for students who found the organization-planning and contents of the clinical practice, and acquired knowledge-skills (respectively) insufficient, 2.00, 1.86 and 1.81 for students who found them sufficient. The difference was statistically significant between groups (X^2=8.53, $p<0.05$; X^2=16.53, $p<0.01$; X^2=14.12, $p<0.01$ respectively, Table V).

The average scores for 'lack of regulation' were 2.52 for students who found the content of clinical practice insufficient, 2.44 for those who found them moderately sufficient and 2.00 for those who found them sufficient. The differences between groups were significant (X^2=10.47, $p<0.01$, Table 4). In addition the average scores for 'use of knowledge' as mental models of learning were 3.00 and 2.66 for students who found the content of clinical practice and acquired knowledge & skills insufficient, 2.25

Table IV. Students' learning styles classified by academic years

Years	Domains of Inventory of Learning Styles (Mode)															
	Processing strategies			Regulation strategies			Learning orientations					Mental models of learning				
	D11	D12	D13	D21	D22	D23	D31	D32	D33	D34	D35	D41	D42	D43	D44	D55
1	**4.2**	2.8	3.2	**3.4**	**3.4**	3.0	3.8	2.6	3.6	**4.6**	2.8	3.4	**4.6**	4.4	3.8	2.4
2	2.8	2.9	**3.4**	2.7	3.0	**3.8**	3.4	3.0	4.0	**4.2**	3.2	3.4	3.6	**4.4**	3.2	3.0
3	**3.8**	1.9	3.4	2.3	**3.5**	2.6	3.4	3.4	3.4	**4.2**	2.4	3.4	**4.2**	3.8	3.4	2.8

Abbreviations: *D11- deep processing, D12- stepwise processing, D12-concrete processing, D21-self-regulation, D22-external regulation, D23-lack of regulation, D31-personally interested, D32-certificate directed, D33-self test directed, D34-vocation directed, D35-ambivalent, D 41-construction of knowledge, D42-intake of knowledge, D43-use of knowledge, D44-stimulating education, D45-co-operation*

and 2.06 for those who found them moderately sufficient. The differences between groups were significant (X^2=6.63, $p<0.05$; X^2=6.68, $p<0.05$ respectively, Table V).

Relationships between outcomes of communication skills and learning styles

The students' opinions on the adequacy of communication skills were related to their processing strategies. The average scores for 'stepwise processing' were 1.63 for students who found the contents of communication skills sufficient and 2.07 for those who found them insufficient; the difference was significant (X^2=6.97, $p<0.05$, Table V).

Discussion

Currently, it is emphasized that process of program development and evaluation should include analyzing of learners' characteristics, needs and perceptions about problem-based learning [ref]. Even if an education program is perfect it will not work if the design, teaching and learning strategies were not adopted by teachers and students. The study offers very valuable information for student-centered program evaluation during the first three years. Examining the relationships of the above-mentioned parameters with learning styles, another parameter that may affect the student reaction, has increased the power of the study.

The average scores of contributions of PBL to students' individual learning and development found in our study indicate that PBL promotes interpersonal relationships and fosters the ability to explore and transfer knowledge, develop cooperative teamwork and problem solving skills. These average scores were similar for all three years, and there was no statistically significant difference. Only second-year students thought more negatively in comparison with the first- and third-year students about whether PBL sessions helped them to feel like a doctor. In general, the students in PBL gained slightly less knowledge but remembered more of the acquired knowledge [5]. PBL has advantages over traditional education in the development of key process skills. PBL has been shown to promote self-directed learning, self-confidence and interpersonal relationships, and develop problem solving and cooperative teamwork skills. The PBL program appeared to provide better preparation with respect to several of the competencies needed in practice, including specific skills, communication skills, and teamwork [13,14].

Vermunt has suggested three important developmental phenomena in students' learning patterns [9]. First; there is an increasing differentiation within learning components. Older students show greater ability to differentiate various learning strategies, conceptions, and orientations than younger students. Second, there is an increasing integration of learning components. Older students show stronger interrelations between their learning strategies, conceptions, and orientations than younger students. Third, application-directed learning as a distinct learning pattern seems relatively late in its development because this dimension is clearly a separate dimension only in adult or advanced groups of students. According to our findings students were more satisfied with the content, organization and planning of other student-centered activities than the complementary presentations given by lecturers to provide information that the students could not understand. The students believe that they benefited from clinical skills training more than all other student-centered activities. However, positive evaluations about student-centered activities have decreased significantly as the years progress.

After analyzing first-year students' perceptions about student-centered problem-based learning variables and learning styles in our study, we found that the students who mostly need external regulation were not satisfied with PBL and benefited little from PBL sessions in terms of problem-solving and reporting skills. Papinczak carried out a research on first-year medical students to assess which learners best adapted to self-directed learning at PBL [15]. His study showed that the deep and strategic learners appeared to be

less vulnerable to the stresses of PBL sessions in a medical course. The students in this group found the experience of learning in a PBL curriculum more satisfying than other subgroups and appear least likely to find it problematic to study medicine in a PBL curriculum. Visser concluded in his study that the correlation between performance and self-regulation would be higher in the problem-based instructional strategy than in the lecture-based instructional strategy [16].

Collaboration is essential for PBL; students work in small collaborative groups and learn what they need to know in order to solve a problem. Collaboration occurs naturally during the group discussions. The tutor helps students learn to collaborate well and asks questions of the group members to ensure that information has been shared between members in relation to the group's problem. Collaborative learning promotes the students' self-confidence and results in students taking more responsibility for their own learning. However, the individual learners who are prone to learning by reading and repeating by themselves benefit to a lesser extent than others from the key aspects of PBL sessions, such as explaining and transferring knowledge and the development of problem-solving skills [14,17, 18]. Our study also demonstrates that the students with a personally interested orientation and using external regulation strategies could not benefit from PBL sessions for acquiring knowledge and skills and they were not satisfied with the assessment and evaluation of modules. In addition, it has been stated [ref] liable to personally interested as learning orientation and stepwise processing as knowledge processing strategies could be affected to the output of PBL modules. PBL module activities were more advantageous for students' who were less dependent on these learning styles than students who were more prone them.

Table V. Relationships between students' learning styles and their perceptions about student-centered learning activities

	Students' Opinions about Program (average score± SD)				
Relate Domain of Inventory of Learning Styles (year)	Low	Moderate	High	χ^2	P
		Outcomes of PBL (n=137)			
		Developing problem solving skills			
Regulation strategies- External regulation	2.44±0.5	2.37±0.6	2.16±0.8	7.18	p<0.05
		Developing reporting skills			
Regulation strategies- External regulation	2.65±0.4	2.37±0.6	2.05±0.8	6.40	p<0.05
		Feeling as a doctor in PBL sessions			
Mental models of learning- Use of knowledge	2.66±0.5	1.86±0.7	2.20±0.7	7.09	p<0.05
		Outcomes of PBL Modules (n=137)			
		Organization and Planning of Modules			
Processing strategies- Stepwise processing	2.12±0.7	2.29±0.6	1.81±0.7	7.37	p<0.05
		Content of Modules			
Processing strategies- Stepwise processing	2.26±0.6	2.35±0.5	1.90±0.6	7.96	p<0.05
		Assessment and Evaluation of Modules			
Processing strategies- Stepwise processing	2.36±0.6	2.50±0.5	1.86±0.6	15.09	p<0.01
Learning orientations- Personally interested	2.20±0.6	2.50±0.5	2.09±0.7	9.82	p<0.01
		Acquired knowledge and skills			
Processing strategies- Stepwise processing	2.19±0.6	2.31±0.5	1.72±0.6	14.13	p<0.01
Learning orientations- Personally interested	2.20±0.4	2.27±0.5	1.97±0.6	6.42	p<0.05
		Outcomes of clinical skills laboratory (n=137)			
		Organization and planning of clinical skills lab practice			
Processing strategies- Stepwise processing	2.17±0.7	2.43±0.6	2.00±0.6	8.35	p<0.05
Learning orientations- Self-test directed	1.830±.5	2.39±0.6	2.23±0.6	8.10	p<0.05
		Content of clinical skills program			
Processing strategies- Stepwise processing	2.41±0.6	2.52±0.5	1.86±0.6	16.53	p<0.01
Regulation strategies- Lack of regulation	2.52±0.5	2.44±0.5	2.00±0.6	10.47	p<0.01
Mental models of learning- Use of knowledge	3.00±0.0	2.25±0.5	2.43±0.6	6.63	p<0.05
		Acquired knowledge and skills			
Processing strategies- Stepwise processing	2.24±0.7	2.43±0.5	1.81±0.5	14.12	p<0.01
Mental models of learning- Use of knowledge	2.66±0.5	2.06±0.6	2.36±0.6	6.68	p<0.05
		Outcomes of communication skills (n=137)			
		Acquired knowledge and skills			
Processing strategies- Stepwise processing	2.07±0.7	2.08±0.6	1.63±0.5	6.97	p<0.05

Secondary school education in Turkey is more teacher-centered and usually learning takes place through the transfer of knowledge from the outside. At the same time academic achievement is mostly measured with multiple-choice exams. For this reason, student-centered active learning implementations in higher education should be regarded as provoking interventions for a change of traditional teaching and educational strategies.

According to Vermunt when learning is conceived more as self-regulated knowledge construction than as taking in already existing external knowledge, the role of teaching changes too, from transmission of knowledge to supporting and guiding self-regulated knowledge construction [19]. Our study also demonstrates that the students who were using a cooperative learning strategy frequently found the contents of PBL to be satisfactoryhan the students who were using this strategy less frequently. Students with a personally interested orientation could not benefit from PBL sessions on explaining and transferring knowledge and development of problem-solving skills. In addition, vocation oriented students found the organization and planning of PBL unsatisfactory.

PBL is a method of learning and teaching in small groups and facilitates not only the acquisition of knowledge but also development of self-regulated learning strategies with several other desirable attributes, such as communication skills, teamwork, problem solving, independent responsibility for learning, sharing information, and respect for others [20].

It is known that clinical skills laboratory training at an early phase diminishes the anxiety of preclinical students' related to the core clinical skills and positively influences their learning during a clerkship [21,22]. In our study, while self-test directed students using stepwise processing strategies were moderately satisfied with the content, organization and planning of the clinical skills program, the students who lack regulation and using knowledge in mental models of learning were less satisfied with the content, organization and planning of the clinical skills program. Also they were less satisfied about acquired knowledge and skills. Clinical skills training at early stages seem to offer the students a superior preparation resource for clerkships as well as influencing the students' learning abilities during the clerkships [22]. So preclinical students prepared to patient-physician relationships and physical examination and their competency related to cognitive and affective domains improved this. In this sense, these findings of our study showed that the students' expectations and motivation improved about basic clinical skills training and learning outputs.

In conclusion; today, medical education is questioned based on the health outcomes and medical errors made in practice. Program development compatible with learner needs and the competency-based approach is gaining importance in undergraduate medical education; various teaching strategies and learning methods have been applied for this purpose. It is important to take into account the diversity of learners and to provide appropriate learning opportunities for all students. Students' learning styles appeared to be associated with student satisfaction in problem-based learning and other student-centered learning activities in this study. Our study was carried out in a medical school that has been applying a student-centered and problem-based learning program in undergraduate medical education for the past ten years. A major limitation to our study is the relatively small sample size. While 177 students were initially enrolled in the first phase of the study, 23 students (12.9%) discontinued in the second phase.

This study provides evidence on relationships between medical students' learning styles and teaching and learning strategies. In conclusion, students' satisfaction in PBL and other student-centered learning activities can emerge after development of self-regulatory skills. Curriculum development and program evaluation studies should consider improving the development of students' self regulatory and professional skills.

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