MENDIVE
REVISTA DE EDUCACIÓN

Original article

A diagnostic approach to the development of scientific thinking in education professionals

Una aproximación diagnóstica al desarrollo del pensamiento científico en los profesionales de la educación

Uma abordagem diagnóstica para o desenvolvimento do pensamento científico em profissionais da educação

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Received: 2022-05-31
Accepted: 2022-11-02

ABSTRACT
The management of the teacher is very important in the development of the scientific thought of the students; but for this to be the case, it is necessary for teachers to achieve this type of reasoning, of which the main characteristics are considered to be its strategic, critical, deep and complex nature. The objective of the article is to expose the results of an exploration of the thought of a sample of 27 recently graduated teachers and seven in the last years of the Pedagogy-Psychology career, to find out to what extent their thinking styles were close to or far from the scientific thought. Considering that the problems challenge people's thinking, two instruments were used: a professional problem and another of a general social nature; Respondents had to explain how they would proceed to solve them. The results point to weaknesses in the strategic nature, depth, criticality and complexity in the way of thinking of the respondents. Other researches consulted are consistent with what was obtained and postulate the importance of the Teaching-Learning Process being oriented to fill these deficiencies. It is concluded that, as a tendency, the thought of the people in the sample moves away from what they theoretically call scientific thought.

Keywords: scientific thought; problem/thought; tendency/thinking of teachers.

RESUMEN
La gestión del docente es muy importante en el desarrollo del pensamiento científico de los estudiantes; pero para que así sea es necesario el logro en los profesores de este tipo de razonamiento, del que se consideran las principales características su carácter estratégico, crítico, profundo y complejo. El objetivo del artículo es exponer los resultados de una exploración al pensamiento de una muestra de 27 docentes de reciente graduación y de siete en los últimos años de la carrera Pedagogía-

Psicología, para conocer en qué medida sus estilos de pensamiento se aproximaban o alejaban del pensamiento científico. Considerando que los problemas retan al pensamiento de las personas, se utilizaron dos instrumentos: un problema profesional y otro de tipo social general; los encuestados debían explicar cómo procederían para resolverlos. Los resultados apuntan a debilidades en el carácter estratégico, en la profundidad, la criticidad y la complejidad en la manera de pensar los encuestados. Otras investigaciones consultadas son coincidentes con lo obtenido y postulan la importancia de que el Proceso de Enseñanza-Aprendizaje se oriente a suplir estas deficiencias. Se concluye que, como tendencia, el pensamiento de las personas de la muestra se aleja de lo que teóricamente llaman pensamiento científico.

Palabras clave: pensamiento científico; problema/pensamiento;
tendencia/pensamiento de docentes.

RESUMO
A gestão do professor é muito importante no desenvolvimento do pensamento científico dos alunos; mas para que assim seja, é necessário que os professores alcancem esse tipo de raciocínio, cujas principais características são consideradas seu caráter estratégico, crítico, profundo e complexo. O objetivo do artigo é expor os resultados de uma exploração do pensamento de uma amostra de 27 professores recém-formados e sete nos últimos anos da carreira de Pedagogia-Psicologia, para saber em que medida seus estilos de pensamento estavam próximos ou distantes do pensamento científico. Considerando que os problemas desafiam o pensamento das pessoas, foram utilizados dois instrumentos: um problema profissional e um problema social geral; os respondentes tinham que explicar como iriam proceder para resolvê-los. Os resultados apontam fragilidades na natureza estratégica, profundidade, criticidade e complexidade na forma de pensar dos respondentes. Outras investigações consultadas coincidem com o que foi obtido e postulam a importância do Processo Ensino-Aprendizagem ser orientado para suprir essas deficiências. Conclui-se que, como tendência, o pensamento das pessoas da amostra se afasta do que teoricamente chamam de pensamento científico.

Palavras-chave: pensamento científico; problema/pensamento;
tendência/pensamento dos professores.

INTRODUCTION

The development of cognition is one of the most important contributions that education, at any of its levels, makes to students. In this sense, it is worth taking into account that among the cognitive psychic processes, thought occupies an important place in the processing of information, so that it becomes knowledge and, although it is not a frequent statement in the psychological literature, it coordinates functions of the other processes and enriches them (Bermúdez and Rodríguez, 2018; Medina, Machado and Vivango, 2018).

The management that the teacher carries out of the Teaching-Learning Process (PEA) is very important for the development of thought; but only if the teacher has achieved an important qualitative growth of his own thinking and strips himself of traditional didactic practices (Figueroa, Pezoa, Elias and Díaz, 2020; Sánchez, 2013; Rodríguez, López, Carrillo, Fajardo, Salgado, Méndez *et al.*, 2012), conditions of whose existence one cannot be sure when for years there has been interaction in the training processes of education professionals, which has made it possible to appreciate the predominance of didactic practices busier in meeting certain institutional requirements established with

pretensions of unanimity, that focused on the intellectual development of the students, with the consequent little encouragement to strategic, deep, critical and complex thinking.

The project that is carried out at the University of Ciego de Ávila, for the development of scientific thought in university students, is justified by the dissatisfactions expressed in the previous paragraph and has needed to go from the appreciations obtained in the pedagogical practice to the most precise diagnosis. about how the University Teaching-Learning Process is favoring or not the aforementioned purpose. With such intentions, it has been investigated, with various methods, both in the performance of teachers and in the trends that are evident in the thinking of students in the final years of the careers, as well as those who have recently graduated.

The project mentioned above is committed to the need to foster, in the university, the development of scientific thought among professionals, and although achieving a definition of this concept is not a task fully achieved by the team of researchers, it is It is agreed that at least it is characterized by being strategic; it includes responding to sufficiently defined purposes, being ordered and self-regulated with respect to the way of proceeding (Chamiso , 2017; Bunge, cited by López, 1990) and processing information critically (Grijalba, 2020; Posso, Montoya and Cuadrens, 2018; Rojas, 2017), deep (Bermúdez and Rodríguez, 2018) and complex (Posso, Montoya and Cuadrens, 2018; Solana, 2019).

Regarding this aspect, brief considerations should be made about the position that is assumed: the distinctive features indicated are manifested in an extremely interrelated way; but by submitting the object in question to analysis, certain typical evidences can be distinguished in each one. For example, in the cases of the trait's depth and complexity, it is difficult to make the distinction because it can be said that when thinking in a complex way, one is thinking in a deep way. However, not always when you think in a deep way, you do it in a complex way.

Going deeper is going from the external, the visible, to the essential invisible, but thinking complexly is more than that. According to Edgar Morin "...Living beings are open systems that can only be defined ecologically, that is, in their interactions with the environment, which is part of them as much as they themselves are part of it" (Morin quoted by Solana, 2019, p.1).

Consider reality as a complex network of closed and open systems and accept that these, predominant in the individual and social spheres, maintain a permanent exchange of content with their environments and constantly feed each other to maintain internal balance and that of their relationship with their own means, in a kind of systematic reorganization, leads to suppose in any phenomenon of reality the presence of causal multifactoriality and recursion, in such a way that the closely connected causes cause effects and these in turn influence the system of causes, "The effects and products are necessary for the process that generates them. The product is a producer of what produces it" (Morin cited by Solana, 2019, p. 1).

The present work reports only on one of the investigations carried out, and its objective is to expose the results of an exploration of the thought of recently graduated teachers and students of the last years of a pedagogical career, to know to what extent, when thinking, they approach or move away from scientific thought.

MATERIALS AND METHODS

As has already been said, an approximation to the general tendencies was tried -it was not forgotten that the thought is marked by

the individuality of each person- in the way of thinking of students and recent graduates of pedagogical careers.

The study is part of a more general diagnosis carried out by the researchers of the research project "Development of scientific thought in university students" that is carried out at the University of Ciego de Ávila, Cuba, and was carried out during the second semester of the year. 2021.

It was taken into account that the studies of cognition, led by cognitive psychologists, since the eighties no longer absolutize laboratory investigations with the pretensions of achieving measurements on the processes of the mind and have been drifting towards more qualitative methodologies.

The controversy about the internal and external in human activity was also thought about and the point of view of Bermúdez and Rodríguez (2018) was assumed, according to which there are no external and internal actions, but that they are two planes at all times. human actions.

It was taken into account that, in any case, to explain the visible part of human actions, in addition to studying the general environment, it is necessary to delve into its internal plane and that, for this, it was convenient to situate people before the need to solve a problem, due to the existing consensus regarding the importance of thinking in this sense.

For the investigation, two surveys were used, with an open question each, in each case the question was preceded by the statement of a problem as a challenge to the thinking of the respondents:

1. Presentation of a professional type problem so that the members of the sample could explain how they would solve it. The problem in question was the following:

Suppose that you are in charge of a pedagogical group (school, faculty, degree or year-long pedagogical group) and they diagnose that there is no progress in the moral values expected to be formed in the students. How would I go about solving that problem?

This instrument was applied to 27 teachers who graduated from pedagogical careers in the last three years, who constitute 40% of the faculty of the "Raúl Corrales Fornos" Pedagogical School in the municipality of Ciego de Ávila.

The sample was intentional, not probabilistic because the survey was carried out on all the teachers of the "Raúl Corrales Fornos" Pedagogical School, who meet the requirement of having graduated from pedagogical careers in the last three years.

2. Presentation of a general life problem that any young person can face. The problem was the following:

Please, imagine that you have to join a new group of people (a student, work or any other group) and that you are interested in belonging to that group, but you have realized that you are not sufficiently accepted by its members. Explain how you would go about solving that problem.

This instrument was applied to seven students of the Bachelor of Education career, specialty Pedagogy Psychology, belonging to the third (four students) and fourth (three students) years, which constitute 100% of the respective enrollments. It was not decided to present them with the professional problem (1) due to considerations that they might still lack the necessary preparation, especially due to the insufficient labor practice actions carried out during 2021 due to the COVID-19 pandemic.

In this case, it was interesting to survey, due to the special influence that these

professionals should have in the psychological development of their future students and in the advice of school teachers, students in the final years of the Bachelor of Education, specialty Pedagogy Psychology. Due to the low enrollment, we worked with the entire population.

The processing of the information that was obtained with the application of the instruments was carried out basically through the interpretation of what the interviewees wrote; that is, qualitatively.

More precisely explained:

The main characteristics that the research team had assigned to scientific thinking were taken into account: strategic, critical, deep and complex.

The strategic thing was intended to warn by the presence of planning to think: precision of objectives to be achieved in determined periods of time, carrying out actions sufficiently ordered when trying to solve the problem.

What is critical, for the expression of positions questioning the environment and the interiority of the thinker.

What is profound, due to the passage of external evidence to the investigation of causality and the study of the essential, what is not visible to the naked eye.

What is complex was aspired to be verified or not by the presence or absence of the analysis of possible multiple factors that intervene in the problem and in its solution, as a manifestation, at least elementary, of the complexity that should characterize scientific thought.

The sincere voluntariness of the participants and their willingness to respond responsibly was guaranteed, especially since they were students of the researchers, both in postgraduate and undergraduate studies, and with whom relationships of fellowship and collaboration are maintained. They had all the time they deemed necessary to respond.

The researchers were aware that studying these characteristics of thinking requires more exhaustive searches; but it is reiterated that it was a first exploratory approach, trying to find general trends. As part of the diagnostic process of the development of scientific thinking in students and recent graduates, the project to which repeated reference has been made applies other methods and techniques, such as discussion groups with students and teachers, as well as the analysis of the products of the activity, in order to triangulate the evidence and delve into causality, since progress can only be made in solving a problem if the causes that cause it are eliminated, or at least mitigated.

RESULTS

In the sample of 27 graduates, the responses were characterized by:

- Being, for the most part, insufficiently coherent and organized. They began writing without exposing any plan. All accepted the existence of the problem without raising the possibility of verifying its manifestations.

- Of the 27 participants, only two precisely referred to critical analyzes of the way in which training in values is carried out and another two did so in a vague, dispersed manner. None made self-critical questions regarding their points of view and the possibility of changing them.

- Three (3) dealt with the causal analysis in a precise way, another three did it in a vague, imprecise way. Twenty-one (21) did not deal with the causes.

- One person carried out a complex analysis, both of causes and of factors to be taken into account for the solution. Eleven addressed various factors, the majority referring to actions to resolve the problem; all referred to well-known and repeated factors: the influence of the school, the family, the community, the student organization, but without penetrating the depth of each of these aspects or addressing them in an interrelated manner.

Two other elements that came to light are curious:

- Nine (9) referred, in a very similar way, to a very repeated algorithmic procedure: make a diagnosis, develop a strategy, but without contextualizing the case or true depth.

- Ten (10) included, without having to do directly with the solution, an explanation of the importance of values in the educational process and named the values that should be prioritized.

In the sample of seven undergraduate students (3rd and 4th years) from the Psychology Pedagogy major, the responses were characterized by:

- Five were imprecisely strategic, if one takes into account that they thought of a few sequenced actions (almost always two) to successfully join the group.

- Two (2) were not strategic in any way.

- Of the seven (7) none showed elements of critical thinking, because they did not question the attitudes of the people with respect to the new people who must join the groups to which they belong, nor about their own attitudes and behaviors and the relationship that these could have with the probable insufficient acceptance by the components of the supposed group.

- Two (2) were more or less profound because they tried to find the causes of their non-acceptance by the supposed group.

- Five (5) did not make evident their interest in approaching the causes of the supposed non-acceptance. They did not show any intention of depth, they exposed superficial ideas.

- Complexity when performing multifactorial analyzes of interrelated elements, did not show any.

- Three (3) ended up writing comments that contribute nothing to the solution of the problem posed, about the need to not pretend to be who you are not to please others.

DISCUSSION

When interpreting the results, it was taken into account that the situation in which the respondents had been placed and their "artificial" nature did not allow them to fully display all the potential of their thoughts, but did allow the main tendencies that characterize them to emerge.

It was interpreted that:

There was no predominance of strategic thinking in the graduates because, as a tendency, they did not start from objectives or propose ordered actions to solve the problem. In the undergraduate students there was more approach to this procedure, probably because the problem was more interesting to them; however, the strategic glimpses were poor. A tendency to spontaneity was observed, to say more on impulse and/or from memory than as a result of reflection.

Among the graduates, some (only four) were partially critical. None of the students were. The difference may be due to the fact that they faced problems of a different nature: the first is very close to the problems that characterize educational environments, the second is more on the level of assumption. In any case, an insufficient critical approach to thinking was evident.

The matter referred to depth behaved slightly higher, especially among graduates, because between the two subgroups, eight people out of 34 dealt, in some way, with the accusations of the problems, although it is worth saying that without delving sufficiently in them.

The complexity was more present among the graduates, because when making approximations to the probable solutions of the problem, it could be appreciated that they focused on the student group as an open system where the interaction of different types of elements occurs (individual, sociological, pedagogical, among others).); probably because, in schools, problems similar to the one proposed are discussed with some frequency and it has become traditional to accept that several factors intervene in it. It should be noted that the multifactorial approach was produced, above all, in the factors to be taken into account for solving the problem and not in the causal analysis, which could be taken as evidence of strategic poverty. In the undergraduate students, no manifestation was found that would allow us to suppose the presence of a complex approach to the issue that was raised.

The tendency among those questioned to end up expressing opinions of a persuasive nature, unrelated to the way to proceed to solve the problem, is striking, possibly the result of criteria installed in the culture, rather than as a result of independent reflection.

Another interesting trend among graduates is to appeal to well-known algorithms in the educational system to propose a solution to the problem, this suggests the establishment of what Bermúdez and Rodríguez (2018) call verbal chains (not knowledge), more typical of of the work of memory than of thought. Actually, this way of proceeding: diagnose, design a strategy... for thirty years it has been repeated and required of schools by the Ministry of Education.

It should be emphasized that the people surveyed are young education professionals who have recently graduated from university and students of the same profession who are in the final years of their studies. As has already been said, educators are of great importance for the development of scientific thought, but it is necessary that they themselves have achieved or strive to achieve this development.

Educational research on the development of scientific thought that handled data and issued judgments in this regard was found only one, but many were found on the education of critical thinking, which constitutes, in the opinion of the researchers, a decisive feature of scientific thinking.

Rojas (2017) acknowledges that in Paraguay it is verified:

> The existence of researchers, a research center, spaces for the publication and dissemination of ideas; however, it is shown as a lack of articulation between the different actors for the rethinking of the production of knowledge in the country. (...) A break with normal science is not visualized. Indeed, its application requires problematizing and de-constructing concepts (...) that allow the reflection of

> these terms, according to a look that gives rise to the context and the different variables and does not remain focused only on the object itself (p. 316).

It is difficult, if one inquiries into the causality of this reality, the predominant tendencies in people's education do not appear among the causes.

Córdova, Velázquez and Arenas (2016), in the article "The role of argumentation in critical thinking and epistemic writing in biology and history: an approach based on the social representations of teachers", report an interesting investigation where they highlight the limitations of teachers to teach students to write critical arguments and how this is reflected in formative failures in students.

In the study carried out by Núñez, Ávila and Olivares (2017), the authors highlight the:

> Need for teachers to develop not only the mental abilities, but also the mental dispositions of students, in other words, to help students develop as people who understand the world rationally, who are intellectually empathetic, willing to listen the points of view of others, especially those with which you disagree. That they be intellectually persevering, with a willingness and ability to learn through difficulties in complicated problems. (...) That they be intellectually autonomous and independent, capable of remaining alone in their beliefs and thinking for themselves (p. 18).

These authors declare dissatisfaction with respect to the achievement of these results and proclaim the importance of substituting descriptive teaching for problem-based learning, to favor a higher development of critical thinking in students.

The detailed investigation carried out by Perico, Rancancio, and Pardo (2007) in an engineering program, allows them to conclude that it is:

> The training of critical thinking in the students of the program is poor (...) the students rarely examine or evaluate what they usually assume, they do not distinguish between relevant facts and those that are not (they are distracted by the facts that have nothing to do with the matter in question), and do not formulate plausible inferences, predictions or interpretations (...) (p. 23).

And then they add that:

> The foregoing can be explained as a lack of strategies at the classroom level, that is, the teaching methods used by teachers in their practices are not being effective in the development of critical thinking training in students (p. 23).

Benavides, Páramo and Reyes (2004) explain how the "little ability to associate concepts, lack of analysis and critical judgment, repetitive and rote thinking, low level of attention and concentration" expressed by engineering students when studying scientific knowledge (p.18) underwent favorable changes due to the application of methodological strategies for the formation of scientific thought, based on

problematization and the stimulation of creativity.

León, Duque and Escobar (2018) give an account of their inquiries in the results of the Saber, Program for International Students Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS) and the Second Regional Comparative and Explanatory Study (SERCE) and ensure that the data analyzed allow inferring shortcomings in the development of scientific thought in the area of Science in Colombian schools, while presenting evidence of the relationship that this has with the survival of the tendency to didactic traditionalism in the performance of teachers.

From the entire investigative process carried out, it can be concluded that:

Among the respondents -students of pedagogical careers and graduates of them at the University of Ciego de Ávila- imperfections related to the characteristics of scientific thought were revealed, because, as a tendency, they did not show planned reasoning and focused on goals. Critically guiding the approach to the proposed problems was not a trend among those surveyed either.

No tendency to think deeply was observed in the respondents, because, although some inquired into causality, they were few and these inquiries were not characterized by being acute.

Respondents were not characterized by complexity in thinking, mainly because while some were multifactorial in their analyses, none dealt with the interrelationship of factors.

The previous judgments allow us to infer that the trend found in a sample of young education professionals in practice and in training, rather than a closeness, is a distance from scientific thought.

Other investigations carried out in various Latin American countries related to critical and scientific thinking, in general, of the student body, show the close relationship between the deficiencies found and the characteristics of teaching.

Investigating to promote the development of scientific thought in students of pedagogical careers is necessarily an extensive and complex process, which is why it is advisable to recommend:

- Carry out new incursions in the diagnosis of the thought of the student body and recent graduates, using other instruments to make comparisons with the results obtained in this report.

- Triangulate this information with that produced by other diagnostic approaches carried out by other members of the research team of the project.

- Continue the search for works on the diagnosis of thought that are carried out in other places in Cuba and the world to compare and make deeper inferences.

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Conflict of interests:

The authors declare not to have any interest conflicts.

Contribution of the authors:

The authors participated in the design and writing of the work, and analysis of the documents.

Cite as
García Gutiérrez, A., Pla López, R., & Ulloa Paz, E. (2023). A diagnostic approach to the development of scientific thinking in education professionals. *Mendive. Revista de educación, 21*(1), e3097. Retrieved from https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/3097