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Conceptions of Learning: The Design and Validation of a Questionnaire for Trainee Teachers

Concepciones acerca del aprendizaje: diseño y validación de un cuestionario para profesores en formación

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Abstract

Teachers as well as trainee teachers have conceptions of teaching and learning that do not correspond to the learning theories studied within the university course programs. The predominating ideas in this paradigmatic context, which are based upon the fact that subjects understand an action scenario, posses an implicit character and differ from the notion that they are expressed explicitly most of times. The objective of this article is to introduce the adaption and validation of an instrument designed to research on the conceptions of trainee teachers of the School of Humanities as well as the School of Exact and Natural Sciences of the National University of Mar del Plata (*Universidad Nacional de Mar del Plata*) in Argentina about learning. Also, it intends to conduct a first analysis of the results obtained after it has been administered. The instrument is an adaption of a dilemma questionnaire designed by Martín, Mateos, Pérez-Echeverría, Pozo, Pecharromán, Martínez, and Villalón, which they administered to 120 students. Cronbach's Alpha was used to determine factor analysis reliability, and consequently construct validity. The following data analysis shows the application of the interpretative theory of learning based on an epistemological conception related to critical realism.

Key words: Conceptions, learning, teaching students, questionnaire.

Resumen

Tanto los profesores ya formados como los profesores en formación, poseen concepciones sobre el aprendizaje y la enseñanza que no corresponden con las teorías del aprendizaje que se estudian formalmente en los cursos universitarios. Las ideas que predominan en la construcción de estos marcos paradigmáticos, desde los cuales las personas entienden un escenario de acción, poseen un carácter más bien implícito y muchas veces difieren de las concepciones que explícitamente se manifiestan. El objetivo de este artículo es presentar la adaptación y validación de un instrumento para indagar las concepciones sobre el aprendizaje que poseen los profesores en formación avanzados de las Facultades de Humanidades y de Ciencias Exactas y Naturales de la Universidad Nacional de Mar de la Plata, Argentina, y hacer un primer análisis de los resultados obtenidos a partir de su aplicación. Esto se llevó a cabo mediante la adaptación de un cuestionario de dilemas elaborado por Martín, Mateos, Pérez-Echeverría, Pozo, Pecharromán, Martínez y Villalón administrado a 120 estudiantes. Para determinar la fiabilidad del análisis factorial y en consecuencia, la validez de constructo, se utilizó el Alpha de Cronbach. El posterior análisis de los datos muestra el uso de la teoría interpretativa del aprendizaje, basada en una concepción epistemológica vinculada con el realismo crítico.

Palabras clave: Concepciones, aprendizaje, profesores en formación, cuestionario.

Introduction

The literature review about research on conceptions and beliefs has demonstrated that teachers as well as trainee teachers conceive and develop their own learning and teaching representations intuitively: teachers through professional practice and trainee teachers through the result from their own experiences. This does not

correspond to the learning theories which are formally studied within university courses (Porlán, Rivero, and Martín, 1998; Strauss and Shilony, 1994).

The predominating ideas in this paradigmatic context, which are based upon the fact that subjects understand an action scenario, posses an implicit character and differ from the notion that they are expressed explicitly most of times. Different research (Gil and Pessoa, 2000) suggests making teachers'conceptions explicit to analyze them later and redefine them eventually, in order to set a starting point for every effort to improve teaching.

Background research on this matter evidence that the analysis of different conceptions about what learning is and how people learn has gained importance during the last years. The topic has been studied from the perspectives of experimental design (Aldridge, Taylor and Chi Chen, 1997; Hammer, 1994; McGinnis, Greber and Watanabe, 1997; Schommer, 1990), and qualitative problem analysis (Baena, 2000; Belenky, Clinchy, Goldberger and Tarule, 1997; Perry, 1997); however, a great number of those studies analyze the explicit representations. On the contrary, this research aims to provide an instrument that allows a closer look to the most implicit level of representation.

I. Objectives

Different studies have found connections between teachers' conceptions and their assumptions on teaching and learning, which play a fundamental role for their performance at the classroom (Haney, Czerniak and Lumpe, 1996; Hewson and Hewson, 1987; Gil, 1991; Gil and Pessoa, 2000; Maor and Taylor, 1995; Medina, Zimancas, and Garzón, 1999; Nespor, 1987, Porlán, 1994). This study attempts to provide information on two aspects, since very little research has been made up to now:

a) The description and characteristics of learning conceptions from an *implicit theory* perspective.
b) The examination of these conceptions within the university environment.

Regarding the first aspect, it is important to understand that conceptions may have different cognitive structure complexity level and that representations of a more implicit nature are the most deeply-rooted; this implies a different perspective from that of the majority of the studies referred here. Most of the time, what subjects express explicitly is not completely related to the implicit representations, which are built upon the subject's own experience in the world more than upon the formal education he or she received. Thus, it is important to study the representations of trainee teachers, analyze those representations to design spaces where to reflect on, and eventually, redefine them.

As regard to the second, the problem concerning the lack of analysis in the university context is observed, and it highlights the utmost importance to collect

empirical information on this matter, since the number of research works is limited (Hativa, 2000; Lantz and Kass, 1987; Van Driel, Bulte and Verloop, 2005).

II. Development

II.1 Conceptual Framework

Studies based on cognitive psychology, consider the possibility of interpreting individuals'actions in terms of their mental representations and processes. From a cognitive perspective, the subject comprehends the object and creates representations to interpret it.

These representations are information units that individuals manage and process, and they account for mental constructions through which individuals understand the world. The notion derives from the assumption that there is a language in thought, a collection of mental representations that work as immediate objects of the mental process control (Martínez Freire, 2002). This perspective considers an elemental difference between perceptions and representations: objects of perception are perceptible for several individuals; while contents of perception are individual.

Current research studies evidence the importance that representation analysis has gained during the last years, as far as its organization and processes of change are concerned (Greca and Moreira, 2000; Pesa, 1997; Tyson, Venville, Harrison and Treagust, 1997). These research works suggest that representations created by individuals have different cognitive structure complexity levels and their modification depend, to a great extent, on the representational level involved.

II.2 Representational Levels

Mental Models

Mental models consist of beliefs, attitudes, and judgments that every subject has when he or she faces different situations. Mental models are representations created in response to specific demands and, in most cases, are developed ad *hoc*, in other words, from the construction of situation models. They are ideas of lower hierarchy, or uncertain answers that subjects will not hesitate to change when facing similar problems, and which are short-term memory activated (Rodrigo, 1997; Rodrigo, and Correa, 1999).

Domain Theories

Mental models correlate with a second level: domain theories. While these theories are of implicit nature, there is a possibility that the subject can be aware of them. Domain theories are explicitly represented within one's memory; consequently, they are more stable than mental models are. They are a collection of rules or regulations upon which situation models are created (Pozo

and Scheuer, 1999), and due to their implicit nature, they are less accessible to researchers through the traditional data collecting methods. They are constructed from representations of a field of knowledge; they determine the conceptions every subject activates in order to fulfill task demands, since they provide the mental models'invariable characteristics which are activated in different contexts.

Implicit Theories

Domain theories are organized upon general and stable structures based on a series of tacit assumptions composed by implicit theories. They are integrated by semantic, schematic, and prototypical knowledge, which is relative to a domain. They are constructed by associative assumptions based on a collection of episodic experiences according to the description of modern theories of connectionism. Implicit theories provide an epistemological and ontological conceptual framework upon which the subject creates domain theories, thus they restrain the selection of processed information, as well as the links between the elements of that information (Rodrigo, 1997).

II.3 Learning as a Representational Change

Rodrigo and Correa (1999) state that changes in domain and implicit theories, which are representations of a higher level, occur throughout processes at the level of mental models; for this reason, learning is understood as a representational change. From the theoretical perspective of Karmiloff-Smith (1994), it is a process of representational re-description through which implicit representations become progressively explicit "by redefining internally the already acquired representations; this is, by representing them again in different representation formats, although they are already represented, so that implicit information turns into explicit knowledge" (p.34).

Learning Domain Theories

According to some authors, individuals'intuitive conceptions of learning can be described upon three domain theories: *direct*, *interpretive*, and *constructive* theories (Pozo and Scheuer, 1999).

a) **The direct theory** considers a direct correlation between thoughts and actions, between learning conditions and achievements. It also contemplates certain determinism: given that there is a series of pre-established conditions to learn something, success is guaranteed. On the other hand, it understands learning as a true copy of the object without taking into consideration psychological processes'analysis. From an epistemological perspective, it is associated with a realistic naive position.
b) **The interpretative theory** involves a more active learning subject; though, it shares the idea of learning a true copy of the object with the direct theory. The activities the subject develops in order to comprehend the object must be such to avoid distortions. From this perspective, the best learning method consists on observing intentionally and closely an expert performing his or her tasks.

Mental activities such as memory, attention, and associations, as well as the teachers' pedagogical profile (since he's a role model) are considered important factors for learning. From the assumption of exact correspondence between subject and object derives the ideal learning, although different results may be achieved as a result from learning. Epistemologically, this theory is based on realistic critical conceptions.

c) **The constructive theory** suggests that the object goes through a transformation when the subject comprehends it through the description of his or her cognitive structure. In this way, the subject's participation within the learning process, and the psychological processes involved constitute the center of the problem and there is no ideal result, since representations developed previously by the subject and related to the object, the comprehension context, and the purposes established according to said learning process are variables that intervene in the results obtained through different contributions. The epistemological support is relativist.

Conceptions of learning may come from different representational levels; nonetheless, there is a continuum including all implicit theories on the topic, including the explicit knowledge. Together, the three aforementioned domain theories constitute a theoretical approach, which gives information on the most important positions found.

III. Methodology

The research conducted was descriptive and transversal. The dilemma questionnaire designed by Martín, Mateos, Pérez-Echeverría, Pozo, Pecharromán, Martínez, and Villalón (2004) was adapted and administered to 120 students. Cronbach's Alpha was used to determine factorial analysis reliability as well as the construct validity for the statistical analysis. Results evidence an Alpha of .705 for all the questionnaire items and four main components that explain 59.7% of the variance. Data analysis demonstrates the interpretative theory preponderance, based on an epistemological conception related to critical realism.

Variables

For the variable *Conceptions of Learning*, three categories were established according to the conceptual framework chosen for this research work:

- Direct theory
- Interpretative theory
- Constructive theory

Subjects

The population considered for this research was the entire population of trainee teachers of the School of Humanities and the School of Exact and Natural Sciences of the National University of Mar del Plata (*Universidad Nacional de Mar*

de la Plata).[1] The non- probability sample, stratified by quota of subjects and subject type consisted of 120 students. Stratification was established by undergraduate program and by a proportional student representation for each program.

Data Collection Instrument

Due to the fact that the objective of this research was to study implicit conceptions, such as the domain theories, a dilemma questionnaire was used. An instrument with these characteristics allows its administration to a relative high number of individuals and, at the same time, it allows collecting more deep information, since questions are not directly formulated, but instead context situations are posed and subjects must get involved and adopt a position.

The dilemma questionnaire was based on a bibliographical search of different questionnaire proposals and it was an adaption of the dilemma questionnaire on learning elaborated by Martín *et al*. (2004).

The final version of the instrument consisted of 12 dilemmas, each with three multiple answer choices, which corresponded to the direct, interpretative and constructive domain theories about teaching and learning, which were described in the theoretical framework.

The instrument used poses dilemmas based on situations related to teaching and learning and it examines domain theories within this field, which are constructed upon epistemological assumptions which are also implicit. Thus, besides providing information about learning implicit theories, the instrument allowed a general approach to the underlying epistemological conceptions. For example, *direct theory* is built upon epistemological principles related to naive realism; the *interpretative theory* is associated to a critical realistic position; and the constructive theory is based on relativist epistemological principles. The questionnaire can be observed in the appendix.

Instrument Validation

Content validity. In order to determine whether the instrument items assessed the categories selected, content validity was measured through a *system of independent judges*, who classified and diagnosed the adaption of categories established for the variable according to the theoretical fundamentals and the questionnaire objective. Three judges were selected, all university professors who were philosophy, psychology and pedagogy specialists. At an interview, they expressed their opinions on the pertinence and adaption of items.

Testing the instrument: check for clarity. In order to assess question items' clarity regarding their wording and to check if they were easily understood by the subjects, a pilot testing was run by administering the questionnaire to a group of people who shared similar characteristics with the subjects who constituted the sample.

Questionnaire reliability. Cronbach's Alpha coefficient was used to determine the questionnaire reliability; in order words, to demonstrate results'stability and consistency. This coefficient is one of the most common ones used to determine the internal consistency or reliability of a questionnaire or scale. It is the average of Pearson correlation coefficients between questionnaire items, if scores are standardized, or covariances if they are not standardized. The coefficient depends on the number of items and on the correlation between the them and their covariances; their value must be between 0.0 and 1.0, and they are acceptable values at 0.70. The statistical package SPSS 12.0 was used for this analysis.

Construct validity: A construct is the measurable variable of a theory or theoretical frame. Its validity refers to the extent that the measurement obtained through the questionnaire correlates with theoretical hypotheses which are related to the assessed concepts.

Factor analysis was used to determine construct validity. Factor analysis is a multivariate statistical method, which establishes the number and characteristics of a collection of constructs that underlie a set of measurements. Its purpose is to interpret a correlation matrix of a number of variables in terms of the lower number of factors. This analysis generates *artificial variables*, called factors, which represent constructs. Factors derive from original variables and must be interpreted according to them. The analysis includes the explanation of variance.

In this study, a *principal components analysis using Varimax rotation* was performed. *Principal components* method consist of a linear combination of all variables, so that the first component explains the maximal amount of total sample variance; the second component explains the next largest amount of variance not accounted for the first component hence it is uncorrelated with the first component, and so on until all variables and components are covered. The number of intercorrelated variables is reduced to a smaller number of uncorrelated factors. On the other hand, the purpose of rotation is to interpret the factors'meaning and significance, if they are not clear in the unrotated matrix (Visauta Vinacua, Martori, and Cañas, 2003). The Varimax procedure is commonly used to minimize the number of variables with weights or high loadings on each factor.

Questionnaire Administration

After the questionnaire was administered, two aspects from the collected data were analyzed:

a) *Content of the conceptions* related to learning.
b) The *influence of the field of education* in the construction of these conceptions.

Procedures for Data Analysis

The following procedures were used to analyze the *content of conceptions* of learning:

a) The *mode*, the value that occurs most frequently in a data set, was calculated through answers in the dilemma questionnaire, in order to determine the position most of the subjects adopted.
b) A descriptive analysis of conceptions was conducted through the *percentage distribution of frequencies* of each position in the various posed dilemmas.
c) A qualitative analysis was conducted to determine the assumptions of each theory implicit in subjects'answers, according to the *three dimensions* of the variable that the components analysis showed.

To analyze the *influence of field of education* on the conceptions of the future teachers about learning, subjects were separated into two groups, depending on their school of origin:

Group 1: Trainee teachers from the School of Natural and Exact Sciences, from the undergraduate programs of Teacher of Mathematics, Chemistry, Physics, and Biology Sciences.

Group 2: Trainee teachers from the School of Humanities, from the undergraduate programs of Teacher of History, Geography, Philosophy, Letters, and Library Sciences.

The comparison was not based on the undergraduate program but on the school, due to the fact that some teacher training programs had few students, and the data collected could have not been significant if the analysis was based on the academic field.

The Chi-square, a statistical test used to test hypotheses and their association between categorical variables, was calculated; for which, appropriate contingency tables had been previously constructed.

IV. Results

IV.1 Results obtained in the validation of the questionnaire

According to the opinion of the *independent judges*, who objected to some questionnaire dilemmas because they were confusing, the dilemmas were restated. In the second consultation some dilemmas were refused again so they were eliminated, as was the case of dilemma 3.

Results from the *pilot testing* showed that some questions were not clear enough, because subjects needed further explanation in order to be able to give an answer.

Also, it evidenced that the way some dilemmas were posed was too extensive. In both cases, dilemmas were modified, so they expressed clearly the main idea.

In the implementation of *Cronbach's Alpha coefficient*, in order to determine questionnaire's validity, dilemma 3 was omitted due to its lack of clarity. This increased the internal consistency of the questionnaire. The result for the scale was:

$$\alpha = 0.7055$$

As it was mentioned before, the value obtained for this coefficient depends on the number of questionnaire items and their covariances. Since it had only twelve items, the obtained value was considered acceptable and the questionnaire was reliable.

Results of the principal components analysis used to examine construct validity are shown in the following table. Items in bold had a higher load than 0.5 in each component.

Table I. Rotated Component Matrix

Dilemma	**Components**			
	1	**2**	**3**	**4**
1	**.587**	.213	-.164	.365
2	.055	-.104	**.744**	-.057
4	.081	-.008	.061	**.855**
5	.091	.157	**.589**	.416
6	.233	**.646**	.077	-.235
7	**.752**	.026	.221	-.203
8	.018	**.734**	-.244	.279
9	.226	**.654**	.190	.096
10	**.595**	.261	.475	.004
11	-.040	**.532**	**.553**	-.042
12	**.693**	.123	-.047	.185

As seen in Table I, factor 1 grouped dilemmas 1,7,10, and 12. Factor 2 grouped dilemmas 6, 8, and 9, although dilemma 11 had also higher load than .50. Factor 3 grouped dilemmas 2, 5, and 11. Finally, factor 4 only included dilemma 4.

Table 2. Variances Explained for Each Factor

Component	Initial Value			Load Rotation Sum		
	Total	Variance (%)	Overall (%)	Total	Variance (%)	Overall (%)
1	2.906	26.420	26.420	1.869	16.995	16.995
2	1.387	12.606	39.026	1.831	16.650	33.645
3	1.171	10.641	49.667	1.615	14.678	48.323
4	1.112	10.106	59.773	1.259	11.450	**59.773**
5	.831	7.553	67.326	–	–	–
6	.775	7.042	74.368	–	–	–
7	.712	6.472	80.840	–	–	–
8	.626	5.692	86.532	–	–	–
9	.568	5.161	91.693	–	–	–
10	.513	4.663	96.356	–	–	–
11	.401	3.644	100.000	–	–	–

Table II shows total amount of variance explained for each factor. The first four factors grouped the eleven dilemmas included in the questionnaire, due to the fact that dilemma 3 was eliminated. These dilemmas were 59.77% of the total variability, which was an acceptable percentage.

Results showed four main components, possible dimensions for variable analysis. The first factor grouped dilemmas 1,7,10, and 12, this indicated that the underlying dimension was related to the concept of learning, in other words, the four dilemmas included in the questionnaire were related to the question: *what is learning?*

The second factor, which included dilemmas 6, 8, 9, and 11, clearly showed that the underlying dimension was connected to the process and the way of learning. They answered the question: *how is learning achieved?*

Factors 3 and 4 grouped dilemmas 2, 4, and 5, which were related to the content of learning. They were associated with the question: *what is learned?*

In short, the results from the principal components analysis demonstrated the existence of three main dimensions of the variable which answered to three fundamental questions: *what is learning? what is learned?* and *how is learning achieved?* These dimensions were used to examine the collected data through the questionnaire administration.

IV.2 Results Interpretation

IV. 2. 1 Learning Concept Content

The following table shows the results obtained from the calculation of the *mode*, in other words, the most selected answer by the subjects in each dilemma.

Table III. Mode for Each Dilemma

	Dilemma											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mode	3.00	3.00	2.00	3.00	3.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00

Table IV and Figure 1 show frequency distribution for each answer submitted by the subjects discriminated by each implicit theory of learning for each dilemma considered in the questionnaire.

Table IV. Answer -Frequency Distribution

	Dilemmas											
Theories	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Direct	4.3	–	17.4	–	8.7	17.7	30.4	–	–	26.1	8.7	13
Interpretative	34.8	26.1	30.4	47.8	47.8	69.6	52.2	34.8	91.3	69.6	69.6	65.2
Constructive	60.9	73.9	52.2	52.2	43.5	13	17.4	65.2	8.7	4.3	21.7	21.7

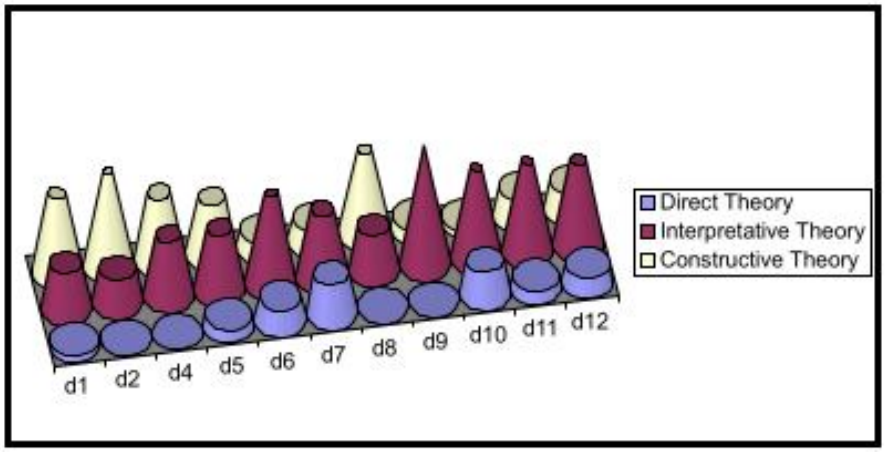

Figure 1: Answer -Frequency Distribution for Each Dilemma

The analysis of the previous data, which can be carried out based on the table included in Annex 2 and which synthesizes the main concepts of each learning domain theory according to the three dimensions of the variable obtained from the statistical analysis, allows to obtain some conclusions:

- In dilemmas related to the dimension: *what is learning?* with the exception of dilemma 1 (where the question is direct and activates *expected* answers), the interpretative theory predominates. In most answers the fact that learning consists of obtaining a *copy of the object* is implicitly considered, although the copy of the object may be distorted by processing limitations.
- In dilemmas related to the dimension: *what is learned?*, the most common position associates with the *constructive theory*, which prioritizes learning strategies over conceptual content learning.
- In dilemmas related to the dimension: *how is learning achieved?*, with the exception of dilemma 8 where the interpretative theory predominates, contradictory to the last dimension, emphasizes the incorporation of information and contents through different external means (explanation from teacher, text book, among others), although processed through the different cognitive skills developed.

IV.2.2. Influence of Field of Education on Conceptions

The following table shows the results of a Chi-square test conducted to analyze the relationship between the variables *of education field and learning conceptions* of the three categories: direct, interpretative and constructive.

Table V. Chi-square Results

Dilemma	Statistic	Degrees of Freedom	P value
1	0,995	2	0,608
2	O,138	2	0,710
4	1,637	2	0,441
5	4,505	2	0,105
6	2,425	2	0,297
7	1,373	2	0,503
8	1,694	2	0,429
9	3,892	2	0,143
10	2,932	2	0,321
11	0,454	2	0,797
12	3,464	2	0,177

As it can be observed, the values obtained from this study are not less than 0.05, which shows there is no association between the variables studied. Field of education seems to have no influence on learning conceptions of the subjects from the sample.

V. Discussion and Future Steps

This article presented the results related to the validation of the instrument, the content of implicit conceptions of learning, and the analysis of the relationship between education and the type of conception of learning.

Instrument validation, through the use of *Cronbach's Alpha*, determined the questionnaire's reliability, as well as factor analysis showed three dimensions of the variable studied.

To summarize results interpretation regarding the content of conceptions, two out of three fundamental dimensions in the questionnaire, represented by 8 of the 11 dilemmas, showed that trainee teachers have implicit conceptions of learning related to the interpretative theory. This theory prioritizes content over strategy, and has an epistemological realistic critical position on knowledge.

The statistical analysis conducted did not evidence a correlation between the education field and the predominating implicit theory of learning.

In order to complement data analysis, there is work being developed to analyze the characteristics or level of consistency of conceptions so as to determine whether they include theories or they are beliefs with a lower level of internal articulation.

Annex 1: Dilemma Questionnaire

In a department meeting, teachers are discussing the different topics related to teaching. In this discussion different points of view are explained. Please select the answer that best describes your opinion.

1. Regarding learning, some teachers think that:

    a) Learning is obtaining a copy of the object, although somewhat distorted, due to the learning process.
    b) Learning is obtaining an adequate copy of what is learned.
    c) Learning is recreating the learning result, necessarily transforming it.

2. Regarding students' previous ideas, the main opinions were:

    a) They are of utmost importance to the student, because knowing them allows the student to reflect on his or her own ideas, compare them with scientific models, and build new knowledge.
    b) It is not very important to know them, because they will be replaced by new contents that students will learn.
    c) It is useful to know them, especially teachers, because they will allow the teacher to show the student differences between the student's ideas and science, which are the correct ones.

3. Regarding the extension of course programs, some teachers think that they should:

    a) Select the most appropriate content so students can reason and develop learning strategies.
    b) Teach all content from the disciplinary logic, since it is indispensable for the student's career advancement.
    c) Teach all content stemming from the logic of the field, without neglecting students' reasoning and understanding as much as possible.

4. The main objectives of a subject are :

    a) To ensure that students develop strategies to understand what they learned.
    b) To ensure that all students acquire basic literacy, because eventually they will manage to understand.
    c) To ensure that students reason and understand as much as possible, although it may sometimes not be achieved with more complex content.

5. Regarding fundamental characteristics to consider when selecting a textbook, teachers thought that books should:

    a) Provide plenty of well-organized thorough information.
    b) Provide variety of activities and problems, although they may not be for every topic.
    c) Emphasize the most important information and provide activities for students.

6. Opinions on how students learn to apply their acquired knowledge were:

    a) Make students face increasingly open situations, where the teacher only acts as a mentor.
    b) Explain clearly to students what to do and present several similar situations to practice what is taught.
    c) Explain clearly to students how they should work, to subsequently make them face different situations.

7. The role of the teacher is primarily to:

    a) Explain the topic and if the content allows it, encourage discussion and analysis.
    b) Explain clearly the established knowledge, as it is accepted in the corresponding discipline.
    c) Promote situations, where students develop skills to do comparisons, argue and develop critical thinking on the subject.

8. The best for students' textbook is:

    a) That all students use the same book, to ensure that all students learn the same.
    b) That each student has different sources of information: texts, papers, science magazines, among others, to contrast different opinions and different perspectives.
    c) That all students use the same textbook, although it would be good the teacher provided other books in class to consult them or compare points of view.

9. The point of view related to questions formulated to assess learning were:

    a) Questions should be as clear and specific as possible, so that students do not lose objectivity when answering.
    b) Questions should be as clear and specific as possible, but at the same time, allow the student to get to the same answer through different methods.
    c) Questions should be open enough so that each student can organize his or her own answer.

10. Concerning the advantages and disadvantages of allowing students to have the study material before the test, teachers believe that:

    a) It is not a good idea because students do not make an effort to study the contents.
    b) It is a good idea because it could allow assessing whether students are able to use the available information to develop their own answers.
    c) It can be a good idea provided that it is accompanied by some other task to verify that the student knows the information.

11. When assessing the solution of a problem, the most important thing is to:

    a) Present a new problem to the student and regardless of the final result obtained, verify that the student can consider different ways to get to a solution and choose from a variety of strategies to solve it.
    b) Pose a problem situation similar to that worked in class and verify that the student follows the procedural steps taught in the classroom and that he or she obtains the correct result.
    c) Pose a new problem situation and verify if the student is able to select an appropriate procedure to get the correct result.

Annex 2. Results Interpretation

In order to interpret the results, the following table A2 may be used to synthesize the main concepts of each learning domain theory, according to the three dimensions of the variable from the statistical analysis.

Table A2. Relation between the main concepts of learning domain theories and dimensions of the variable

Variable Dimension	Direct Theory	Interpretative Theory	Constructive Theory
What is learning Dilemmas 1, 7, 10 and 12	Learning is to obtain an adequate copy of the object. It includes obtaining a correct result without considering the procedures followed.	Learning is to obtain a copy of the object, but with processing limitations. It prioritizes the correct result, but accepts different procedures to achieve it.	Learning is to represent the object necessarily. It prioritizes the use of adequate strategies over the result.
What is learned Dilemmas 2, 4 and 5	Education contents; information	Content and certain cognitive skills are needed to understand. It prioritizes content.	Cognitive abilities and contents. It prioritizes cognitive skills.
How learning is achieved Dilemmas 6, 8, 9 y 11	Through the incorporation of information by external means (explanation from the professor, textbook, etc.), practice, and repetition.	Through the incorporation of external information, but processed by the different cognitive skills developed.	Through strategy development that allows research, information search, problem solutions, and the elaboration of new questions.

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[1] The university programs of Teacher of Mathematics, Physics, Chemistry, and Biology are offered at the School of Exact and Natural Sciences, while Teacher of History, Geography, Letters, Philosophy, English, and Library Science are offered at the School of Humanities; both schools are from the National University of Mar del Plata (Universidad Nacional de Mar del Plata). The programs prepare graduates to give classes at a secondary and higher education level at the educational system in Argentina. The programs last 4 years and share classes of other undergraduate programs. Teacher training is complemented with a number of pedagogical courses that prepare students for their teaching practice.