The development of demonstration and refutation: application at the University of Havana

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Introduction

In response to the analysis and implementation of the Guidelines of the Economic and Social Policy of the Party and the Revolution, and especially those aspects oriented to the educational area, the improvement of teaching and the increase of its quality in higher education are promoted. From this point of view, it is essential to improve the transforming role of today's Cuban universities. These challenges demand students with a development of their logical thinking, which has generated in Cuba researches that assume it as an object of analysis from dissimilar dimensions, which serve as antecedents to this thesis Sanz (1989) and Hernández (1992). In these doctoral works, the procedures and logical actions of thought are studied in depth from a psychological approach.

Other studies that have served as support for this research, from a pedagogical point of view, are the proposals of González (2000) and González (2008). The former proposes a methodological strategy for the development of oral expression skills in university students, relating the discussion method and cooperative work with a system of tasks, and the latter proposes a didactic strategy to favor the development of logical thinking. An additional contribution were the results of the master's thesis of the author of this

research Travieso (2013), where the potentialities of the teaching-learning process as a way for the consolidation of this procedure in university students are shown. In these studies, deficiencies in logical thinking and its procedures were found; evidently, it is necessary to deepen in this subject, which would make it possible to raise the quality of learning, as they integrate actions that underlie the assimilation of any type of content, stimulating self-reflection, and with this, the productive nature of learning is overcome and enhanced. This area is not always considered in the curricular improvement processes, and teachers do not take advantage of the possibilities to reach higher levels in the cognitive activity of students in the teaching-learning process. Likewise, proposals of didactic strategies oriented to the development of logical thinking are scarce in the analyzed bibliography.

In this direction, the national and international literature consulted and the author's teaching experience show, in particular, difficulties in learning associated with the procedures and logical actions of university students' thinking, when facing the demands imposed by the higher education level.

Specifically, in studies conducted at the University of Havana (UH), there are difficulties in refutation and demonstration Barreto et al. (2014); Duvergel (2014). Namely: there are problems regarding the use of logical action: concept of compulsory properties, according to the analysis of the results, where only 17% of students use it; students use these logical procedures in their career, but not intentionally, but from their empirical knowledge; and the notions about demonstration and refutation they have are presented in a fragmented way. They do not have mastery of the terminology used, its definition, nor of logical actions; and therefore, they are not able to propose concrete actions for its development in their career.

It is evident that the development of refutation and demonstration faces the university teacher to a great challenge, attending to his role of guide and orientator in the teaching-learning process. His performance requires stimulating a cognitive and affective attitude in the student that favors the consolidation of logical thinking, through ways that encourage the use of these procedures.

Development

An important theoretical reference is the work of Vygotski, Soviet psychologist, who delved into the study of thinking, in this regard states: "Verbal thinking is not an innate, natural form of behavior, but is determined by a historical-cultural process and has specific properties and laws that cannot be found in the natural forms of thought and speech" (1968, p. 54).

Logical thinking is conceived as: "That type of thinking that is directed to the solution of problems and situations using as ways the concepts and logical operations, which are characterized by their mediated, generalized and abstract character" (González, 2008, p. 12). Logical thinking has a set of logical actions that integrate the thinking process itself.

Demonstration, as a logical procedure of thinking and, in particular, of judgment as a way of thinking, is considered one of the procedures least addressed by psychological science. Demonstration is understood as the way of: "Establishing a finite sequence of steps to support the veracity of a proposition or its refutation" (Hernández, 2013, p. 124), which is consistent with the position assumed in the present research.

This logical procedure is integrated, in turn, by logical actions: dichotomous classification, deduction of consequences, concept of obligatory properties.

Refutation is another of the logical procedures that make up the judgment. It is considered one of the least worked from psychological science.

Different authors have defined refutation throughout history, in the present study we assume the proposal of Guetmanova, who postulates that this procedure is the: "Logical operation that seeks to destroy a demonstration by establishing the falsity or lack of foundation of the thesis previously stated" (1991, p. 264). This logical procedure has been used since antiquity; it was already referenced in ancient Greece; moreover, it is currently recognized as Socratic refutation or the method of Elenchus.

Guetmanova, in her research, proposes the following structure for the logical procedure of refutation (1991, p. 265): Refutation thesis: the judgment to be refuted. Arguments of refutation: the judgments by which a thesis is refuted. Mode of refutation: consists in the refutation of the thesis, or in the criticism of the arguments, or in the revelation of the inconsistency of the demonstration.

Developmental Didactics, on the other hand, grants a new vision of the processes, institutions and actors involved in the educational system. A primordial role is given to the teaching task, since it is the moment in which the student comes into direct contact with the contents that are the object of learning (materialized-verbal plane), and makes

possible the transit towards its internalization. The teacher, in turn, becomes an orientor, a guide for the student, through the use of different means (levels of help) and methods, fundamentally of a participative type. These logical procedures deserve special attention in the university teaching-learning process, where the development of theoretical thinking implies scientific demonstration and refutation and, therefore, the need for students to master them.

In this article, the fundamental results of the implementation of the didactic strategy oriented to the development of demonstration and refutation are presented, which has possibilities of application in different subjects and careers, which is based on a social need. Likewise, it constitutes a reference for the teaching-methodological work of those subject groups interested in contributing to the development of thinking in students, which is a way little explored by teachers to increase the quality of professional training.

The study presented has a propositional-transformative character, the methodology is mixed in that it combines quantitative and qualitative aspects. Different methods are used to approach the object of study. The sample of students who executed the diagnostic tests on demonstration and refutation was established as follows: 29 second year students of the Information Sciences career of the University of Havana, who were taught the subject Introduction to Pedagogy, in the academic year 2015-2016.

As methods of data collection empirical methods were used were: Documentary analysis: for the review of official documents on the curriculum of the career in question (Study Plan D and E and the analytical program of the subject Introduction to Pedagogy), and of the bibliography, as well as in the elaboration of a guide for the analysis of programs according to the indicators elaborated. The latter was redesigned to achieve greater coherence with Study Plan E, paying special attention to the weight given to Pedagogy in the specialist's profile in general. Scientific Observation: It allowed recording and analyzing verbal and non-verbal information, as well as behaviors or conducts towards the content addressed in the classes, based on the use of an observation guide. Standardized tests: Three questionnaire-type diagnostic tests (initial, middle and final) were designed, in which open questions predominate, with the purpose of diagnosing the development of demonstration and refutation as logical procedures of thought in the students of the sample. The Survey: A questionnaire was designed and applied to quality informants, for the evaluation of the proposed didactic strategy. The Interview: to complement the information of the applied techniques,

which allowed enriching the information related to the problematic situation. The content was recorded by the author, with the consent of the subjects. The semi-structured interview was used with teachers of the 2nd year of the CI career and students who participated in the teaching-learning process.

Methods of data analysis: Analytical-Synthetic: to delve into each of the indicators separately; and to know to what extent they are influencing the development of demonstration and refutation as logical thinking procedures; and the Logical-Deductive: to approach thinking from different edges (Logic, Pedagogy and Psychology) and in the analysis of demonstration and refutation as logical procedures and their development from the teaching-learning process. Both methods were used to elaborate the theoretical-methodological foundations, as well as during the analysis and interpretation of the results. Statistical methods were also used during the analysis of the data: the absolute and relative frequency distribution: to describe the frequency of the data obtained in the diagnostic tests during the analysis and interpretation of the results; Pearson's correlation coefficient: to establish the relationship between the logical procedures of refutation and demonstration, in the sample elements and the Signs test: to compare the medians of the data in each of the moments of application of the diagnostic tests and to measure the levels of development of the logical procedures studied.

Among the main results, it was obtained that 13 face-to-face classes were given, of which 11 theoretical-practical classes, 1 seminar and 1 lecture were. Three classes were dedicated to the application of the initial, middle and final diagnostic tests. In addition, a space for consultations was established to clarify the main uncertainties of the students in the subject and a course work was designated as the final evaluation. The enrollment included 33 students and the sample of students analyzed was of 29 subjects, which could be followed up during the whole process. During the teaching-learning process, the presence of two teachers who shared the teaching was established, alternating the roles of teacher-observer/reporter. This made it possible to record class observations.

The course began with the application of the initial diagnostic test, to ensure that the students did not receive subject contents that would influence the results obtained and thus achieve a diagnosis of the real development of the logical procedures of demonstration and refutation thinking in the students. It was highlighted that the students reported that they had never heard of refutation, showing anxiety and restlessness before the test. The results obtained in the initial diagnostic test were not

satisfactory. The students subject to analysis showed a poor command of the logical procedures demonstration and refutation, where an empirical knowledge was evidenced and the logical actions constituting them were unknown. An incorrect execution was denoted in most of the problemic tasks, where 17% of the students executed correctly half or more of the 11 tasks designed in the case of demonstration. As for the refutation, 28% of the sample correctly executed half or more of the 8 tasks presented. They presented difficulties in both the elaboration and recognition problem tasks. Thus, more than half of the students answered incorrectly the recognition tasks (type of tasks considered to have a lower level of complexity) related to demonstration (61% of the total number of students) and refutation (58% of the total number of students). In the elaboration-problem tasks related to the procedures studied, 97% of the sample failed to answer correctly.

Their execution was characterized by a lack of reflection on the required actions, 94% of the students had a low level of awareness in relation to their actions, and consequently, limited possibility of generalizing these actions according to the different types of problemic tasks. Eighty-nine percent of the students failed to transfer the actions during the execution of the tasks, and only 4 students (11%) had an average level of generalization of the contents. This indicated that they are still at a lower level of the assimilation process, at the materialized stage, where the use of supports is required during the teaching-learning process and the execution of the problem-solving tasks in particular.

During the analysis, it was also possible to find the existence of difficulties with the logical actions corresponding to the procedures studied. Regarding demonstration, 61% of the students presented difficulties in the use of dichotomous classification, 67% had difficulties in the deduction of consequences and 81% of all students showed deficiencies in the determination of the concept of obligatory properties. In relation to the refutation, 53% presented difficulties in relation to the negation of the refutation thesis, in 58% of the students the treatment of the refutation arguments was insufficient and 83% of the sample presented deficiencies in relation to the mode of refutation.

In the following class, the framework of the subject was worked on and the first ideas about the contents to be worked on during the semester were addressed. Subsequently, demonstration and refutation were explained and an individual exercise on demonstration was carried out, where students were given levels of help consisting of logical actions to demonstrate, which they handed in writing at the end of the class. The

students received from this moment not only the orientation of the content related to the logical procedures, but the problem tasks were related to daily life, which had a low level of complexity. In addition, they came into contact with the methodology for the analysis of problems, having been previously explained a set of theoretical contents.

In most of the following classes, the previously addressed contents were taken up again and problem-solving tasks that contributed to the development of demonstration and/or refutation were tackled. In general, students showed a superior development when facing tasks that required demonstration, than those that required refutation.

In meeting four, the problem-solving task was presented, providing levels of help (a box referring to the logical actions of each logical procedure: demonstration and refutation); however, a moment of regression in the process of development of logical procedures is shown, when the students referred concerns in relation to the correct presentation of demonstration and refutation, requesting that the teacher in the next class develop an example exercise with both procedures. In contradiction with this group need, little help was required during the execution of the initial teaching task. It is suggested that the students at this moment reflected the problematic, that is, the felt need to get to the essence of what is still unknown to them. This showed that for this moment of the teaching-learning process, the students began to appropriate the logical procedures under study. However, even though there is a need to continue working on the elaboration of demonstrations, it possessed a development superior to that found in the refutation.

In class eight, the average diagnostic test is applied. When contrasting the results obtained in the medium diagnostic test with the previously declared results of the initial diagnostic test, it was found that in the case of the total number of correct questions, the students surpassed the results of the initial diagnostic test. In general, discrete advances were shown in terms of the average diagnostic test, in relation to the students' starting level. It should be noted that some students were able to satisfactorily solve recognition tasks, surpassing their starting level when faced with elaboration tasks. There was a transition in part of the sample, from low and medium levels in terms of the degree of awareness and generalization, to the achievement of reflection on the logic of action and the application of different actions independently of the different levels of complexity of the problem tasks according to their content (daily life, subject, professional practice). There are students who, at the time the average diagnostic test was applied, arrived at a mental stage of formation of the actions, internalizing them, showing a favorable

execution in coherence with the demands of the presented problemic tasks. This is due to the gradual development of the logical procedures studied, which took place during the application of the different teaching tasks in the teaching-learning process, as well as the levels of assistance provided to the student that favored the internalization process according to their learning rhythms.

At the end of the teaching-learning process of the subject, a final diagnostic test was performed. Regarding the number of correct tasks solved by the students, significant progress was shown in relation to the logical procedures studied. 25 (86%) students responded correctly to the demonstration tasks presented in the final test, surpassing their starting level. On the other hand, more than half of the sample, 18 students (62%), obtained results superior to the initial test in terms of refutation. As for the recognition problem tasks, progress was also reflected in the final diagnostic test for both demonstration and refutation. In the demonstration procedure, 79% of the subjects surpassed their starting level, while for the refutation, 24% of the sample managed to obtain satisfactory results in relation to those obtained in the initial diagnostic test. All this attests to the value of the didactic strategy implemented in the developmental teaching-learning process that contributes to overcome the development levels of the logical procedures demonstration and refutation in the students.

In relation to the elaboration problem tasks, the results are more discrete but it was evidenced that the students surpassed their real development reached at the beginning of the course, 17% of the sample surpassed their starting level in relation to the demonstration tasks, while 31% of the students did so in relation to the refutation tasks. It is valid to point out that the students obtained in this type of problem tasks of greater complexity than those previously described, more favorable results in the refutation procedure than demonstration, contrasting with the perception of the students regarding their difficulties in the execution of the tasks, where they had referred to refutation as a more complex logical procedure.

On the other hand, moments of regression are defined when analyzing the teaching-learning process, and the frequent request for help by the students, which may reflect the spontaneous transit that took place through the different levels of complexity of the teaching tasks, where difficulties and errors were assumed as inherent to the learning process; and which finally led to the levels of development reached.

In relation to the properties of the action, progress was noted in the development of the logical procedures under study. In the particular case of the degree of consciousness, it

was observed that in relation to the demonstration procedure, at the beginning of the academic course the students were all in a low degree of consciousness, not being possible for them to reflect on the logic of the action during the execution of the tasks; however, at the end of the process and the culmination of the work with the designed teaching tasks, However, at the end of the process and at the culmination of the work with the designed teaching tasks, the number of subjects in the lower degree of consciousness decreased, it was defined that only 52% of the subjects remained in a low degree of consciousness, while 21% were in a medium degree of consciousness and 28% emerged with a high degree of consciousness, clearly reflecting the sequence of actions through which they were able to solve the problem tasks that were presented.

These ideas reinforce that the didactic strategy for the development of demonstration and refutation, based on the assumptions of Logic, the Historical-Cultural Approach and Developmental Didactics, surpasses the traditional teaching strategies currently used in university classrooms, which limit the conscious reflection of students on their object of learning.

Regarding the refutation procedure, a similar behavior was manifested, where 93% of the students were located in a low degree of awareness in their starting level, however, already in the final diagnostic test, less than half of the subjects of the sample remained in a low degree of awareness. Thirty-eight percent of the subjects were at a medium level of awareness and 14% of the subjects moved up to a high level of awareness. In relation to the degree of generalization, results similar to those previously described were found. The students in the initial diagnostic test remained in the low and medium degrees of generalization for both logical procedures, while at the end of the teaching-learning process, one percent of the students reached the medium and high degrees of generalization. Thus, in the demonstration procedure, of the 66% of the students who were at the beginning in a low degree of awareness, in the final test only 12% of the students remained without being able to apply the logical actions to the different types of problemic tasks. At the beginning of the process, 34% of the students were in the medium degree of generalization; however, at the end of the teaching-learning process this value increased and 61% of the students reached a medium degree of generalization. In addition, 27% of the sample managed to implement the logical actions of the demonstration procedure to the problem tasks with different contents (daily life, subject and professional practice). It is corroborated that the process of internalization of logical procedures, especially demonstration and refutation, is

complex and requires a planned and systematic treatment where students gradually appropriate the constituent logical actions. This is achieved with the design and implementation of a developmental teaching-learning process oriented to the consolidation of demonstration and refutation in students, which justifies the progress shown.

The results obtained so far are the result of the design and management of the problem tasks during the teaching-learning process, which favored in the students the development of demonstration and refutation as logical procedures, despite their complexity for the students in the sample.

Regarding the refutation procedure, it was found that although 62% of the students were at the beginning of the course in a low degree of generalization, at the end of the course only 21% of the students were not able to use the logical actions to the different types of tasks that were presented. The number of students who appeared in a medium degree of generalization increased from 38% to 58% of the sample, and 21% of the students in the final diagnostic test reached a high degree of generalization.

It was also possible to locate the students in relation to the plane of formation of the action in which they were at the beginning and end of the subject Introduction to Pedagogy. The development achieved by the students in this sense was clearly shown. At the beginning of the course, 69% of the students were in a materialized stage of action formation in relation to demonstration, and 31% were in a verbal stage; at the end of the teaching-learning process, only 30% of the students remained in a materialized stage, 33% were in a verbal stage and 36% of the students reached a mental stage, showing the internalization of the logical procedure in question.

As for refutation, the percentage of students in the materialized stage decreased, although in the initial diagnostic test there were 59% of students in this stage, in the final diagnostic test only 39% remained in this position. The number of students in the verbal stage increased, since 38% of the sample was there at the beginning of the process, and at the end of the process, 45% of the students were already in this stage of action formation. In the initial diagnostic test, one student was placed in a mental stage; however, in the final test, 15% of the subjects in the sample were already in this location.

Analyzing the results of the students during the teaching-learning process, it was proposed their placement in the levels of development of the logical procedures demonstration and refutation previously established by the author. In general, 48% of

the subjects participating in the study were placed in the higher levels of development (I and II) of demonstration, and in the case of refutation, 45% of the students in the sample. This reflects that the students ascend to higher levels of development of demonstration and refutation, in that they possess greater capacity to generalize logical actions to different types of tasks, when contrasted with their starting levels. On the other hand, they are more independent in their actions with the content and move from a materialized plane to a verbal and mental plane in the formation of the action, being able to reflect on the logic of their actions.

All this has a bearing on the fact that it can be affirmed that the didactic strategy designed and applied during the teaching-learning process of the subject Introduction to Pedagogy, contributes to the development of the logical procedures under study.

The analyses carried out in the present application of the didactic strategy for the development of demonstration and refutation were complemented with the results of the use of the statistical package for Social Sciences (SPSS). It was evidenced by means of the signs test, that no significant differences were obtained in the results found when contrasting the tests (refp1-refp2), which corresponds to the fact that at the beginning of the course the students showed greater difficulties in relation to the refutation, in addition, the development of logical procedures in the students implies processes of great complexity; however; when contrasting the diagnostic tests: refp2-refp3; refp1-refp3 and demp1-demp2; demp2-demp3, demp1-demp3, demp1-demp3, did show significant differences that translate into advances in the levels of development for both demonstration and refutation, by this time the students had interacted with the tasks that were systematically presented in classes and found the necessary support levels for the development of demonstration and refutation, from their personal potentialities.

Likewise, when analyzing possible correlations between the logical procedures demonstration and refutation, it is found that initially, at the beginning of the teaching-learning process, there are weak correlations between these logical procedures (0.310), however, as the teaching-learning process progresses, a closer relationship is shown. In the average diagnostic test, progress is shown (0.886) and in the final diagnostic test, the correlation is even stronger, the value grows (0.896), despite the fact that the levels of help are removed from the students. This implies a simultaneous development of the logical procedures under study in the students, favored by the management and application of a teaching-learning process that intentionally provided problemic tasks to contribute to the consolidation of demonstration and refutation.

Conclusions

The theoretical assumptions of the didactic strategy, which are based on Developmental Didactics and take into account resources of the Historical-Cultural Approach and Logic, provide the teacher with theoretical-methodological tools for the approach and understanding of thought, its procedures and logical actions.

The design of the didactic strategy favors the development of demonstration and refutation as logical procedures of thought. This was possible through the use of tasks with demonstration and refutation contents. Likewise, attention is paid to those that are related to daily life, to the subject and to professional activity, and they are worked both from the recognition and from the elaboration.

In the initial diagnostic test designed to work with demonstration and refutation, there is a predominance of incorrect execution, even in the tasks containing lower levels of complexity, and they show difficulties in the different logical actions of the procedures studied. By introducing the problemic tasks in the teaching-learning process, students achieve satisfactory results in terms of the logical procedures studied. It was found that in the middle and final diagnostic test, most of the students achieve progress in generalization, independence and, in some cases, and they are able to base their actions correctly, both in demonstration and refutation.