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## WEB PAPER

# Problem based learning approaches to the technology education of physical therapy students

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## Abstract

**Background:** Problem-Based Learning (PBL) is a whole-curriculum concept.

**Aim:** This study aimed to compare learning preferences and strategies between physical therapy students taught by PBL and those receiving conventional lectures on massage therapy, trauma physical therapy, and electrotherapy, hydrotherapy, and thermotherapy.

**Methods:** This quasi-experimental study included 182 male and female students on physical therapy diploma courses at three universities in Andalusia (Spain). The Canfield Learning Skills Inventory (CLSI) was used to assess learning strategies and the Approaches to Study Skills Inventory for Students (ASSIST) to analyze study preferences.

**Results:** At the end of the academic year 2009/10, physical therapy students taught by PBL considered the most important learning strategies to be group work, study organization, relationship of ideas, and academic results. In comparison to conventionally taught counterparts, they considered that PBL reduced lack of purpose, memorizing without relating, the law of minimum effort, and fear of failure. Among these PBL students, the most highly rated study preferences were: organization of course tasks, cordial interaction with the teacher, learning by reading and images, and direct hands-on experience.

**Conclusion:** For these physical therapy students, PBL facilitates learning strategies and study preferences in comparison to conventional teaching.

## Introduction

The aim of problem-based learning (PBL) is to stimulate independent learning, allowing students to rehearse approaches to complex situations and to develop a definition of their own deficiencies in cognitive understanding (Rodríguez-Suárez 2003). PBL is a whole-curriculum concept and not a teaching modality. If it is not feasible to implement the whole concept, implementers may use it as a major learning modality or improve their traditional curriculum by incorporating the educational principles underlying PBL, i.e., learning in context, self-directed learning, and collaborative learning. Different norms, beliefs, values, and external factors give PBL a different flavor and may change it outright (Taylor & Mifflin 2008). The evolution of PBL variations in different institutions, countries, and continents has been dependent on implementation problems. Reported difficulties include a variable understanding of PBL, and scarcity of resources. The most important factors remain the scarcity of resources, i.e., trained “faculty, facilities and funds” (Zuberi 2011).

The authors of the AMEE Guide stress that dissemination of the PBL concept has created confusion in the understanding and practice of this learning, leading to difficulties in interpreting PBL research findings PBL. Other possible

## Practice points

- Physical therapy students taught by PBL considered the most important learning strategies to be group work, study organization, relationship of ideas, and academic results.
- Among PBL students, the most highly rated study preferences were organization of course tasks, cordial interaction with the teacher, learning by reading and images, and directed hands-on experience.
- In comparison to conventional teaching, physical therapy students taught by PBL reported reductions in lack of purpose, memorizing without relating, the law of minimum effort, and fear of failure.
- The PBL is a teaching/learning method that facilitates learning strategies and study preferences in physical therapy students.

causes of differences include an incomplete training of educators in the appropriate skills and an excessive haste in designing PBL curricula, leading to a poor preparation and inadequate staff training (Azer 2011). The concept of self-directed learning (SDL) is considered central to adult learning.

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and PBL. However, several authors have raised concerns about this generalization and questioned whether SDL can be automatically achieved by the introduction of a PBL curriculum. In PBL, students direct their learning by identifying unknown issues in relation to the case. SDL develops competencies, skills, and attitudes that foster the learning process. The authors of the AMEE Guide highlighted the role of small group work in PBL, providing the security and authority that students need for their own learning (Barrows & Tamblyn 1980; Maudsley et al. 2010; Azer 2011).

Physical therapy curricula have traditionally followed a content-based behaviorist model, with teachers deciding the learning needs and methods of their students. The theoretical preparation tends to incorporate practice elements in order to familiarize students with the process involved in problem-solving (Hartling et al. 2010). PBL is closely related to evidence-based physical therapy, which was developed to improve the quality of physical therapeutic care and optimize the utilization of limited resources. Evidence-based decision-making is based on the findings of the most recent high-quality research, and there is wide agreement that the methodology required for this approach should be taught throughout university courses (Wolf 2000; Abdelkhalek et al. 2010). Evidence relevant to clinical practice is related to the cause, diagnosis, prevention, and treatment of diseases. Importantly, the evidence-based model should be regarded as adding a further dimension to the decision-making process rather than replacing the judgment and experience of clinicians (Hofgaard et al. 2006).

Albanese and Mitchell (1993) reviewed seven studies that compared faculty supervisors' clinical ratings between medical school graduates from PBL programs and those from conventional courses, consistently reporting more positive clinical ratings for the PBL students. Students from a Dutch medical school running a PBL program reported higher satisfaction with their training and interpersonal skills preparation in comparison to students from two schools with conventional curricula, but no differences were found in their ability to manage clinical cases (Busari et al. 1997; Rideout et al. 2002; Hendry et al. 2006). A study on perceived changes in self-directed learning over 4 years in a baccalaureate nursing education program with an integrated problem-based learning curriculum supported SDL as a maturational process (Kocaman et al. 2009).

Integration within the European Higher Education Area (EHEA) is a prime objective of Spanish universities and implies the reconsideration of conventional teaching methods and the introduction of alternative quality models. A key requirement of the Bologna Declaration on which the EHEA is based is that teaching be centered on student work. Learning strategies are located at the same hierarchical level as the thematic knowledge specific to each discipline. They are integrated within a planned sequence of actions and are flexibly adjusted and adapted as a function of the learning context. The development of different learning and rating strategies can disorientate students to some degree, and teachers need to study the profiles and learning needs of their students and seek ways to improve the learning environment. During the academic year 2009/10, the discipline of physiotherapy at the Universities of

Granada, Almeria and Cadiz was included in new study plans introduced into Spanish universities as a result of the Bologna Declaration, and a PBL approach was adopted for both the theoretical and practical content of these courses. With this background, the objective of this study was to compare learning preferences and strategies between physiotherapy students taught by PBL (academic year 2009/10) and those taught by conventional lectures (academic year 2008/09) in the subjects of massage therapy, physiotherapy, electrotherapy, hydrotherapy, and thermotherapy.

## Method

### Design

This study had a quasi-experimental design, since the participation of students in the different courses was not randomized. The courses were in massage therapy (University of Almeria), trauma physical therapy (University of Granada), and electrotherapy, hydrotherapy, and thermotherapy (University of Cadiz). The study period was from September 1 2008 to July 31 2010.

### Study sample

The study included 182 male and female students on the Diploma Course in Physical therapy at three Universities in Southeastern Spain (University of Granada [ $n=62$ ], University of Almeria [60] and University of Cadiz [ $n=60$ ]) during the academic year 2008/09. During the academic year 2009/10, the number of students was 176 (University of Granada [ $n=61$ ], University of Almeria [58] and University of Cadiz [ $n=57$ ]). Data on students repeating the subject were excluded from the analyses. Written informed consent was obtained from the students in accordance with the Helsinki Declaration (2000 modification). The study was approved by the ethical and research committees of all three universities.

### Measurement instruments

We used the Approaches to Study Skills Inventory for Students (ASSIST) to analyze study preferences and the Canfield Learning Styles Inventory (CLSI) to assess learning strategies.

The ASSIST questionnaire evaluates the use of learning strategies in study activities and the quality of the learning obtained. Three categories are considered: Superficial Learning (search for significance, relationship of ideas, use of evidence, interest in ideas); Strategic Learning (lack of purpose, memorizing without relating, law of minimum effort, fear of failure); and Deep Learning (organized study, time management, attention to task demands, achievements, and effectiveness monitoring). Students respond to questions on their study habits, and scores for each item are added together to obtain sub-scale scores (Tait & Knight 1996).

A Spanish adaptation of the CLSI Questionnaire (Canfield 1992) was used, which contains two of the three categories in the original, i.e., *Learning Conditions* and *Modes*

of Learning. The *Learning Conditions* category comprises eight subscales:

- *Classmates*, valuing a good relationship with other students for effective learning
- *Organization*, valuing a clear and logical organization of tasks
- *Objectives*, valuing the opportunity to modify objectives or procedures
- *Competition*, valuing comparisons with other students as motivational
- *Teacher*, valuing a cordial interaction between teacher and students
- *Details*, valuing specific and detailed information
- *Independence*, valuing the independent work of student
- *Authority*, valuing discipline and order in class and the controlled development of study activities.

The *Modes of Learning* category comprises four subscales: *listening*, expressing preference for learning by lectures or talks; *reading*, preference for learning by reading; *images*, preference for learning from visual material; and *experience*, preference for direct experience. Students assign a score to the four responses offered for the 18 items in the questionnaire according to their preference (from 1 = most preferred option to 4 = least preferred option).

## Procedure

Participating students completed the two questionnaires (pre-test) during the first week of the academic year 2008/09 after signing their informed consent to participation in the study. During this academic year, massage therapy, trauma physical therapy, and electrotherapy, hydrotherapy, and thermotherapy were taught in a conventional manner, with lectures for the theoretical content plus individual learning in theoretical-practical classes. For massage therapy, 10 hours (1-h classes) were assigned to theory and 120 hours to theoretical-practical content; for trauma physical therapy, 30 hours were assigned to theory and 230 hours to theoretical-practical content; and for electrotherapy, hydrotherapy and thermotherapy, 25 hours were assigned to theory and 100 hours to theoretical-practical content. All subjects were assessed by a test-type exam and a theoretical-practical exam at the end of each course. Each student completed the two questionnaires (post-test) again during the last week of the academic year 2008/09.

During the academic year 2009/10, these three subjects were included in the new study plans introduced into Spanish universities as a result of the Bologna Declaration, and a PBL approach was adopted for both the theoretical and practical content of these courses. The development and implementation of PBL followed the sequence described in Table 1. All students on these courses completed the ASSIST and CLSI questionnaires in the first and last weeks of the academic year.

## Statistical analysis

SPSS version 18.0 was used for the data analyses. The reliability and validity of the model hypothesis were studied by analyzing the residual independence, normal distribution,

**Table 1.** Sequence of development and implementation of PBL.

- (1) Formation of student work groups.
- (2) Selection of group coordinators.
- (3) Identification and resolution of group dynamics problems up to that point.
- (4) Selection by tutor of practical cases for students to resolve.
- (5) Group consultation of literature and analysis of the problem to be solved.
- (6) Brainstorming on the approach to the problem (e.g., hypothesis presentation).
- (7) Assignment of activities with the participation of the coordinator and each group member.
- (8) Individual work, including reading, literature search, and preparation of material for case reports.
- (9) Group work for: partial review of the case, presentation and discussion of reports, preparation of conceptual maps, progress assessment, self-assessment, and task assignment according to the consensus reached on the problem.
- (10) Feedback on the assignment of tasks with suggestions for improving the method of their distribution.
- (11) Search for additional information.
- (12) Individual work reading new material.
- (13) Report preparation, with each member explaining how their information would contribute to resolving the problem.
- (14) New review of the problem.
- (15) Synthesis of the presentations by the coordinator and integration of the knowledge used for the solution.
- (16) Individual presentations on broader perspectives of the problem.
- (17) Self-assessment.
- (18) Feedback from tutor on the group dynamics.
- (19) Recommendations on optimal methodologies to improve the information and learning process.
- (20) Exercise on knowledge transfer to other situations requiring the same information.
- (21) Self-assessment of participation in the different student activities.
- (22) A final session with the coordinator on the group dynamics, identifying challenges for individuals and the group.

and homogeneity of variances. After descriptive study of the demographic variables, residual independence was analyzed by plotting observed against residual values; data points were randomly distributed and showed no trend, verifying the hypothesis of residual independence. The Kolmogorov-Smirnov test was used to examine the normal distribution of variables. An imputed score was calculated for standardized scales missing  $\leq 10\%$  of responses. Analysis of variance (ANOVA) was used to analyze differences within each academic year and the Student's *t*-test for independent samples to analyze differences between academic years.  $p < 0.05$  was considered significant in all tests.

## Results

In the academic year 2008/09, the study sample included 182 students (massage therapy course,  $n=58$ ; trauma physical therapy course,  $n=61$ ; electrotherapy, hydrotherapy, and thermotherapy course,  $n=57$ ). After excluding students who were repeating the course ( $n=6$ ), the study sample in the academic year 2009/10 comprised 58 students on the massage therapy course (mean age 21.43 yrs), 61 students on the trauma physical therapy course (mean age, 20.12 yrs), and 57 students on the electrotherapy, hydrotherapy, and thermotherapy course (mean age 19.96 yrs).

**Table 2.** Mean pre-test scores on approaches to study skills inventory for students.

Groups	Problem-based learning			Conventional classes		
	1 (N = 58)	2 (N = 61)	3 (N = 57)	1 (N = 60)	2 (N = 62)	3 (N = 60)
Search for significance	16.64 (2.13)	15.81 (2.30)	15.67 (2.53)	15.07 (3.49)	17.71 (1.93)	16.31 (2.63)
Relationship of ideas	16.40 (2.32)	14.38 (2.89)	14.32 (3.06)	14.69 (2.65)	16.00 (3.18)	15.22 (3.41)
Use of evidence	16.34 (2.08)	16.12 (2.19)	15.96 (2.53)	15.00 (2.79)	17.21 (1.52)	16.63 (2.35)
Interest of the subject	17.00 (2.26)	15.70 (2.40)	15.73 (2.61)	15.53 (2.53)	16.57 (3.75)	15.46 (1.95)
Study organization	15.54 (2.94)	13.57 (3.21)	13.52 (3.32)	12.00 (3.78)	14.85 (4.27)	13.53 (2.87)
Time organization	15.26 (3.43)	14.68 (3.13)	14.33 (3.49)	12.07 (3.75)	14.57 (3.58)	13.63 (3.97)
Attention to task demands	15.96 (2.62)	14.66 (2.48)	14.45 (2.60)	14.53 (2.32)	15.14 (1.79)	14.29 (3.49)
Achievements	18.04 (10.18)	15.64 (2.20)	15.64 (2.48)	15.46 (6.11)	15.92 (1.85)	15.66 (2.99)
Effectiveness monitoring	17.42 (1.83)	16.61 (2.70)	16.54 (2.86)	15.00 (2.76)	17.28 (2.61)	16.77 (3.21)
Lack of purpose	8.06 (2.99)	8.38 (2.81)	7.81 (2.73)	11.07 (4.07)	8.14 (2.76)	10.62 (3.47)
Memorizing without relating	10.48 (3.15)	10.25 (2.79)	9.96 (2.96)	10.61 (2.18)	9.57 (2.24)	10.85 (2.56)
Law of minimum effort	11.88 (3.08)	11.37 (2.96)	11.16 (3.26)	14.69 (2.95)	11.71 (4.33)	12.22 (3.41)
Fear of failure	15.24 (4.06)	16.42 (7.26)	16.05 (7.50)	15.46 (2.66)	15.00 (5.05)	15.15 (4.14)

Note: Values are presented as means and standard deviations (SD). Groups: 1= Massage therapy (University of Almeria); 2: Trauma physical therapy (University of Granada); 3: Electrotherapy, Hydrotherapy and Thermotherapy (University of Cadiz).

### Learning strategies (ASSIST)

No significant differences in scores were found between ASSIST results at the beginning of the two academic years (Table 2). No significant differences in results were found between the beginning and end of the academic year 2008/09 (conventional classes) (Tables 2–4). After the introduction of PBL, significant differences were found in some item scores between the beginning and end of the academic year (2009/10) for all three subjects (Tables 2–4): *massage therapy* (interest in the subject,  $p < 0.030$  and lack of purpose,  $p < 0.019$ ), *trauma physical therapy* (relationship of ideas,  $p < 0.001$ ; study organization,  $p < 0.002$ ; academic results,  $p < 0.008$ ; lack of purpose,  $p < 0.006$ ; memorizing without relating,  $p < 0.001$ ; law of minimum effort,  $p < 0.008$ ; fear of failure,  $p < 0.018$ ), and *electrotherapy, hydrotherapy and thermotherapy* (study organization,  $p < 0.026$ ; academic results,  $p < 0.022$ ; lack of purpose,  $p < 0.002$ ; memorizing without relating,  $p < 0.001$ ; law of minimum effort,  $p < 0.001$ ; fear of failure,  $p < 0.018$ ).

Significant differences were found between the end of each academic year in some items on all courses, as follows: *massage therapy* (use of evidence,  $p < 0.043$ ; interest in the subject,  $p < 0.025$ ; study organization,  $p < 0.040$ ), *trauma physical therapy* (relationship of ideas,  $p < 0.041$ ; academic results,  $p < 0.032$ ; study organization,  $p < 0.028$ ; memorizing without relating,  $p < 0.043$ ), and *electrotherapy, hydrotherapy and thermotherapy* (lack of purpose,  $p < 0.023$ ; memorizing without relating,  $p < 0.027$ ; law of minimum effort,  $p < 0.034$ ; fear of failure,  $p < 0.044$ ).

### Study preferences (CLSI)

No significant differences in scores were found between CLSI results at the beginning of the two academic years (Table 5). In the courses given by conventional lectures in 2008/09, no significant differences were found between the beginning and end of the academic year (Tables 5–7). After the introduction of PBL, significant differences were found between the beginning and end of the academic year (2009/10), as follows: *massage therapy* (organization,  $p < 0.019$ ), *trauma physical therapy* (professor,  $p < 0.017$ ; images,  $p < 0.041$ ; direct experience,  $p < 0.001$ ), and *electrotherapy, hydrotherapy and thermotherapy* (professor,  $p < 0.001$ ; reading,  $p < 0.007$ ; images,  $p < 0.012$ ; direct experience,  $p < 0.001$ ).

Significant differences were found between the end of each academic year in the following courses and items: *massage therapy* (classmates,  $p < 0.038$ ; organization,  $p < 0.042$ ), *trauma physical therapy* (classmates,  $p < 0.028$ ; professor,  $p < 0.035$ ; images,  $p < 0.044$ ), and *electrotherapy, hydrotherapy and thermotherapy* (professor,  $p < 0.016$ ; reading,  $p < 0.023$ ; images,  $p < 0.031$ ; direct experience,  $p < 0.024$ ).

## Discussion

In this study, physical therapy students taught by PBL developed a greater preference for organization and a good relationship with the teacher and for learning by reading, images and direct experience. In comparison to conventional teaching, student taught by PBL showed significant



**Table 3.** Mean post-test scores on approaches to study skills inventory for students.

Groups	Problem-based learning			Conventional classes		
	1 (N = 58)	2 (N = 61)	3 (N = 57)	1 (N = 60)	2 (N = 62)	3 (N = 60)
Search for significance	16.80 (1.99)	15.37 (2.94)	15.07 (3.10)	15.69 (2.68)	16.71 (2.33)	16.46 (2.93)
Relationship of ideas	15.80 (2.76)	16.37 (2.47)	15.14 (3.01)	15.30 (3.11)	16.50 (2.65)	15.47 (2.96)
Use of evidence	16.13 (1.95)	16.46 (2.14)	16.11 (2.52)	15.76 (2.61)	16.78 (1.92)	16.55 (2.88)
Interest of the subject	17.11 (2.04)	16.50 (2.41)	15.77 (2.97)	15.92 (2.81)	16.50 (2.76)	15.22 (2.36)
Study organization	15.26 (2.53)	15.89 (2.95)	15.09 (3.54)	12.46 (4.84)	14.21 (4.09)	13.14 (3.01)
Time management	15.01 (2.47)	15.75 (2.25)	15.29 (3.32)	12.46 (3.77)	14.28 (4.26)	13.78 (4.23)
Attention to task demands	15.26 (2.40)	15.07 (2.05)	15.37 (2.52)	14.84 (3.31)	14.21 (2.48)	14.22 (4.15)
Achievements	16.30 (2.16)	17.07 (2.05)	16.70 (2.11)	14.23 (3.63)	19.00 (14.23)	15.37 (3.11)
Effectiveness monitoring	17.11 (1.81)	16.07 (3.22)	15.44 (3.92)	16.61 (2.02)	16.78 (2.32)	16.88 (3.96)
Lack of purpose	9.42 (3.07)	10.55 (3.36)	9.57 (3.37)	11.07 (3.32)	10.14 (3.89)	10.95 (4.13)
Memorizing without relating	10.71 (2.91)	13.94 (3.00)	13.27 (3.12)	10.69 (2.39)	9.78 (4.15)	10.66 (3.21)
Law of minimum effort	11.80 (3.06)	14.01 (2.61)	13.22 (3.08)	14.84 (2.99)	11.42 (4.71)	12.77 (3.58)
Fear of failure	15.30 (3.51)	13.94 (3.00)	13.22 (3.09)	15.23 (3.13)	14.35 (4.71)	15.99 (4.17)

Note: Values are presented as means and standard deviations (SD). Groups: 1= Massage therapy (University of Almeria); 2: Trauma physical therapy (University of Granada); 3: Electrotherapy, Hydrotherapy and Thermotherapy (University of Cadiz).

**Table 4.** P-value of differences between pre- and post-test scores on approaches to study skills inventory for students.

Groups	Problem-based learning			Conventional classes		
	1 P (N = 58)	2 P (N = 61)	3 P (N = 57)	1 P (N = 60)	2 P (N = 62)	3 P (N = 60)
Search for significance	0.796	0.321	0.192	0.615	0.043	0.093
Relationship of ideas	0.101	0.001*	0.164	0.651	0.566	0.223
Use of evidence	0.449	0.437	0.816	0.471	0.234	0.375
Interest of the subject	0.030*	0.111	0.945	0.733	0.941	0.244
Study organization	0.482	0.002*	0.026*	0.730	0.156	0.102
Time management	0.437	0.497	0.141	0.764	0.470	0.286
Attention to task demands	0.104	0.027*	0.086	0.750	0.066	0.186
Academic results	0.212	0.008*	0.022*	0.532	0.414	0.113
Effectiveness monitoring	0.281	0.304	0.084	0.117	0.420	0.095
Lack of purpose	0.019*	0.006*	0.002*	1.000	0.038	0.147
Memorizing without relating	0.853	0.001*	0.001*	0.937	0.842	0.107
Law of minimum effort	0.688	0.008*	0.001*	0.897	0.710	0.086
Fear of failure	0.940	0.035*	0.018*	0.859	0.413	0.115

Note: \*P-value < 0.05 (95% confidence interval). Groups: 1= Massage therapy (University of Almeria); 2: Trauma physical therapy (University of Granada); 3: Electrotherapy, Hydrotherapy and Thermotherapy (University of Cadiz).

improvements in the relationship of ideas, interest in the matter, study organization, and academic results, with reductions in lack of purpose, memorizing without relating, the law of minimum effort, and fear of failure.

The PBL-taught students considered that direct hands-on experience was the best learning strategy and facilitated cordial interaction with the teacher. The role of the teachers was transformed in our PBL courses; they were no longer the

**Table 5.** Mean pre-test scores on the Canfield learning skills inventory.

Groups	Problem-based learning			Conventional classes		
	1 (N = 58)	2 (N = 61)	3 (N = 57)	1 (N = 60)	2 (N = 62)	3 (N = 60)
Classmates	16.45 (3.31)	15.85 (3.21)	14.81 (3.04)	14.84 (2.96)	15.71 (2.61)	13.26 (1.23)
Organization	11.31 (2.72)	13.09 (2.86)	12.20 (2.97)	12.07 (3.40)	12.14 (1.95)	12.03 (2.60)
Objectives	15.05 (2.94)	16.98 (2.16)	16.46 (2.47)	16.76 (2.48)	15.71 (2.58)	15.23 (3.07)
Competence	17.17 (2.72)	17.38 (2.42)	16.51 (2.59)	16.92 (2.43)	16.42 (1.45)	17.03 (1.96)
Professor	12.80 (3.58)	13.96 (2.99)	13.08 (3.08)	13.00 (3.62)	12.00 (3.25)	12.39 (4.08)
Details	12.33 (3.34)	13.05 (2.61)	12.22 (2.75)	11.23 (3.39)	12.57 (3.25)	12.87 (4.19)
Independence	17.11 (3.81)	20.57 (10.22)	20.06 (10.59)	17.30 (2.13)	18.00 (4.33)	16.88 (3.63)
Authority	17.72 (3.29)	16.81 (3.37)	16.06 (2.90)	16.92 (2.75)	17.42 (3.08)	16.91 (4.10)
Listening	15.64 (3.40)	14.77 (3.50)	13.87 (3.64)	14.84 (3.46)	13.71 (3.29)	13.63 (3.83)
Reading	19.86 (3.46)	20.16 (3.00)	20.31 (3.16)	19.61 (3.22)	20.28 (2.64)	19.47 (3.76)
Images	12.33 (3.89)	15.35 (3.47)	14.70 (3.49)	13.38 (3.40)	13.50 (5.47)	12.97 (5.66)
Direct experience	12.15 (4.09)	12.37 (3.12)	11.31 (3.26)	12.15 (4.09)	12.50 (2.73)	12.48 (3.19)

Note: Values are presented as means and standard deviations (SD). Groups: 1= Massage therapy (University of Almeria); 2: Trauma physical therapy (University of Granada); 3: Electrotherapy, Hydrotherapy and Thermotherapy (University of Cadiz).

**Table 6.** Mean post-test scores on the Canfield learning skills inventory.

Groups	Problem-based learning			Conventional classes		
	1 (N = 58)	2 (N = 61)	3 (N = 57)	1 (N = 60)	2 (N = 62)	3 (N = 60)
Classmates	16.56 (2.80)	15.53 (2.93)	14.85 (3.02)	15.15 (2.73)	15.64 (2.70)	14.36 (3.19)
Organization	12.34 (2.39)	12.85 (3.57)	11.81 (2.70)	14.46 (2.36)	11.64 (2.61)	11.05 (3.21)
Objectives	15.60 (3.34)	17.79 (3.57)	17.03 (3.69)	15.46 (2.72)	15.21 (2.54)	14.36 (3.47)
Competence	17.05 (2.65)	16.83 (2.18)	16.29 (1.79)	17.78 (2.39)	17.50 (2.44)	16.30 (3.21)
Professor	13.94 (3.30)	15.27 (3.20)	14.41 (2.33)	13.55 (3.31)	14.07 (3.42)	13.62 (2.97)
Details	11.47 (3.50)	12.90 (4.37)	12.09 (3.88)	12.93 (2.66)	11.71 (4.17)	12.52 (3.88)
Independence	18.07 (4.08)	18.37 (3.17)	17.94 (3.17)	19.27 (3.14)	17.28 (3.47)	18.67 (3.27)
Authority	16.50 (3.95)	16.29 (2.88)	15.54 (3.04)	16.61 (3.64)	16.92 (3.22)	16.23 (4.01)
Listening	14.25 (3.71)	14.72 (3.94)	13.87 (3.64)	13.69 (4.64)	14.14 (4.68)	13.96 (3.89)
Reading	20.41 (3.66)	18.87 (4.95)	18.36 (5.10)	21.00 (2.82)	19.00 (3.55)	19.87 (3.91)
Images	12.74 (3.68)	14.11 (3.21)	13.14 (3.02)	12.30 (2.62)	14.05 (5.24)	13.66 (4.47)
Direct experience	12.58 (4.29)	15.42 (4.48)	14.61 (4.33)	13.00 (4.81)	12.85 (3.84)	12.56 (3.51)

Note: Values are presented as means and standard deviations (SD). Groups: 1= Massage therapy (University of Almeria); 2: Trauma physical therapy (University of Granada); 3: Electrotherapy, Hydrotherapy and Thermotherapy (University of Cadiz).

**Table 7.** *P*-value of differences between pre- and post-test scores on the Canfield learning skills inventory.

Groups	Problem-based learning			Conventional classes		
	1 <i>P</i> (N=58)	2 <i>P</i> (N=61)	3 <i>P</i> (N=57)	1 <i>P</i> (N=60)	2 <i>P</i> (N=62)	3 <i>P</i> (N=60)
Classmates	0.831	0.576	1.000	0.811	0.942	0.413
Organization	0.019*	0.701	0.941	0.638	0.502	0.387
Objectives	0.286	0.160	0.631	0.227	0.530	0.527
Competence	0.810	0.197	0.421	0.328	0.245	0.461
Professor	0.064	0.017*	0.001*	1.000	0.020	0.622
Details	0.145	0.809	0.790	0.104	0.310	0.593
Independence	0.200	0.149	0.200	0.083	0.377	0.740
Authority	0.071	0.306	0.434	0.711	0.511	0.124
Listening	0.062	0.938	0.631	0.543	0.666	0.467
Reading	0.426	0.146	0.007*	0.119	0.202	0.373
Images	0.549	0.041*	0.012*	0.484	0.644	0.201
Direct experience	0.598	0.001*	0.001*	0.650	0.744	0.553

Note: \**P*-value < 0.05 (95% confidence interval). Groups: 1= Massage therapy (University of Almeria); 2: Trauma physical therapy (University of Granada); 3: Electrotherapy, Hydrotherapy and Thermotherapy (University of Cadiz).

main source of initial information and had a lesser direct influence on the first steps of the learning process. On the other hand, they were consulted by students on their self-directed learning, and the tutor groups were crucial for organizing the learning tasks.

In comparison to PBL students, those taught by conventional methods were more likely to describe a lack of purpose towards learning, non-association of ideas in memorizing subjects, application of the law of minimum effort (with the teacher generating all of the discourse), and a fear of failure in the clinical setting. The PBL students expressed significantly greater levels of preference for their educational experience in comparison to their conventionally taught counterparts, in agreement with numerous reports on the positive response to PBL by medical and nursing students (Busari et al. 1997; Kaufman & Mann 1997; Rideout et al. 2002; Hendry et al. 2006; Kocaman et al. 2009; Abdelkhalk 2010; Samy 2011). PBL tests the ability of students to function in situations they have yet to encounter, enabling them to identify their learning needs and access appropriate resources. These outcomes were achieved and valued by our students, as also found in previous studies on this educational approach (Rideout et al. 2002). In the present study, satisfaction was especially marked on the level of independence provided by the PBL program, relationships with the teaching staff (supportive and positive), and on confidence in their ability to solve problems in clinical practice. Oja (2010) examined the evidence regarding the use of problem-based learning to improve critical thinking. The studies reviewed indicate a positive relationship between problem-based learning and improved critical thinking in nursing students.

It has been proposed that physical therapy programs have less specific objectives in comparison to some other areas of medicine, allowing the students greater scope to interpret and/or negotiate their meaning (Handal et al. 1990; Abrandt-Dahlgren & Dahlgren 2002). Solomon et al. (1996) compared the performance of physical therapy students from an

integrated PBL program with those from a program that introduced PBL into some senior courses in an otherwise conventional curriculum. Higher scores were observed for PBL students in basic and clinical science questions, although the differences did not reach statistical significance. Quantitative studies in medical students on PBL and conventional courses (Kaufman & Mann 1997; De Leng et al. 2006; Kocaman et al. 2009; Abdelkhalek et al. 2010; Ki Chan et al. 2010) all reported that the former have a more favorable perception of their learning environment. A qualitative study in physical therapy students also found them to have a positive view of the PBL approach (Solomon & Finch 1998; Abrandt-Dahlgren 2000).

PBL introduces students to carefully constructed problems sequenced according to a logical progression of massage therapy, trauma physical therapy, and electrotherapy, hydrotherapy, and thermotherapy. Physical therapy students taught by PBL reported that they enjoyed the collaborative learning process and appreciated the multiple ways of understanding a topic with their team members and the freedom that the small group offers for face-to-face interaction (Wood 2003; Khan et al. 2006).

### Study limitations

One study weakness was the lack of follow-up during hospital practice stays in order to detect differences in the students' approach to patients. Post-graduation follow-up of the students would also have been valuable but proved unfeasible due to the large number starting their professional life in other Spanish provinces and states of the European Union. It was not possible to examine differences in knowledge revealed by the theoretical-practical examinations, which were conducted in pairs, with different questions on the practical case under review for each individual student. Finally, although the students were not informed of the study hypothesis, they may have come to realize its nature.



## Conclusion

For these physical therapy students, the main contribution of PBL is its enhancement of group work, study organization, the relationship of ideas, and academic results. In comparison to conventionally taught counterparts, physical therapy students considered that PBL reduced lack of purpose, memorizing without relating, the law of minimum effort, and fear of failure. PBL-taught students placed greater value on the organization of course tasks, cordial interaction with the professor, and learning by reading, images, and direct hands-on experience. The PBL evaluated in this study is a teaching/learning method to facilitate learning strategies and study preferences in physical therapy students.

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## Appendix I.

Translation of the Spanish Adaptation of the Approaches to Study Skills Inventory for Students (ASSIST).

# LEARNING STRATEGY QUESTIONNAIRE

*Adaptation of: Approaches and Study Skills Inventory for Students (ASSIST)*

**Subject:**

**e-mail:**

**Gender:** ☐ Male ☐ Female

This questionnaire asks you to indicate your agreement or disagreement with comments made by other students in relation to study habits. Please start to complete and give an **immediate** response. When you decide on your response, think about **this subject in particular**. It is also very important that you respond to all of the questions: make sure that you have done so.

**5** means *I agree*

**4** means *I more or less agree*

**2** means *I more or less disagree*

**1** means *I disagree*

Try not to respond with **3** (*I don't know*) unless you truly do not know or believe that the question is not applicable to your work mechanics.

		5	4	3	2	1
1.	I organize myself to find the study conditions that help me to work easily	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2.	When I work on a subject, I think about how best to impress the evaluator	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3.	I often find myself wondering whether the work I do here is really worth it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4.	I usually try to understand by myself the meaning of what I must study	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5.	I organize my study time with care to take best advantage of it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.	I find that I only have to concentrate on memorizing a good part of what I must learn	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7.	I go over the work thoroughly to check the reasoning and find the sense of it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8.	I am drowning in the amount of material that I must address	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9.	I seek the evidence and try to reach my own	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	conclusions on what I am studying					
10.	It is important to me to know that I am doing as well as I can	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11.	I try to relate the ideas I encounter with other different topics or subjects when possible	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12.	I read little more than is really essential to pass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13.	I regularly think about ideas related to the classes when I am doing other things	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14.	I believe that I am fairly systematic and organized when I have to prepare for the exams	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.	I play close attention to the comments of tutors on coursework to try to obtain better grades next time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16.	There are not too many tasks in subjects that I find interesting or relevant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17.	When I read an article or book, I try to find out for myself exactly what the author wishes to express	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18.	I can set to work when required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19.	Large parts of what I am studying make little sense: they are like unrelated fragments or pieces	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20.	I think about what I want to gain from every subject for my studies to be well-directed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21.	When I work on a new topic I try to see how all the ideas fit together	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22.	I often worry about whether I shall be able to do my work correctly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23.	I often question things that I have heard in class or read in a book	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24.	I believe I am doing well, and this helps me to put more effort into the work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25.	I concentrate on learning only those pieces of information that I have to know in order to pass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26.	I find that the study of topics can sometimes be passionate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27.	I follow the readings suggested by the tutor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28.	I bear in mind the tutors who will evaluate subjects and what they will focus on	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29.	When I look back, I sometimes wonder why I ended up here	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30.	When reading, I sometimes stop to reflect on what I am trying to learn	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

31.	I work throughout the week instead of leaving it to the last moment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32.	I am not completely sure what is important in the classes, so I take notes on everything	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33.	Ideas from text books or articles stimulate me, initiating long chains of my own thoughts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34.	Before starting a task or answering an exam question I think about how I can achieve greater focus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35.	I often panic if I am behind with work, homework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36.	When reading, I carefully study the details in order to see how they fit together	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
37.	I put a lot of effort into studying because I am determined to do it well	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38.	I adapt my studying just to what a task or exam appears to require	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
39.	I find some of the ideas in the subjects truly attractive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40.	I am used to planning the week ahead, either mentally or on paper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
41.	I pay close attention to what appears important in the classes and I concentrate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
42.	I am not really interested in this subject but have had to take it for other reasons	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
43.	Before approaching a problem or task I try to explore the background	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
44.	I generally make good use of the time I have during a day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
45.	I often have problems in seeing any sense in the things I have to memorize	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
46.	I like to play with my own ideas, although they don't get me very far	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
47.	When I have finished part of the work, I check whether it fulfills the requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
48.	I am often worried about work that I think I will not be capable of doing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
49.	It is important to me to be able to follow the argument or see the reason for things	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
50.	I do not find it at all difficult to motivate myself	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
51.	I like to be told exactly what I have to do in tasks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
52.	I am sometimes captivated by some topics and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Appendix II.

Approaches (scales) and strategies (sub-scales) forming the *ASSIST questionnaire*.

Deep learning	
Search for meaning	4 + 17 + 30 + 43
Relationship of ideas	11 + 21 + 33 + 46
Use of evidence	9 + 23 + 36 + 49
Interest in ideas	13 + 26 + 39 + 52
Strategic learning	
Study organization	1 + 14 + 27 + 40
Time management	5 + 18 + 31 + 44
Attention to the requirements of tasks	2 + 15 + 28 + 41
Achievements	10 + 24 + 37 + 50
Monitoring effectiveness	7 + 20 + 34 + 47
Superficial learning	
Lack of purpose	3 + 16 + 29 + 42
Memorizing without relating	6 + 19 + 32 + 45
Law of minimum effort	12 + 25 + 38 + 51
Fear of failure	8 + 22 + 35 + 48

Appendix III.

Spanish Adaptation of the Canfield Learning Study Inventory (*CLSI*).

ACADEMIC PREFERENCE  
QUESTIONNAIRE  
*Adaptation of the Canfield Learning Style Inventory (CLSI)*

Subject:

e-mail:

The following part of the questionnaire serves to determine the preferences of students with regard to some elements of the teaching. Because it considers preferences, there are no *good* or *bad* responses.

There are four responses for each question. You must order them according to your preferences **WITHOUT REPEATING ANY EVALUATION**. Mark **1** alongside the option you **most** prefer, **2** alongside the next, **3** alongside the next, and **4** alongside that which you **least** prefer.

1	Remember your preferred classes. Why did you like them? Put in order the following reasons.	1	2	3	4
a)	I liked my co-students. We shared our ideas and interests.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	The class was well organized. The ideas followed an order.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



	I could set my own objectives.				
c)	The teacher let me study what I was most interested in.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	The teacher knew how I was in comparison to the others. The grading of each student was fair.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>2</b>	<b>What types of teacher do you like? Put in order the following descriptions.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	They are cordial and friendly. They take a personal interest in me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	They give clear information on the work that needs to be done and how it has to be done.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	They let me decide what to study and how to do things.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	They set a high requirement level in class. They make me do the work required to achieve this level.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>3</b>	<b>In what way do you learn best? Number the following options</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	Listening to others talk about a subject.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Reading what other people have written on a subject.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Looking at images, graphs, videos.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Working myself on the subject.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>4</b>	<b>In your opinion, what types of teacher are the worst? ( 1 = the worst, ..., 4 = the least bad )</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	Teachers who do not explain clearly what needs to be done. I never know what I am supposed to do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Teachers who never let me do things on my own. They don't let me take my own decisions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Teachers who are too permissive when students are noisy and who let them do what they want.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Teachers who are only interested in the subject matter. They are not interested in the students.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>5</b>	<b>What change would improve your educational experience? Order the following proposals from most useful to least useful.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	More information to know how I do my work in comparison to the other students.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

b)	More group activities. More opportunities to meet and know other students.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	More class outlines. More information on their content.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	More opportunities to establish my own objectives. More opportunities to think for myself.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>6</b>	<b>Classes usually involve different activities. Order the following descriptions in accordance with your preferences.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	Carrying out experiments or projects in the laboratory.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Viewing slides, videos, graphs, or diagrams.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Oral explanations and question-and-answer sessions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Reading the textbook and other recommended reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>7</b>	<b>In the large part of courses, students are evaluated and given a grade.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
	<b>What do you think about grades? Order the following sentences in accordance with your opinion.</b>				
a)	Grades sometimes create jealousies among students. They cause bad feelings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Teachers sometimes set exams with unfair questions. The questions have nothing to do with the textbook or what was explained in class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Grades and exams are sometimes not useful for me. They do not help me to know how I am doing. They do not help me to see what I have to study more.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Grades sometimes do not really show who is doing well and who is doing badly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>8</b>	<b>Imagine that you want to inform yourself about a task. In what way would you like to learn? Order the following procedures in accordance with your preferences.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	Someone explaining it to me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Reading a book or article that explains it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Observe a demonstration of the task in class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Attempt to perform the task itself as a test.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>9</b>	<b>What method would most help you to learn? Order from 1 (most useful) to 4 (least useful).</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	To get to know the teacher; to have the opportunity to see and speak with him/her; to have the opportunity to go and see and talk with him/her.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

b)	To know exactly what has to be done for the subject; to know exactly what is expected of me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	To have the opportunity to make my own decisions; to be able to plan my own work.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	To have a teacher who tells me how and what to study.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>10</b>	<b>What is your responsibility as a student? Order the following procedures in accordance with your preferences.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	Collaborate with other students and help them as much as I can.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Compare myself with the other students and try to do better than them.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Make my own decisions about what I can do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Ask the teacher questions when the explanation is confused.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>11</b>	<b>If a person wants to be a teacher, what do you think is the most important thing for them to learn? Order the following options in accordance with their importance.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	How to identify with the students. How to have a good relationship with them.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	How to maintain order in class. How to get the students to work.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	How to make the students work and learn on their own account.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	How to inform the students about the demands of the subject, the class norms, and the evaluation criteria.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>12</b>	<b>Imagine that you want to know what a new type of plastic is like. How would you like to learn this? Order the following options in accordance with your preferences.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	Listening to a talk or oral explanation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Directly experimenting with it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Looking at a documentary or slides.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Reading a book or an article.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>13</b>	<b>Remember the teachers who most helped you. Order the following options in accordance with your preferences.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	They made it very clear what you had to do. They did not make you strain to guess what they wanted.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	They liked the students. They really wanted to help and understand them.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

c)	They controlled their classes. They required everybody to behave correctly, pay attention, and study in class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	They let students work on their own account. They considered each person as an individual.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	<b>If you did a class on how to keep the environment clean, how would you like to learn? Order the following options in accordance with your preferences.</b>	1	2	3	4
a)	Doing a field study.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Looking at documentaries, films, etc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Listening to an oral explanation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	<b>Try to remember the classes that you did not like. Why didn't you like them? Order the following options from 1 (what most displeased you) to 4 (what least displeased you).</b>	1	2	3	4
a)	The class was not organized. I could never predict what would come after.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	The students argued and fought too much in class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Whatever the quality and amount of the work you did, the professor approved it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	I was not allowed to do what I wanted to do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16	<b>What importance do the following ideas have for a class? Order the following sentences in accordance with their importance.</b>	1	2	3	4
a)	I have the opportunity to make friendships. The students help each other.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	The concepts and contents are ordered. They follow one another in a comprehensible manner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	I can decide how and what to study. I have the possibility of deciding what topics to study in greater depth.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	The grading is fair and truly shows the students that are doing better.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	<b>What things displease you in a class? Order the following sentences from 1 (what most displeases you ) to 4 (what least displeases you)</b>	1	2	3	4
a)	The professor was hostile, got angry for no reason and was inconsiderate.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	I could not understand what I had to do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

c)	I could not do things in the most appropriate way for me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	The teacher was unable to control the class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18	<b>What do you most like to do in a class? Order the following activities in accordance with your preferences.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
a)	The teacher explains and then responds to questions from the students.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b)	Read on the topic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c)	Look at images, documentaries, graphs, presentations, etc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d)	Experiment or practice with the material.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## Appendix IV.

Scales and subscales of the *CLSI questionnaire*.

Learning conditions	
Co-students	1a + 5b + 7a + 10a + 15b + 16a
Organization	1b + 5c + 7b + 10d + 15a + 16b
Objectives	1c + 5d + 7c + 10c + 15d + 16c
Competency	1d + 5a + 7d + 10b + 15c + 16d
Teacher	2a + 4d + 9a + 11a + 13b + 17a
Details	2b + 4a + 9b + 11d + 13a + 17b
Independence	2c + 4b + 9c + 11c + 13d + 17c
Authority	2d + 4c + 9d + 11b + 13c + 17d
Modes of learning	
Listening	3a + 6c + 8a + 12a + 14d + 18a
Reading	3b + 6d + 8b + 12d + 14b + 18b
Images	3c + 6b + 8c + 12c + 14c + 18c
Direct experience	3d + 6a + 8d + 12b + 14a + 18d