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Learning styles among university students and learning-centered teaching

Estilos de aprendizaje en estudiantes universitarios y enseñanza centrada en el aprendizaje

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Abstract

The aim of this work was to assess the impact of learning-centered methods, implemented by four professors into the learning styles of some students on the Educational Processes and Contexts, a course of the Master's Degree in Secondary Education Teaching at the University of Valencia (Spain). Another aim was to analyze the students' assessment employed methods. The sample included 117 subjects from this Master's Degree in 2014-15, divided into four groups from four different specialties. A quasiexperimental design was used along with pre-test/post-test measures with the ILS (Inventory of Learning Styles) questionnaire (Vermunt, 1994). Students also assessed the methods used by their professors with a quantitative questionnaire. The professors followed learning-centered methods with different methodological formats with the four groups. Significant improvements were found in many of the variables measured by the questionnaire (deep learning, self-regulation, personal interested-based learning direction, using knowledge, cooperation, etc.) in the four student groups, and the pre-test/post-test differences were bigger in groups 1 and 4 than in groups 2 and 3. The inter-group comparisons reflected significant differences in the pre-test among all four groups, which did not appear in the post-test so all the groups were equal after applying the learning-centered methods. The students positively assessed the used methods. The results confirmed the positive influence of learning-centered methods on students' learning styles and provided some ideas to improve teaching-learning processes with university students.

Keywords:

Student centered learning, Learning styles, Deep learning, Self-regulation, University students.

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Resumen

El objetivo de este trabajo era valorar el impacto de los métodos centrados en el aprendizaje, implementados por cuatro profesores/as, en los estilos de aprendizaje de los alumnos de la asignatura de Procesos y Contextos Educativos en el Máster de Educación Secundaria de la Universidad de Valencia. También se pretendía analizar la valoración del alumnado sobre los métodos utilizados. La muestra fue de 117 estudiantes, que cursaban estos estudios durante el curso 2014-15, repartidos en cuatro grupos de cuatro especialidades diferentes. Se usó un diseño cuasiexperimental, con medidas de pretest/postest, mediante el cuestionario ILS (Learning Styles Inventory) de Vermunt (1994); además, el alumnado valoró los métodos utilizados por sus profesores mediante un cuestionario cuantitativo. Los profesores utilizaron métodos centrados en el aprendizaje con diferentes formatos metodológicos en los cuatro grupos. Se constataron mejoras significativas en un número importante de las variables que analiza el cuestionario (aprendizaje profundo, autorregulación, orientación centrada en el interés personal, uso del conocimiento, cooperación, etc) en los cuatro grupos, siendo las diferencias mayores en los grupos 1 y 4 que en los grupos 2 y 3. Las comparaciones entre los grupos reflejaron diferencias significativas en el pretest entre los cuatro grupos, que no se dieron en el postest, igualándose los grupos. Los alumnos valoraron positivamente los métodos utilizados. Los resultados corroboraron la influencia positiva de los métodos centrados en el aprendizaje en los estilos de aprendizaje de los estudiantes, y aportan ideas para la mejora de los procesos de enseñanza-aprendizaje del alumnado universitario.

Palabras clave:

Aprendizaje centrado en el alumno, Estilos de aprendizaje, Aprendizaje Profundo, Autorregulación, Estudiantes universitarios.

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The learning-centered model has gradually made its way to university training. After some original works, like that by Barr and Tagg (1995) which presents a theoretical basis of the model along with its description, and some empirical works conducted using a phenomenographic approach (Gow & Kember, 1993; Kember, 2009; Martin & Ramsden, 1992; Samuelowicz & Bain, 1992 y 2002), which analyze what teachers do and what they say about how they work and why they do so, the characteristics of this model have been specified. Generally speaking, when the learning-centered model, also known as the student-centered model, was characterized, its characterization was done as opposed to a teaching-centered model, also known as a teacher-centered model or a classical instructional model.

The teaching-centered model emphasizes the role of teachers as instructors and transmitters of built knowledge because it is teachers who know the subject. Their basic task consists in explaining well so that students can reproduce what teachers have taught them. Master classes tend to be used and a conventional exam is the most usual way to evaluate students.

Students' autonomy, learning and development of self-regulation skills is encouraged with the learning-centered model. The teacher is understood to be a mediator between content and students, and the mediator's fundamental task is to create good environments and learning experiences. Different methods are employed, and efforts are made to use an innovative methodology that allows students to acquire the expected learning results and to develop active and committed learning: cooperative work, problem-based learning, project-based learning, case studies, research works, etc. These are compatible with a quality presentation methodology (Zabalza, 2012). Efforts are made to follow a significant evaluation methodology that uses various sources to collect information and to return feedback to students (Hernández 2012) to help them mobilize the self-assessment (Hannafin, 2012) and self-regulation processes of the learning process.

The constructive alignment concept is most coherent with this model (Biggs, 2005). It defends that all teaching-learning process components have to work in harmony, "in line", so that both teaching methods and evaluation procedures are arranged to achieve the foreseen competences and learning results, which must be coherent to achieve them.

The literature contains a considerable number of publications with recommendations for implementing the model into different knowledge areas (Bista, 2011; Brackin, 2012; Campbell, 2012; Hunting & Chalmers, 2013; McLean & Gibbs, 2010; Menacherry, Wright, Howell & Knight, 2008; Mostrom & Blumberg, 2012; Nitza, 2013; Prieto, 2008; Schweisfurth, 2015; Sue, 2014; Tagg, 2003), and there are examples of the specific developments of some of its elements (Armbruster, Patel, Johnson & Weiss, 2009; Bruehl, Pan & Ferrer-Vinent, 2014; Chen Zhou, Sun, Wu, Lu & Tian, 2015; Koles, Nelson, Stolfi, Parmelee & DeStephen, 2005; Roy & McMahon, 2012; Lucieer et al., 2016; Tagg, 2003; Tessier, 2007; Tien, Rotht & Kampmeier, 2002).

The present article provides data of a research work whose main objective was to analyze/assess the effects of the learning-centered methodology on university students' learning from the conviction of having to make empirical data available that help improve University teaching-learning quality.

Thus the objective of this work is to evaluate the impact of this methodology, which was implemented by four professors, who taught the Educational Processes and Contexts course of the Master's Degree in Secondary Education Teaching at the University of Valencia (Spain), into the students' learning styles. The intention was to also analyze students' assessment of the applied learning-centered methods.

The hypotheses are as follows:

Applying learning-centered methods will imply statistically significant differences in the students who form the four sample groups

between the pre-test and post-test on the *Inventory of Learning Styles (ILS) scales and subscales*, which will improve, and a significant difference in means, with deep learning increasing as opposed to surface learning, while students self-regulation will increase; personal interest-based and vocation-based learning direction will also increase, while knowledge building/use and cooperation will improve. We also assume that inter-group differences will appear in the post-test depending on the methodological format used, and that students' assessment will be positive.

Method

Design

A quasiexperimental design was used with four non equivalent groups, a pre-test and a post-test, and no control group[1]. The independent variable was the methods, which took the different methodological formats used by the teachers. The dependent variables were the dimensions that the ILS questionnaire evaluates, which are found in the Instruments Section. Qualitative data collection when the subject ended was also included, for which open questionnaires were used to know students' perception of the process.

Sample

The sample was made up of 117 students of the Master's Degree in Secondary Education Teaching taught at the University of Valencia (Spain), which they studied during academic year 2014-15. The students were divided into four groups (Group 1 with 39, Group 2 with 25, Group 3 with 28 and Group 4 with 25 students). They all studied the same subject, but had different professors: two female teachers and two male teachers.

The students in Group 1 studied the Spanish Language specialty (Professor 1), those in Group 2 were taught French and Classic Languages (Professor 2), the students in Group 3 learned Biology and Geology (Professor 3), while the Group 4 students studied Vocational Guidance (Professor 4).

Of the whole student sample, 74.4% were females (87) and 15.6% were males (30). Per group, the frequencies and percentages of the groups in gender terms were as follows:

Table 1. Frequencies and percentages of the sample groups according to gender

		Frequency	Percentage
Group 1	Male	16	41.0
	Female	23	59.0
Group 2	Male	4	16.0
	Female	21	84.0
Group 3	Male	7	25.0
	Female	21	75.0
Group 4	Male	3	12.0
	Female	22	88.0

Instruments

The ILS (*Inventory of Learning Styles*) by Vermunt (1994 and 1998) was used, along with a questionnaire devised by the research group for the students to complete to assess the usefulness of the methods used by the teachers to help them learn.

The name ILS is slightly mistaken as it does not exactly evaluate learning styles in the same way that the literature normally refers to them because its concept of learning styles is broader than it is in the classic interpretation of learning styles (Vermunt & Vermetten 2004; Vermunt 2005). Learning styles, as a theoretical construct whose origin is normally attributed to Kolb (1976), appeared in the 1970s as the preferred ways to learn that subjects employed (Entwistle & Peterson, 2004) as a relatively general and constant predisposition to always adopt the same

[1] Having a quasiexperimental design with a non equivalent control group of students who also learned the subjects of the same degree, but by the traditional methodology, would have been a more robust method. It was not possible to carry out such an initiative given the need to count on traditional teachers for this research, who did volunteer to participate in such research. The use of four student groups whose teachers followed different methods allowed intergroup comparisons as some groups could be compared with others, which makes the study design more robust.

strategy in different situations, even when the task requires certain specific demands (Schmeck, 1982a and 1982b).

Nonetheless, Vermunt uses the concept as a superordinate concept in which the cognitive and affective components of learning, the metacognitive self-regulation components of learning, learning conceptions and learning guidelines are combined (Vermunt & Vermetten 2004). Vermunt's version of the "learning styles" concept better matches what is understood as "learning patterns" or "orientations to studying" (Entwistle & McCune, 2004; Vermunt, 1996). Indeed Vermunt preferred the name learning patterns, but strangely enough he did not change the name of his assessment. instrument, which continues to be known as "*Inventory of Learning Styles*" (*ILS*).

Vermunt (1994 and 1998) designed the ILS questionnaire to identify learning in patterns university student samples. This survey included 120 items arranged on 16 scales, some of which include subscales. Scales are grouped as four main blocks (Learning, Regulation, Learning directions and Mental learning models). By combining factors (scales and subscales), Vermunt's learning patterns were defined (1998 and 2005).

The four main blocks are:

I. *Processing strategies.* They refer to the actions performed to process learning contents. This dimension, or domain, is formed by 27 items distributed on three scales, and the first two which include two subscales:

Scale 1. Deep processing (11 items)

Subscale 1a. Relating and Structuring (relating the elements of a subject with one another and with available knowledge; structuring them as a whole).

Subscale 1b. Critical processing (forming one's own point of view about the subject by drawing one's own conclusions and being critical with the conclusions reached from texts, authors and teachers).

Scale 2. Stepwise learning (11 items)

Subscale 2a. Memorizing and Rehearsing (learning facts, definitions, lists, etc., by repetition)

Subscale 2b. Analyzing (analyzing the subject step by step and studying the included elements in detail one by one)

Scale 3. Concrete processing (5 items) (specifying and applying contents by connecting them with one's own experience and practically using what has been learnt)

II. *Regulation strategies.* These are used by learners to guide, regulate, revise and control the process and the learning results. This dimension consists in 28 items distributed on three scales. The first two are formed by two subscales.

Scale 4. Self-regulation (11 items)

Subscale 4a. Self-regulation of learning processes and results (regulating one's own learning by planning, revising, diagnosing problems, self-assessing, self-adjusting, etc.).

Subscale 4b. Self-regulation of learning content (consulting the literature and sources not included in the program)

Scale 5. External regulation (11 items)

Subscale 5a. External regulation of learning processes (being guided in regulating the learning process by external sources, such as objectives, guidelines, questions, etc., of teachers and authors of manuals)

Subscale 5b. External regulation of learning results (assessing one's own learning by external means, like tests, tasks or questions provided by others)

Scale 6. Lack of regulation (6 items) (finding it difficult to regulate learning processes)

III. *Learning orientations.* This block includes students' intentions, attitudes and concerns about their studies, and contains 15 items on five scales.

Scale 7. Personal interest (5 items) (students' interest centers on their development as a person).

Scale 8. Certificate directed (Certificate directed; 5 items) (students study to obtain high qualifications, pass exams, obtain a degree).

Scale 9. Self-test directed (5 items) (students study to demonstrate to themselves that they can deal with higher education demands well).

Scale 10. Vocation direction (5 items) (students study to obtain professional skills and find a job).

Scale 11. Ambivalent (5 items) (doubtful and uncertain attitude about studies, one's own capacities, the chosen study area, etc.

IV. *Mental learning models or Learning conceptions.* This block includes individual's beliefs and conceptions about how they conceive knowledge and ways to learn. It is made up of 40 items on five scales:

Scale 12. Construction of knowledge (9 items) (learning here is understood as knowledge building itself; most learning tasks are understood as students' tasks)

Scale 13. Instake of knowledge (9 items) (learning is understood as taking the knowledge provided by the educational process and memorizing it; learning activities are seen as the teacher's tasks)

Scale 14. Use of knowledge (6 items) (learning is understood as acquiring knowledge to use and apply it. Activities are seen as students' and teacher's tasks)

Scale 15. Stimulating education (8 items) (learning activities are understood as students' tasks, but teachers and authors of manuals must constantly stimulate students to use these activities)

Scale 16. Cooperation (8 items) (value is conferred to learning in cooperation among peers by sharing tasks to learn with others)

The survey is arranged into two parts: the first includes the learning and regulation strategies, and items are answered on a 5-grade Likert-type scale from "never" to "almost always". The second includes the learning orientations and learning conceptions, which are answered with a 5-grade Likert-type scale from "disagree entirely" to "agree entirely".

With our research work, we did not intend to delimit students' learning patterns by crossing the scores of the factors to determine which groups of subjects emerged from this crossing, and which were their learning patterns.[2] We intended to analyze only the changes that took place in the different factors analyzed by the instrument (scales and subscales) from the pre-test to the post-test in order to delimit whether applying learning-centered methods favored their improvement, and to also determine any possible existing inter-group differences in both the pre-test and the post-test.

To assess the methods, when teaching ended all the students completed a *quantitative questionnaire* devised by the research team to assess how useful the teaching and assessment methods that their teachers employed are for their learning (on a 5-grade scale from Not at all to A lot).

Data collection procedure

The students completed the ILS questionnaire when the subject started being taught (the pre-test) by contextualizing their answers in line with their usual way of learning. They once again completed it when teaching ended (the post-test) by contextualizing their answers in line with the professors and the subject they were studying on the website https://poliformat.upv.es/portal. When teaching the subject ended, the students also answered the two above-mentioned questionnaires.

The dynamics and methodology followed in the subject

The four professors used a student learning-centered methodology for their participation and commitment. The four methodological formats they used had their similarities and differences, but shared the aligned teaching approach (Biggs, 2005) and a variety of working methods, which is a good strategy for students' to learn competences in the Master's

[2] Vermunt (1996) found four patterns: Non directed, Reproduction-directed, Meaning-directed and Application-directed. With a sample of Asian students, Marambe, Vermunt and Boshuizen (2012) found four patterns: Meaning-directed, Reproduction-directed, Idealistic passive learning-directed and Lack of regulation or Ambivalent direction.

Degree in Secondary Education Teaching. Using these methods helps them to be integrated and subsequently used in teachers' professional work.

In both cases a coherent assessment was contemplated with the methods employed for teaching-learning, for which the tasks were considered suitable to assess learning, which did not hinder any specific assessment procedure being used. The employed assessment procedures returned feedback to the students with a view to improving the process.

The methods that the four teachers employed are presented below:

Professor 1 (Group 1) used the methodology presented below in the Spanish Language Group:

TEACHING METHODS	
1. Master class (presentation methodology)	A participative master class is resorted to. The presentation part is confined to presenting the program, the structure and contents of each subject, exercises, practical classes, etc. Debate in class about the questions posed by the teacher is promoted. Questions are also previously prepared by students. This allows doubts to be solved, and questions about particularly complex/difficult contents to be explained.
2. Questions about the subject to be commented on in class	Questions with different levels of complexity are raised on the subjects that students must prepare individually using the materials provided by the teacher –manual, bibliography, slides– or those that students must autonomously locate. Students must send questions to the teacher via the virtual classroom by a deadline date before being discussed and debated in class.
3. Student presentations	Students must present in class the work done in groups (described below) to the teacher and the class group, which is supported by a presentation program (ppt, prezi, etc.)
4. Cooperative work	Students must work in a group on a theme related with the program. This work must be handed to the teacher before a set time and must be defended in class before the teacher and classmates. Several class sessions are organized to this end, although autonomous work outside the classroom is usually required.
5. Individual works	These are included in a portfolio, as described below.
6. Practical classes	Students as groups attend a series of practical classes on the program's contents and include the Aronson Puzzle Technique, case studies, videos, etc.
7. Tutoring in class	Group tutoring is done to follow-up and counsel group work.
8. Class discussions	These are done using the questions raised by the teacher and solved by students, and are sent via the virtual class
9. Portfolios	Students must hand in two portfolios with the answers to the questions raised by the teacher while being debated in class. A reasoned self-assessment is also expected. The second time portfolios are handed in, which apart from the questions and self-assessment, must also include the group work done during the 4-monthly period.

ASSESSMENT METHODS	
1. Students' self-assessment	Every time portfolios are handed in, and also in the exam, students have to self-assess their work, their effort and their learning by using the set assessment criteria
2. Written open-response tests	A written exam is sat that includes short-response questions of various levels of complexity (40% of the mark)
3. Presenting works (co- assessment)	The group work presentation before the class is assessed according to the set criteria, with classmates using the co-assessment and the teacher using the assessment
4. Students' group work	Students' group work is assessed according to the set assessment criteria
5. Portfolios	The portfolios, which are handed in twice, are assessed according to the set assessment criteria (questions represent 20% of the mark, practical reports represent 20% and group work represents 20%)

Professor 2 (Group 2) used the following methodology in the French and Classic Languages group.

TEACHING METHODS	
1. Master class (presentation methodology)	The teacher initially resorts to oral presentation, supported by visual presentations to set out objectives, contents, practical classes and the other activities included in each theme. As from theme 3, the teacher cuts the time which she intervenes in and includes students in the presentations as a co-presentation of themes. Student contributions are based on previous readings recommended by the teacher, which are relevant to lead the presentations and to encourage questions of interest raised about them.
2. Questions about the theme to comment on in class	The teacher asks questions during presentations. Some are asked orally to prompt students' immediate reaction and participation. Others are proposed to be done later in writing as a task to be sent to the Virtual Class/Moodle Platform. The teacher corrects and assesses them, and returns them with feedback.
3. Student presentations	Some of the practical classes that the teacher proposes to be solved in cooperative groups end by presenting the results obtained by each group to the class as a whole, which allows discussion and debate about them.
4. Cooperative work	The teacher raises questions to work cooperatively (groups with 3-4 students). A work done in a group of four people is also presented audiovisually ("group project") at the end of the subject. This was done throughout the academic year and was supervised by the teacher.
5. Personal work corrected by the teacher	Students perform seven individual tasks on the main aspects of each theme. Questions involved summarizing the work done+extended readings+critical reflection.
6. Practical classes	These are held during class sessions, mainly in cooperative groups. This method is closely linked to problem-based learning.
7. Class discussions	The teacher works in detail with the group dynamics during the first two sessions held to create a suitable classroom climate to get all the students involved in the discussions held during each session. The group is formed by students from two different degrees who have worked the degree by following a very different methodology.
8. Problem-based learning	Some practical classes stem from real situations (statistical data, teachers' testimonials, interviews with professionals, documentaries, etc.) where a problem is presented to be discussed and to offer opinions/solutions.

ASSESSMENT METHODS	
1. Level tests	An initial level test is taken that includes 10 incomplete sentences about pedagogic contents and attitudes to ways of learning. This test is done individually, and is then shared. This test is done to assess students' previous knowledge about the subject and their attitudes, which allows the teacher to work from the group's real situation.
2. Students' self-assessment without using the digital platform	At the end of the academic year, a self-assessment report is placed on the Virtual Class with six closed-answer questions (with five response options, from 5/agree entirely to 1/disagree entirely). A final qualitative open question is included to ask students to make a self-assessment on a numerical score from 1 to 10, and to explain their answer.
3. Written open-response tests	When the subject ends, a final exam is sat with open-response questions to assess knowledge and capacity to reflect.
4. Individual student work	These individual works are placed in the Virtual Class. They are used to assess the accuracy of responses, the suitability of written discourse and the capacity to critically reflect.
5. Student group works/Final project	Once the group-class is formed, students form groups with 3-4 people to do an audiovisual project, which is presented at the end of the academic year. Since groups are formed and possible work themes are presented using the subject's contents, the teacher sets times to direct by group tutoring. The group work process is assessed (with a work contract template), as are the end product+ presentation (video).
6. Active participation	Different practical sessions, debates, etc., are organized to collect any evidence for participation.
7. Reading a book-review-active participation during dialog-based discussion	Students are proposed a list of five readings about one of the program's themes. They choose the book on which an individual review is to be done and to participate in dialog-based discussion. To participate in this discussion, the group is subdivided to encourage participation and debate. During this discussion, the teacher hands out a script with a selection of book fragments and some questions to prompt/guide discussion. The teacher moderates, but does not participate in, the discussion.

Professor 3 (Group 3) used the following methodology in the Biology and Geology group:

TEACHING METHODS	
1. Master class (presentation methodology)	A participative master class is resorted to. The teacher explains the fundamental concepts of each theme and poses questions so that students can debate as part of the explanation. Students previously obtain the material and basic texts on the theme they work with from the Virtual Class.
2. Questions on the subject to comment on in class	For all the themes, the teacher asks some key questions, which are posted on the Virtual Class to be given. During the explanation, the teacher asks students these questions to assess their understanding of the theme's basic concepts, to explain the most complex questions and to encourage students to participate and debate.
3. Solving exercises and problems	In class, different tasks, exercises and problems are presented about the contents being worked on, which are solved with the teacher acting as a mediator, and are shared at the end: moral dilemmas, analyzing situations, conflicts, etc.
4. Student presentations	In class students have to present the work done in groups about one of the themes considered in class with the support of a presentation program (ppt, prezi, etc.).
5. Cooperative work	Students prepare the theme set out by the teacher using the Aronson Puzzle Technique, which make them work in different groups in class and to present the end product. The assessment criteria include clarity, specification, comparison, a summary of the fundamental aspects, the employed references and adapting work to the parameters set for the research.
6. Practical classes	In class students work as groups on a series of practical activities related to the program contents, which include the Aronson Puzzle, case studies, simulation techniques, role-playing, conflict-solving, analyzing values, decision making, etc.
7. Class tutoring	Group tutoring is done to follow-up and counsel group work
8. Class discussions	They involve practical activities done by students as groups, whenever possible, and are shared and discussed as a class group.
9. Projects	The teacher proposes voluntarily doing an entrepreneurial project to present it to the MOTIVEM Awards, which have been run since 2013 by the ADEIT Foundation of the Universidad de Valencia (Valencia University).
10. Research work	Throughout the academic year, students have to do two research works as groups: one in the Aronson Puzzle Technique context and one about gender equality.
11. Portfolios	Students hand in to the teacher the practical work on each theme that they work on as groups, along with the answers to the questions on this theme. The teacher corrects these works and returns them to the students so they can be definitively written, and this forms part of the subject's portfolios.

ASSESSMENT METHODS	
1. Students' self-assessment	Students self-assess the work carried out as groups at the end of the academic year.
2. Co-assessment	Students co-assess the research works conducted by the other class groups, which are presented in class. Assessments ae made of the relevance of the theme, the objectives set out, the activities, the presentation done and the feasibility of the proposals.
3. Written open-response tests	A traditional written exam is done on five themes, of which one is ruled out, in which students have to demonstrate the knowledge they have acquired from performing all the activities in the subject. One of the themes is practical, similarly to the works done in class
4. Presenting works (co-assessment)	The works done as groups on the two research themes are presented to the class group, along with those done in the groups that participate in the MOTIVEM Awards. The presented works are assessed with the Co-assessment system, as indicated in Point 2.
5. Individual student works	Students are obliged to read a book about any relevant educational theme, and choose from a list of 12 books presented by the teacher. They have to answer a series of questions about the book contents. They can also read a second book voluntarily to obtain a higher mark.
6. Student group works	The teacher offers a series of practical activities to be done as groups on each theme. Part of this work, particularly that which refers to searching and investigating, has to be done outside class times.
7. Projects	The teacher assesses students' participation in the projects for the MOTIVEM Awards and, according to the quality of the project and its presentation, he gives them up to another point toward their mark for the subject.
8. Portfolios	As a whole the portfolio represents 50% of the mark of the subject and it includes the self-assessment of the group work, which represents 10% of this mark.

Professor 4 (Group 4) used the following methodology in the Vocational Guidance group:

TEACHING METHODS	
1. Master class (presentation methodology)	Uses: presenting the subject (objectives, competences, methodology and assessment) when the theme starts and whenever necessary given the complexity of contents. This is combined by directly asking the group questions.
2. Questions on the subject to comment on in class	Use: continuous and in all the classes (inside/outside) to identify former knowledge and/or to examine in detail. They are handed in to the teacher who revises/assesses them to offer the group general feedback.
3. Solving exercises and problems	Use: exercises are sporadically suggested to reinforce contents. The teacher focuses on designing and following up exercises, clarifying doubts, posing questions, redirecting exercises, etc.
4. Student presentations	Use: the dynamics that predominate in most classes. Sometimes presentations are voluntary, while the teacher selects a student on other occasions. Some presentations take a given programmed format. Resources (power point, posters, etc.) can be used or improvised.
5. Cooperative work	Use: the subject's main methodology. Base-groups are formed at the start of the academic year. These groups are independent of those that are organized for class dynamics (metaplán, Aronson Puzzle).
6. Personal work corrected by the teacher	Use: it centers on the individual portfolio prepared during the academic year. The teacher suggests three time points (halfway through, at the end of the first 4-monthly period and when the academic year ended) for follow-up and to make the improvement proposals that he considers.
7. Practical classes	Use: with several objectives and the time spent on them vary. Some practical classes are scheduled for 4-hour sessions and others last 30 minutes. Designs can be individual, group, or a combination of both.
8. Research work	Use: simple (done individually or as pairs) research work is considered when the academic year starts, and includes methodological and presentation rigor. Research stems from themes, a book or a movie (related to the subject). Work is supervised by the teacher.
9. Learning contract	Use: as groups (the whole class) at the start of the academic year and is agreed on. The methodology and assessment criteria are determined.
10. Portfolios	Use: individual. It reflects the activities done in class by emphasizing what has been learnt, the obtained results and the difficulties to undertake the work, including a self-assessment to justify students' role in the work. Portfolios are handing out officially twice.

ASSESSMENT METHODS	
1. Students' self-assessment	Assessing the work done. Students have to be aware of what they have learnt, the difficulties they encounter and the obtained results.
2. Written open-response tests	Short questions with different levels of complexity that have to be answered according to the work done or with the materials provided by the teacher.
3. Presenting works (co-assessment)	Works are assessed according to the set criteria in the heading, and are explained and agreed on beforehand by the teacher.
4. Individual works	Assessments are made to ensure contextualized work, a suitable bibliographic search has been made, and the work's structure and presentation are appropriate.
5. Student group works	They have to meet the assessment criteria to assess the product (presented work) and the process (follow-up and group's report on the process), individual and group self-assessments, which are added to the portfolio.
6. Portfolios	Delivered twice according to the set assessment criteria (activities and assessments 50%, group work 30%, written tests 20%)

Results

Statistical analyses

Having verified the normality of the dimensions (Kolmogorov-Smirnov test) by SPSS 22.0, and given the size of the groups, an analysis of variance (ANOVA) for repeated measures was performed to compare evolution from the pre-test to the post-test of each group using effect size estimations (partial η^2). For the inter-group comparisons, a univariate ANOVA was run after checking with the Levenne test that the assumed variance equality among groups was met. *Post hoc* tests were used (Tukey) when the three groups were compared.

[Next page]

The results of the evolution from the pre-test to the post-test are presented for the four student groups, the first with Professor (Group 1), the second with Professor 2 (Group 2), the third with Professor 3 (Group 3) and the fourth with Professor 4 (Group 4), which all employed a different methodological format. This allowed us to verify whether the different teaching formats brought about positive changes in all four student groups to determine if different effects actually derived from using the various methodological formats or from belonging to one group or another.

Table 2. ANOVA F and the significance of the differences between the pre-test and the post-test in Groups 1, 2, 3 and 4

		Group 1				Group 2				Group 3				Group 4			
Subscales and Scales		*Mean*	*SD*	*F*	*Partial* η^2	*Mean*	*SD*	*F*	*Partial* η^2	*Mean*	*SD*	*F*	*Partial* η^2	*Mean*	*SD*	*F*	*Partial* η^2
1. Subscale 1a Relating and structuring	Pre	3.4324	.63842	7.121*	.165	3.4309	.72788	1.246	.047	3.1378	.71532	5.314*	.164	3.3429	.82375	3.2400*	.697
	Post	3.7066	.61532			3.6099	.74676			3.5510	.46773			3.7886	.73900		
2. Subscale 1b Critical processing	Pre	3.2973	.77244	9.679**	.212	3.2788	.80414	.815	.032	3.0536	.73710	1.170	.042	2.6600	.85355	15.569**	.393
	Post	3.6757	.67922			3.4327	.77317			3.3036	.81183			3.4700	.55114		
3. Scale 1 Deep processing	Pre	3.3649	.64509	10.086**	.219	3.3549	.67891	1.493	.056	3.0957	.69817	2.861	.096	3.0014	.77315	11.703**	.328
	Post	3.6911	.60739			3.5213	.65970			3.4273	.59132			3.6293	.59017		
4. Subscale 2a Memorizing and rehearsing	Pre	3.2162	.99037	16.335***	.312	3.2154	1.0243	4.069*	.140	2.9714	.87214	1.321	.047	2.7200	1.0344	4.300*	.152
	Post	2.6324	.91106			2.7154	1.1102			2.6571	1.05810			2.1600	.95568		
5. Subscale 2b Analyzing	Pre	3.2643	.52835	2.111	.055	3.2756	.65649	.127	.005	3.3095	.54379	1.100	.039	3.2400	.59915	.057	.002
	Post	3.3784	.54099			3.2179	.85475			3.4940	.70926			3.2733	.61215		
6. Scale 2 Stepwise learning	Pre	3.2403	.57972	6.564*	.154	3.2455	.73386	2.364	.086	3.1405	.54617	.104	.004	2.9800	.71823	2.281	.087
	Post	3.0054	.59847			2.9667	.83209			3.0756	.82904			2.7167	.69167		
7. Scale 3 Concrete processing	Pre	4.5541	.75722	20.055***	.358	4.4423	.92819	8.106*	.245	3.9643	.92974	.343	.013	4.6200	1.0852	3.547	.129
	Post	4.0108	.49204			3.9308	.82548			3.8429	.63095			4.0960	.70739		
8. Subscale 4a Self-regulation process and learning results	Pre	3.3205	.66871	2.838	.073	3.6429	.76585	.240	.010	3.1327	.71790	2.901	.097	3.2686	.77187	5.744*	.193
	Post	3.5019	.72110			3.7088	.80354			3.5000	.72270			3.7314	.60232		
9. Subscale 4b Self-regulation of learnt content	Pre	2.8447	.95616	5.091*	.124	3.3173	.79862	1.390	.053	2.8571	1.03956	4.185*	.134	2.4700	.81112	13.270**	.356
	Post	3.1892	.88664			3.4808	.78716			3.2946	.73615			3.3700	.76417		
10. Scale 4 Self-regulation	Pre	3.0826	.72467	5.086*	.124	3.4801	.69179	1.241	.047	2.9949	.73964	4.498*	.143	2.8693	.69108	11.485**	.324
	Post	3.3456	.71993			3.5948	.69682			3.3973	.65150			3.5507	.56344		
11. Subscale 5a External regulation of learning processes	Pre	3.2045	.65494	30.037***	.326	3.0000	.64464	.092	.004	3.1012	.67180	.011	.000	3.0933	.53377	.853	.034
	Post	3.1216	.54948			3.0577	.70229			3.0833	.58707			2.9467	.69841		
12. Subscale 5b External regulation of learnt results	Pre	3.6865	.61921	39.163***	.387	3.5070	.58891	.591	.023	3.5286	.67377	.055	.002	3.5432	.72915	.955	.038
	Post	3.4757	.53614			3.4154	.65464			3.4984	.58224			3.6702	.60149		
13. Scale 5 External regulation	Pre	3.4455	.57842	.957	.026	3.2535	.50186	.019	.001	3.3149	.61349	.032	.001	3.3183	.55785	1.354	.053
	Post	3.2986	.45848			3.2365	.57269			3.2909	.51692			3.3084	.60577		
14. Scale 6 Lack of regulation	Pre	2.6149	.67397	4.296*	.107	2.5000	.69442	.408	.016	2.8929	.63052	4.001*	.129	2.5467	.60000	1.354	.053
	Post	2.4054	.65910			2.3846	1.0149			2.5786	.62855			2.2960	.94361		
15. Scale 7 Personal Interest	Pre	3.3182	.52802	36.149***	.368	3.4000	.56000	.009	.000	3.3929	.54835	.131	.005	3.2240	.55172	4.556*	.160
	Post	3.3405	.52465			3.4154	.77133			3.4571	.61066			3.5280	.48263		
16. Scale 8 Certificate directed	Pre	2.9676	.60647	15.963***	.205	2.7846	.62206	.060	.002	2.9929	.63124	1.947	.067	3.2400	.69761	3.607	.131
	Post	2.8919	.67263			2.8308	.81130			2.7286	.64455			2.8480	.58389		
17. Scale 9 Self-test directed	Pre	3.1027	1.07870	21.318***	.356	3.0462	1.1190	.835	.032	3.5071	.96068	8.226**	.234	3.8720	.62684	12.660**	.345
	Post	2.9351	1.02746			3.2462	.98843			2.8143	.99022			2.9680	1.0225		
18. Scale 10 Vocation direction	Pre	4.2811	.57631	1.154	.031	4.0462	1.0044	1.771	.066	4.1071	.55640	1.738	.060	4.6160	.35081	7.295*	.233
	Post	4.3514	.55659			4.3769	.68895			4.2857	.50605			4.3040	.49706		
19. Scale 11 Ambivalent	Pre	2.1459	.65769	.318	.009	2.0231	.45722	1.457	.055	2.6214	.66073	3.905	.126	2.2080	.74494	.133	.006
	Post	2.2054	.77529			2.2231	.77009			2.2286	.74578			2.1360	.69933		
20. Scale 12 Construction of knowledge	Pre	3.7024	.68306	2.838	.073	3.8932	.74667	.435	.017	3.6548	.68047	1.953	.067	3.8978	.48847	.064	.003
	Post	3.8589	.63594			4.0171	.71020			3.8611	.50659			3.9378	.43754		
21. Scale 13 Instake of knowledge	Pre	3.3363	.55276	1.169	.031	3.2949	.73766	.065	.003	3.3016	.57684	3.520	.115	3.4178	.67226	3.099	.114
	Post	3.2523	.54600			3.2479	.79834			3.0516	.68858			3.0667	.64947		
22. Scale 14 Use of knowledge	Pre	3.9910	.56648	6.543*	.154	3.6795	.87423	2.908	.104	3.7083	.72807	7.014*	.206	4.5000	.45896	5.257*	.180
	Post	4.1802	.55469			4.0192	.84896			4.1429	.48371			4.1600	.47987		
23. Scale 15 Stimulating education	Pre	3.8885	.65004	.918	.025	3.5144	1.0537	1.065	.041	3.8973	.75081	.044	.002	4.1250	.53885	.849	.034
	Post	3.9493	.63085			3.7452	.82119			3.8616	.64938			3.9750	.60596		
24. Scale 16 Cooperation	Pre	2.8161	.61863	38.363***	.516	2.8702	.80271	12.921**	.341	3.0580	.68843	4.701*	.148	3.2650	.45689	2.357	.089
	Post	3.2770	.82398			3.5112	.88360			3.4107	.71513			3.5500	.64246		

* p<.05, **p<.01, ***p < .001

Evolution from the pre-test to the post-test for the Group 1 students with Professor 1 (methodological format 1)

Statistically significant differences were found and the post-test improved in 16 of the 24 analyzed factors (scales or subscales).

For Scale 1, Deep learning, and for the two subscales that made it up (Relating/Structuring and Critical processing), the post-test increased in all three cases. Both the level of significance and the effect size value were high[3].

A high level of significance was also observed for Scale 2, Stepwise learning and for one of its two subscales: Memorizing and rehearsing. The effect size was medium or large, and the scores in the post-test lowered in all cases. This proved that the surface learning approach was used less.

The same can be stated for the Concrete Learning scale, which displayed a considerable reduction, a high level of significance and a high effect size value.

Scale 4, Self-regulation, and one of its subscales, significantly improved, obtained a medium effect size, and scores increased.

The mean scores lowered for both subscales of Scale 5, External regulation, and both the level of significance and the effect size value were high. Scale 6, Lack of regulation obtained a medium effect size value.

These results indicated that the students' level of self-regulation rose, but their level of external regulation lowered.

Personal interest-based learning direction increased (Scale 7), but Certificate directed (Scale 8) and Self-test directed (Scale 9) lowered. The level of significance and the effect size value were both high.

Regarding the Mental models/Learning conceptions scales, Scale 14 significantly increased, Using knowledge obtained a high effect size value, and Scale 16, Cooperation, obtained a level of significance and effect size value that were high.

In short, the Group 1 students' Deep learning significantly increased (Relating/Structuring and Critical processing), but their surface learning, Stepwise learning and Concrete learning reduced. Their Personal interest-based learning direction and Self-Regulation improved, but their Self-test directed and Certificate directed diminished. Their Using knowledge and Cooperation both increased.

Evolution from the pre-test to the post-test for the Group 2 students with Professor 2 (methodological format 2)

The improvements in Group 2 were more limited. Statistically significant differences were found, with the post-test improving, for 3 of the 24 analyzed factors (scales or subscales).

On Scale 1, Deep processing, and on both its subscales, the post-test scores increased, but no significant difference in means was observed.

For Subscale 2 (Memorizing and reviewing) of Scale 2, Stepwise learning, the scores in the post-test lowered. Here the level of significance was high and there was a medium effect size. These results proved that students' surface learning approach diminished.

The same happened on the Concrete learning scale, which significantly lowered, but its level of significance and effect size value were high.

Improvements were obtained for Scale 4, Self-regulation and also for its two subscales, but they were not significant.

Regarding the Mental Models/Learning conceptions scales, Scale 16 significantly increased, and the Cooperation scale obtained

[3] The proposal by Cohen (1988) has been typically used to specify the partial η^2 effect size as small-=.01-.06, medium =>.06-.14 and large-sized = >.14. Fritz and Morris (2012) interpreted in a recent study about effect size, also for partial η^2, a small size from .01, a medium one from .059 and a large one from .14. These authors provide the following assessment scale for φ: a small effect size from .01, a medium one from .24 and a large one from .37.

a high level of significance and a medium effect size.

In short, the Surface approach of this group of students significantly diminished, as did their Memorizing and rehearsing. The same can be stated of their Concrete learning. However, their Cooperation increased.

Evolution from the pre-test to the post-test for the Group 3 students with Professor 3 (methodological format 3)

Statistically significant differences were found and improvements were observed in the post-test for 7 of the 24 analyzed factors (scales or subscales).

For Scale 1, Deep processing, and the two subscales that made it up (Relating/Structuring and Critical learning), the post-test scores improved, and the differences on the Relating/Structuring subscale were significant. There was a good level of significance and a high effect size value.

For Scale 2, Stepwise processing, its two subscales lowered the mean scores, but there were no significant differences.

The same occurred with Concrete learning.

A significant improvement was noted for Scale 4, Self-Regulation, and for Subscale 4b, Content Self-Regulation, which respectively obtained a high and medium effect size, with higher scores.

The mean scores on Scale 5 (External Regulation) lowered, but without any significant differences. On Scale 6, Lack of Regulation, Lack of regulation also lowered, but level of significance was high and effect size was low.

Self-test directed (Scale 9) reduced, but obtained a high effect size value.

The Mental Models/Learning conceptions scales, Scale 14, significantly increased, as did Using knowledge and Cooperation (Scale 16), with a high level of significance and a high effect size value in both cases.

Basically, the students in this group obtained significantly increased Relating/Structuring on the Deep learning scale. Their Concrete learning lowered. Self-regulation improved, while lack of regulation worsened. Self-test directed lowered and Using Knowledge and Cooperation increased.

Evolution from the pre-test to the post-test for the Group 4 students with Professor 4 (methodological format 4)

There were statistically significant differences, and the post-test improved, in 11 of the 24 analyzed factors (scales or subscales).

On Scale 1, Deep processing and the two subscales that make it up (Relating/Structuring and Critical learning), the post-test score increased in all three cases. The level of significance and the effect size value were both high.

On Subscale 2a (Memorizing and Reviewing) of Scale 2, Stepwise learning, the level of significance was high, the effect size was large and the post-test scores lowered. These results evidenced that these students' surface learning approach diminished.

For Scale 4, Self-regulation significantly improved, as did its two subscales. Effect size was large and scores rose.

Their personal interest-based learning direction (Scale 7) increased, and their Self-test directed (Scale 9) lowered. The level of significance and the effect size value were high. The same can be stated for Vocation direction.

For the Mental Models/Learning conceptions scales, the mean of Scale 14, Using knowledge, significantly lowered, but there was a large effect size value. Cooperation, Scale 16, increased, but no significant differences were found.

In short, the Deep learning (Relating/Structuring and Critical learning) of this group of students significantly increased, while both their surface approach use and Stepwise learning lowered. Self-regulation significantly improved, and their personal interest-based learning and Vocation direction both increased, unlike their Self-test directed,

which reduced. Using knowledge increased for this group.

When we analyzed the results of all four groups, we observed improvements for them all and in the desired direction (a deeper learning approach, higher self-regulation and personal interest-based learning and vocation-based rates, and improved Cooperative work. These improvements were clearer for Groups 1 and 4, slightly less clear for Groups 2 and 3, and the improvements made by Group 2 were the least clear.

Results obtained for the pre-test and post-test when separating groups into classes

We performed a univariate ANOVA to verify if statistically significant differences existed in both the pre-test and post-test among the four student class groups led by the four professors. We intended to confirm the teacher effect and the subject/group and format effect.

The table below includes only the subscales and scales that gave significant differences in the pre-test. None of these differences was found in the post-test.

Table 4. ANOVA F and the significance of the differences in the pre-test and post-test

	Scales and subscales	Groups	*Mean*	*S.D.*	*F*
1.	Subscale1b Critical processing Pre	1	3.3269	.76767	4.065**
		2	3.2700	.81943	
		3	3.0536	.73710	
		4	2.6600	.85355	
2.	Scale 3Concrete processing Pre	1	4.5321	.76987	2.961*
		2	4.4900	.91424	
		3	3.9643	.92974	
		4	4.6200	1.08522	
3.	Subscale 4b Self-regulationContentLearningPre	1	2.8817	.97031	3.232*
		2	3.2800	.79162	
		3	2.8571	1.03956	
		4	2.4700	.81112	
4.	Scale 4 Self-regulationPre	1	3.1006	.72340	3.270*
		2	3.4686	.70351	
		3	2.9949	.73964	
		4	2.8693	.69108	
5.	Scale 9 Self-test directed Pre	1	3.1641	1.08567	4.254**
		2	2.9840	1.09532	
		3	3.5071	.96068	
		4	3.8720	.62684	
6.	Scale 10 Vocation Direction Pre	1	4.2769	.56868	3.765*
		2	4.0560	1.02391	
		3	4.1071	.55640	
		4	4.6160	.35081	
7.	Scale 14 Use of knowledge Pre	1	3.2934	.57311	7.301***
		2	3.3156	.74514	
		3	3.3016	.57684	
		4	3.4178	.67226	
8.	Scale 16 Cooperation Pre	1	2.7903	.68256	2.846*
		2	2.9450	.72086	
		3	3.0580	.68843	
		4	3.2650	.45689	

gl= 4 and 145; * p<.05, **p<.01, ***$p < .001$

Statistically significant differences were found only on 8 scales/subscales of the 24 that made up the questionnaire in the pre-test among the four groups, and none were found in the post-test, where groups were found to be equal.

On Subscale 1, Critical learning, differences were specified between Group 1 and Group 4 to favor Group 1 ($p<.01$) and also between Groups 2 and 4 to favor Group 2 ($p<.05$). Thus Groups 1 and 2 obtained higher Critical learning levels than Group 4.

On Scale 3, Concrete learning, the difference among the four groups was only specified afterward between Groups 1 and 4 to favor Group 4 ($p<.05$). Group 4 obtained the highest level of Concrete learning.

On Subscale 4b, Content self-regulation, and Scale 4, Self-regulation, differences were found between Group 2 and Group 4 to favor Group 2 ($p<.05$), and Group 2 obtained a higher level of Self-regulation.

On Scale 9, Self-test directed, differences were found between Group 1 and Group 4 to favor Group 4 ($p<.05$), and also between Group 2 and Group 4 to favor Group 4 ($p<.01$). Group 4 was more Self-test directed.

On Scale 10, Vocation direction, differences were found between Group 2 and Group 4 to favor Group 4 ($p<.05$), and also between Group 3 and 4 to favor Group 4 ($p<.05$). Group 4 was the most vocation-directed one.

On Scale 14, Using knowledge, differences were found between Group 1 and 4 to favor Group 4 ($p<.05$), between Group 2 and Group 4 to favor Group 4 ($p<.01$) and between Group 3 and Group 4 to favor Group 4 ($p<.001$). Hence Group 4 was the group that was more inclined toward Using knowledge.

On Scale 16, Cooperation, differences were found only between Group 1 and Group 4 to favor Group 4 ($p<.05$), so Group 4 had higher levels of Cooperation.

Thus minimum differences were observed in the pre-test, which disappeared in the post-test where no difference was significant. Although the groups were not equivalent groups in the pre-test, very few differences were found, and the few found favored Groups 1 and 2, as opposed to Group 4, in Critical learning, Concrete learning and Self-regulation, and to favor Group 4 as opposed to the others in Self-test directed, Vocation direction, Using knowledge and Cooperation.

Thus it appears that the learning-centered methods used by the teachers with all four groups made the groups appear similar as no significant differences were obtained in the post-test.

The results obtained to assess students regarding the employed methods

When teaching ended, the students answered the questionnaire devised by the research team to assess the usefulness of learning by the teaching-assessment methods used by the teachers on a 5-grade scale (Not at all-A lot).

The students assessed practically all the teaching methods positively. High scores were obtained for their usefulness for learning, except for Class discussions (1.86), Teacher 2, the Master class (2.96), Teacher 3, Portfolios (2.86), and Teacher 4.

The Master class was well assessed by the students for all four professors, with means above 3 in one case and means close to 4 in the other cases.

The mean scores obtained in the questions about the subject to be commented on in class, student presentations, cooperative work, personal work corrected by the teacher, and practical classes are worth stressing because the means were above 4 in most of these cases.

Table 5. Degree of the methods' usefulness according to the students

TEACHING METHODS	USEFULNESS							
	Group 1		Group 2		Group 3		Group 4	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Master class	3.82	.716	3.58	1.316	2.96	1.076	3.76	1.338
Questions about the subject to be commented on in class	4.58	.614	4.13	1.154			4.05	1.117
Solving exercises and problems			3.96	1.398	4.12	.711	4.00	1.265
Student presentations	3.68	1.065	4.46	.721	3.54	1.392	4.57	.676
Cooperative work	3.88	1.008	4.46	.658	4.12	1.177	4.57	.507
Personal work corrected by the teacher	4.73	.452	4.42	1.139			4.10	1.513
Practical classes	4.27	.574	3.61	1.803	4.23	.863	4.57	.598
Tutorials in class	3.17	1.267			3.92	1.055		
Class discussions			1.86	2.151	4.08	1.077		
Projects					4.00	1.190		
Problem solving			3.96	1.398				
Research work	3.91	.963			4.08	1.139	3.90	1.640
Learning contract							3.90	1.300
Portfolios	4.61	.556			3.23	1.232	2.86	1.57
ASSESSMENT METHODS				USEFULNESS				
Level tests			1.52	1.982				
Self-assessment	3.81	.938	2.12	2.027	3.92	.881	3.05	1.900
Co-assessment	3.65	.978			3.88	.758		
Written open-response tests	4.05	.705	3.08	2.060	3.79	1.062	3.85	1.35
Individual oral tests								
Oral presentations of themes-works	4.08	1.010	4.28	.843	4.13	1.116	4.74	.562
Individual works	4.41	.599	3.72	1.429	4.12	.780	4.53	.697
Group works	3.62	1.114	4.24	.970	4.50	.659	4.74	.562
Projects			4.00	1.696	4.38	1.209	3.00	2.285
Portfolios	4.46	.611			3.17	1.308	4.26	.872
Reading-reviewing a book with dialog-based discussion			4.28	1.49				

Research works and using portfolios were also well assessed, except for Professor 4, who obtained a low score. However, when her students assessed this assessment method, their score exceeded 4.

The best assessed methods were personal work corrected by the teacher, cooperative work, practical classes, questions about the subject and conducting research work.

Most of the assessment methods were positively assessed about their usefulness for learning, and class presentations were very well considered (all the groups with scores over 4), as were group works, using portfolios and individual works. Written tests were also positively assessed. The self-assessment exercises obtained inconsistent scores, which were positive for Groups 1, 3 and 4. The eco-assessment exercises were positively assessed in Groups 1 and 3.

Discussion

The objectives of the present work were to assess the impact of learning-centered methods, which were implemented by the four teachers, on the learning styles of the students of the Educational Processes and Contexts course of the Master's Degree in Secondary Education Teaching at the University of Valencia. It also intended to analyze the assessments that the students made of the employed methods.

The hypotheses stated that applying learning-centered methods would lead to statistically significant differences between the pre-test and the post-test on the ILS scales and subscales for the students in the four groups that made up the study sample; they would improve, with a significant difference in the means; deep processing, which would increase, unlike surface learning; students' self-regulation would increase; personal interest-based learning and vocation-based directions would also increase; construction and using knowledge and cooperation would improve. We assumed that there would be intergroup differences in the post-test depending on the used methodological format, and that students would provide positive assessments.

As we assumed, significant differences were found between the pre-test and the post-test for a considerable number of the variables analyzed by the ILS questionnaire.

The expected improvements were observed for all four student groups (increased deep learning approach, higher self-regulation rates, personal interest-based learning and vocation direction and improved cooperative work). These improvements were clearer in Groups 1 and 4, and were slightly less clear for Groups 2 and 3.

The improvement hypotheses were confirmed to a great extent in Groups 1 and 4, and Group 3, but to a lesser extent in Group 2.

Deep processing significantly increased in Groups 1 and 4 (which occurred on its two subscales, Relating/Structuring and Critical learning), while Surface learning lowered. Students' Self-regulation also improved, while External Regulation and Lack of External Regulation reduced. Personal Interest-based learning and Vocation direction also increased, but the latter only rose in Group 4. In turn, Self-test directed lowered in Group 1, and Certificate directed also significantly reduced. For the Mental learning models, Using Knowledge increased in the two groups, and Cooperation also improved in Group 1.

The improvements noted in Group 3 were slightly worse than those observed in Groups 1 and 4. Nevertheless, the Relating/Structuring subscale score significantly increased for the Group 3 on the Deep processing scale. Self-regulation improved, but Lack of regulation lowered. Self-test directed reduced, while Using knowledge and Cooperation increased.

As previously mentioned, improvements were more limited in Group 2, with a significant reduction noted on the Memorizing/Reviewing subscale as part of the Stepwise learning scale. Concrete learning reduced and Cooperation increased.

However, the hypothesis about the inter-group differences in the post-test was not confirmed, which were assumed to appear depending on the different methodological formats employed. The differences in several variables found in the pre-test did not appear in the post-test. This means that the four formats, which contained several of the same elements and other different ones, but shared the same direction, made the groups equal, which became equivalent groups in the second measure of the different analyzed variables (*ILS*).

The last of the hypotheses was confirmed as students positively assessed the teaching and assessment methods with the quantitative questionnaire that they completed to assess them. They gave high scores for most methods as regards their usefulness for learning. The assessment they indicated in the qualitative questionnaires was also very positive, and they also made suggestions on minor matters.

Our results confirmed that learning-centered methods influenced students' learning styles, and this came over most clearly in Groups 1, 3 and 4, but less clearly in Group 2, where improvements were not so marked. As we see it, these results are coherent with the employed methods, which focus on the students' Deep learning and encouraging their Autonomy/Self-regulation, and center on the personal interest-based learning and vocation directions, and on a way to work to enhance Cooperative work and the Efficient use of acquired knowledge. The combination of the employed methods for both teaching (presentation methodology, questions, class discussions, project-based learning, cooperative work, research work, portfolios, etc.) and for assessing (self-assessment, co-assessment, written tests, class presentations, portfolios, etc.) encourages students to develop self-regulatory capacities as they are expected to get more involved in the process, as well as deep learning and to develop communication skills, team work, and the self-assessment/co-assessment of the learning process itself.

Some studies have made similar considerations, normally with small-sized samples like our own. Armbruster et al. (2009) worked with classes given to introduce Biology to a US university. Their work achieved improved levels of interest, self-managed learning, etc. This they achieved by changing from a master classes methodology to one that focused more on the learning developed by teachers by redesigning the course, and using problem-solving techniques in groups, along with formative assessment and self-assessment elements. Bruehl, Pan and Ferrer-Vinent (2014) restructured a chemical course for first-year students who had to consider an important question, and investigate in order to find answers and to communicate the results to audiences of experts and beginners using the scientific literature to develop critical thought and the problem-solving skill. The self-assessment of students' attitudes and beliefs about the usefulness of this experiment was positive. Chen et al. (2015) redesigned a physiopathology lab course at a Chinese university to encourage students' active learning, critical thought, and how they self-managed their learning. When they compared their results with the control group (which worked by a traditional method), these authors found significant differences that favored the first group in the lab tests and in students' assessments.

Another study by Tessier (2007) used peer tutoring as a work method to supplement the presentation methodology followed. As part of a primary education teacher training program, general biology students taught one another in small groups and previously became experts in one part of the subject matter. Better learning results and higher marks were obtained than by traditional methods. The work by Tien, Roth and Kampmeier (2002) is also interesting because they used group work led by students on an Organic chemistry course at a US university.

The course was redesigned, group leaders were trained and problem-solving workshops were run using metacognitive reflection with leaders' help. Performance improved in terms of retaining information and students' attitudes.

We believe that our work is relevant enough because it used a more integrative methodological consideration than that of the aforementioned works thanks to the combination of methods used herein to teach and assess, its clear training direction, and the employed methods also included the constructive alignment concept. This consideration is coherent with the kind of studies that include student samples by using a range of methods, and also because the used methods can be learnt and applied later in students' professional tasks. This consideration achieved better improvements in the variables evaluated by the ILS questionnaire, especially in groups 1, 3 and 4.

We are aware of, one the one hand, the limitations of this work, one of which is lack of control groups, which has been explained and justified in note 2. On the other hand, our sample size is small and is not representative of the university or the degree.

Notwithstanding, we believe that it is an interesting work thanks to the methodological design used for teaching and assessing, and also because of the results it obtained, which encourage other teachers to advance in the learning-centered teaching line.

References

Armbruster, P., Patel, M., Johnson, E. & Weiss, M. (2009). Active learning and student-centered pedagogy improve student attitudes and performance in introductory biology. *Education, 8*, 203-213. doi: https://doi.org/10.1187/cbe.09-03-0025

Barr, R.B. & Tagg, J. (1995). From Teaching to Learning. A New Paradigm for Undergraduate Education. *Change*, *27* (6), 13-25. doi: https://doi.org/10.1080/00091383.1995.10544672

Biggs, J. (2005). *Calidad del aprendizaje universitario.* Madrid: Narcea.

Brackin, M. (2012). Two-Year College Faculty and Administrator Thoughts about the Transition to a Learning-Centered College. *Community College Journal of Research and Practice, 36*(3), 179-190. doi: https://doi.org/10.1080/10668920802708561

Bruehl, M., Pan, D. & Ferrer-Vinent, J. (2014). Desmystifying the chemistry literature: building information literacy in first-year chemistry students trough student-centered learning and experiment design. *Journal of Chemical Education, 92,* 52-57. doi: https://doi.org/10.1021/ed500412z

Campbell, C. (2012). Learning-Centered Grading Practices. *Leadership, 41*(5), 30-33.

Chen, J., Zhou, J., Sun, L., Wu, Q., Lu, H. & Tian, J. (2015). A new approach for laboratory exercise of pathophysiology in China based on student-centered learning. *Advances in Physiology Education, 39,* 116-119. doi: https://doi.org/10.1152/advan.00143.2014

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Entwistle, N. & McCune, V. (2004). The Conceptual Bases of Study Strategies Inventory. *Educational Psychology Review*, 16(4), 325-345. doi: https://doi.org/10.1007/s10648-004-0003-0

Fritz, C. O. & Morris, P. E. (2012) Effect Size Estimates: Current Use, Calculation, and Interpretation. *Journal of Experimental Psychology*: General. 141:1, pp. 2-18. doi: https://doi.org/10.1037/a0024338

Gow, L. & Kember, D. (1993). Conceptions of teaching and their relationship to student learning, *British Journal of Educational Psychology, 63,* 20-33. doi:

https://doi.org/10.1111/j.2044-8279.1993.tb01039.x

Hannafin, M. (2012). Student-Centered Learning. En N.M. Seel (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 3211-3214). Nueva York: Springer. Available from http://link.springer.com/content/pdf/bfm%3A978-1-4419-1428-6%2F1.pdf

Hernández, R. (2012). Does continuous assessment in higher education support student learning? *Higher Education*, 64, 489-502. doi: https://doi.org/10.1007/s10734-012-9506-7

Hunting, L. & Chalmers, D. (Eds.) (2012). *University teaching in focus. A learning-centred approach.* Londres: Routledge.

Kember, D. (2009). Promoting student-centred forms of learning across an entire university. *Higher Education*, *58*, 1-13. doi: https://doi.org/10.1007/s10734-008-9177-6

Kolb, D. (1976). *The Learning Style Inventory: Technical Manual.* Boston: McBer and Company.

Koles, P., Nelson, S., Stolfi, A., Parmelee, D. & DeStephen, D. (2005). Active learning in a Year 2 pathology curriculum. *Medical Education, 39,* 1045-1055. doi: https://doi.org/10.1111/j.1365-2929.2005.02248.x

Lucieer, S.M., Van der Geest, J.N., Elói-Santos, S.M., Delbone de Faria, R.M., Jonker, L., Visscher, Ch., Rikers; R.M.J.P. & Themmen, A.P.N. (2016). The development of self-regulated learning during the pre-clinical stage of medical school: a comparison between a lecture-based and a problem-based curriculum. *Advances in Health Sciences Education, 21,* 93-104. doi: https://doi.org/10.1007/s10459-015-9613-1

Marambe, K.N., Vermunt, J.D. & Boshuizen, P. A. (2012). A cross-cultural comparison of student learning patterns in higher education. *Higher Education, 64, 299-316.* doi: https://doi.org/10.1007/s10734-011-9494-z

Martin, E. & Ramsden, P. (1992). An expanding awareness: how lecturers change their understanding of teaching. En M.S. Parer (Ed.), *Research and Development in Higher Education,* Vol. 15 (pp. 148-155). Sidney: HERDSA.

McLean, M. & Gibbs, T. (2010). Twelve tipos to designing and implementing a learner-centred curriculum: Prevention is better than cure. *Medical Teacher, 32,* 225-230. doi: https://doi.org/10.3109/01421591003621663

Menacherry, E.P., Wright, S.M., Howell, E.E. & Knight, A.M. (2008). Physician-teacher characteristics associated with learner-centered teaching skills. *Medical Teacher, 30*(5), e137-e144. doi: https://doi.org/10.1080/01421590801942094

Mostrom, A. & Blumberg, P. (2012). Does Learning-Centered Teaching Promote Grade Improvement? *Innovative Higher Education, 37*(5), 397-405. doi: https://doi.org/10.1007/s10755-012-9216-1

Nitza, D. (2013). Learning-centered teaching and backward course design-From transferring knowledge to teaching skills. *Journal of International Research,* 9(4), 329-338

Prieto, L. (coord.) (2008). *La enseñanza universitaria centrada en el aprendizaje*. Barcelona: Octaedro.

Roy, E.B. & McMahon, G.T. (2012). Video-based cases disrupt Deep critical thinking in problem-based learning. *Medical Education, 46,* 426-435. doi: https://doi.org/10.1111/j.1365-2923.2011.04197.x

Samuelowicz, K. & Bain, J.D. (1992). Conceptions of teaching held by academic teachers. *Higher Education*, 22, 229-249. doi: https://doi.org/10.1007/BF00138620

Samuelowicz, K. & Bain, J.D. (2001). Revisiting academics' beliefs about

teaching and learning, *Higher Education*, *41*, 299-325. doi: https://doi.org/10.1023/A:1004130031247

Schmeck, R.R. (1982a). Learning style of college students. In R. Dillon & R.R. Schmeck, *Individual differences in cognition*, Vol. I, (pp. 233-279). New York: Academic Press.

Schmeck, R.R. (1982b). *Learning strategies and learning styles.* New York: Plenum Press.

Schweisfurth, M. (2015). Learner-centred pedagogy: Towards a post-2015 agenda for teaching and learning. *International Journal of Educational Development*, *40*, 259-266. doi: https://doi.org/10.1016/j.ijedudev.2014.10.011

Sue, T. (2014). Student-Centred Learning: A Humanist Perspective. *Teaching in Higher Education*, *19*(3), 266-275. doi: https://doi.org/10.1080/13562517.2013.860099

Tagg, J. (2003). *The learning paradigm college*. Bolton, Massachusetts: Anker Publishing Company, Inc.

Tessier, J. (2007). Small-group peer teaching in an introductory biology classroom. *Journal of College Science Teaching 36*(4), 64-69.

Tien, L.T., Roth, V. & Kampmeier, J.A. (2002). Implementation of a peer-led team learning instructional approach in an undergraduate organic chemistry course. *Journal of Research in Science Teaching 39* (7), 606-632. doi: https://doi.org/10.1002/tea.10038

Vermunt, J.D. (1994). *Inventory of Learning Styles (ILS) in Higher Eduction.* The Nederlands: Tilburg University, Department of Educational Psychology.

Vermunt, J.D. (1996). Metacognitive, cognitive and affective aspects of learning styles and strategies: A phenomenographic analysis. *Higher Education*, 31, 25-50. doi: https://doi.org/10.1007/BF00129106

Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology*, *68*, 149-171. doi: https://doi.org/10.1111/j.2044-8279.1998.tb01281.x

Vermunt, J.D. (2005). Relations between student learning patterns and personal and contextual factors and academic performance. *Higher Education*, 49, 205-234. doi: https://doi.org/10.1007/s10734-004-6664-2

Vermunt, J.D. & Vermetten, Y.J. (2004). Patterns in Student Learning: Relationships Between Learning Strategies, Conceptions on Learning, and Learning Orientations. *Educational Psychology Review*, *16*(4), 359-384. doi: https://doi.org/10.1007/s10648-004-0005-y

Zabalza, M.A. (2012). Metodología docente. *REDU (Revista de Docencia Universitaria*, *9*(3), 75-98.

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