

Curricular strategies in the pedagogical training of future physics and mathematics teachers

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ABSTRACT

One of the problems identified in terms of integrality in the pedagogical training of future Physics and Mathematics teachers is the insufficient use of the potential of curricular strategies. To this end, this article aims to define this concept and to offer guidelines for the implementation of such strategies. Methods such as analysis-synthesis, content analysis and document review were used. The results show consensus in the use of such strategies, for which curricular work, teachers' preparation and students' protagonism are indispensable conditions.

Keywords: Strategy; Curricular strategy; Training; Pedagogical training

Introduction

In one of its slogans, the Technical University “Luis Vargas Torres” of Esmeraldas, Republic of Ecuador, declares that it has been working since 1970, in the formation of high-level professionals, with a sense of relevance, critical, proactive and humanistic, focused on the sustainable development of society. To achieve this, it conceives the process from an integral perspective, since social demands require an increasingly

competent graduate, which in the case of the School of Education is nuanced because it cannot ignore the fact that we are facing a process of training trainers of men.

This Faculty has as its mission the integral formation of education professionals: critical, proactive and humanistic, through a current educational process, articulated between teaching, research and linkage with society, for the sustainable development of society, based on the appropriate construction of the universal and ancestral Ecuadorian culture, science and technology.

In the case of Physics and Mathematics, the concept of integrality in the pedagogical training of future teachers presents a growing multidimensionality and challenges. It should be taken into account that these subjects are among the most difficult to learn by the students of the different educational levels that receive them, through the teaching-learning process developed by the teachers who graduate from this University. For this reason, this integral formation is very complex.

On the other hand, it is not possible to respond to all the requirements that society makes to the process of undergraduate training of these professionals, in the time that their careers last, because there are many disciplines and subjects that make them up and there are also objectives and contents that cannot be addressed from only one of them and demand the competition of the greatest amount of educational influences by the teachers of the university institution, with a transverse and gradual approach, to include their treatment in the different years, from an appropriate gradation.

This problem can be answered with one of the tools available to the management process of the pedagogical training of future teachers of Physics and Mathematics careers, which are the curricular strategies, whose theoretical and practical development is increasingly growing. In relation to their conceptualization and the guidelines for their implementation, it is the purpose of this article.

In line with the objective of the work, materials that address the concept of curricular strategies, which appear in normative documents, texts published in scientific journals indexed in SciELO and other relevant databases, were selected as a premise for the use of documentary review and the theoretical methods of analysis-synthesis, induction-deduction and content analysis. Together, they made it possible to delimit the features that define the concept of curricular strategy, its importance, and the methodological requirements for its implementation, with the help of teachers and directors, in order to contribute to make more

pertinent the management of the pedagogical training of future teachers in the Physics and Mathematics careers of the Technical University “Luis Vargas Torres” of Esmeraldas, Republic of Ecuador.

Development

The concept of curricular strategy has been defined by authors such as: Ministry of Higher Education (MES) (2003); Horruitiner (2008); Ministry of Higher Education (2016); Chacón (2022); Del Sol *et al.* (2021); Del Toro and Valiente (2019); Hernández & Sánchez (2022); Mosqueda *et al.* (2019); Morales *et al.* (2015), among others. This expresses an equally necessary quality when conceiving the curriculum of a university degree, and is related to “...those general objectives that it is not possible to achieve, with the required level of depth and mastery, from the content of a single discipline and demand the additional competition of the remaining ones” (Horruitiner, 2008; Ministry of Higher Education, 2016; Del Sol *et al.*, 2021).

For the Ministry of Higher Education (2003) the curricular strategies are:

Those general aspects of each profession that cannot be formed from a particular discipline, requiring the assistance of the remaining ones, so that they are coherently integrated into the curriculum of each career, as part of its design and with a real balance between the whole and each of its parts. (p. 8)

Among the terms and expressions with which this concept has been delimited, those that qualify it as “general objectives”, “system of cultural knowledge of great social repercussion”, “pedagogical approach to the teaching process with the purpose of achieving general objectives”, “strategic actions” and “system of general actions” are common. From the analysis of the definitions systematized above, curricular strategies are assumed as systems of actions oriented to the treatment of contents that respond to objectives of a high degree of generality, cover all the components and dimensions of the pedagogical training process of future Physics and Mathematics teachers, and demand, for their achievement, disciplinary and interdisciplinary work.

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Regarding their importance, the Ministry of Higher Education (2016) highlights that they help to increase the effectiveness in the fulfillment of the general objectives of the careers, and that they are associated with certain knowledge, skills, values and modes of professional performance declared in the programs of the disciplines and that are key in the comprehensive training of students. These are "...contents that it is not possible to address them with due depth from a single discipline and require the competition of several." (Ministry of Higher Education, 2016, p. 16)

In another order of things, among the general contents that can be the object of treatment for the pedagogical training of future teachers of Physics and Mathematics careers, and that have been the object of inclusion in curricular strategies, were identified in the literature consulted, those of ethics and citizenship training (Chacón, 2022), of modern approaches to management (Ministry of Higher Education, 2003), of environmental education from higher mathematics (Del Sol *et al.*, 2021), also from the Philosophy class (Hernández & Sánchez, 2022) and in the Mathematics course (Mosqueda *et al.*, 2019), likewise, contents for the use of information and communication technologies in the solution of learning tasks; English language, economic, environmental, political, legal and social training, use of the mother tongue (Ministry of Higher Education, 2016), preparation for school management (Del Toro and Valiente, 2019), among others.

It is also recommended that the topics related to research training and the use of artificial intelligence, which in a coherent manner, can contribute to broaden the profile of the professional in the pedagogical careers of Physics and Mathematics, in tune with the scientific-technical advances and the approach of competencies that, in an emerging manner, floods today the labor market and reaches the educational institutions where the graduates of the university institution will work.

Thus, the Faculty, through inter-faculty and inter-institutional alliances and agreements, can offer continuous training for its professors, aimed at contributing to the treatment of the objectives and contents of the curricular strategies that are approved, as an organizational assurance for the adequate management of this process, which will imply including procedures for the implementation of the actions.

Among the guidelines that make it possible to concretize the treatment of the objectives and contents of the curricular strategies in the disciplines and subjects of the teacher who works in the Physics and Mathematics careers, the following stand out:

1. Determination of the place of each topic in the program of the discipline and the subject (based on possible relations with the content of the same). To this end, it is essential that teachers, when preparing their programs, identify the truly fundamental contents, which constitute the backbone of the subject and which, as invariants, “make it possible to understand its internal logic and appropriate its essences. That and no other should be the content of the programs of each subject and that is how it should be taught in the classroom: from invariants of the content.” (Horruitiner, 2006, p. 100)
2. Gradation of the content by years of the course, in the case of those disciplines and subjects that vertically cross the plan of the teaching process, from the curricular point of view.
3. Analysis of the system of objectives, functions and tasks that the future teacher will have to fulfill and that were previously determined in each of the years of the careers, as well as their dosage in the purposes of the disciplines and subjects.
4. Accuracy of the content of the subject that has the possibility of treatment of each node of articulation due to its high degree of generality and transcendence, in groups of curricular strategies to be defined in both careers.
5. Establishment of the interdisciplinary articulation nodes of the subjects of the Mathematics and Physics careers and of those defined by curricular strategies. Then, with a team work among the professors of each year, discipline and subject, design the didactic requirements for their approach in the formative process.

The interdisciplinary articulation nodes are:

Those contents of a subject of a discipline or subject, which include knowledge, skills and the values associated with it and that serve as the basis for a process of interdisciplinary articulation in a given university career to achieve the most complete formation of the graduate. (Fernández, as cited in Morales, Kindelán and Guzmán, 2015, p. 35)

Their definition is a resource to make the organization and coherence of the content of curricular strategies viable.

Planning of teaching tasks that allow the effective development of curricular strategies and facilitate the application of the evaluation of student achievement.

Another guiding element in order to embark on the path of using the actions designed in the curricular strategies is to specify the directions in which these actions should be addressed.

In this sense, it is essential in the first place, the institutionalization (legalization) by the authorities of the careers and the Faculty of Pedagogy of these strategies, which implies their insertion in the strategic planning of the administrative work and at the level of disciplines and subjects, in all academic years.

Previously, it is suggested that an initial diagnosis be made on the preparation of the students in relation to the content of the curricular strategies that are assumed, based on the established indicators, as a source of information to redesign the planning of the course, the documents of each academic year, and the dosage of the activities of the subjects.

Another key direction is associated to the pedagogical accompaniment for the preparation of the teaching staff, with a view to the treatment of the curricular strategies, from the subjects they teach, for which it is an elementary condition or premise, the identification of the possible nodes of interdisciplinary articulation, which allow the logical integration of the contents, from the curricularly agreed invariants.

It will also be necessary to direct actions towards the work that future teachers will carry out in their professional practice and in all the formative scenarios in which they develop teaching, research and the link with society. A last aspect, no less important, is the inclusion of objectives and contents in the integral evaluation process of the future teacher, in order to know the achievements reached, as a feedback mechanism for the continuous improvement of the training process and the redesign of the actions of each curricular strategy in the new cycle of its management.

Due to the degree of generality and transcendence of its contents, it is proposed that one of the curricular strategies works as an “umbrella” for the rest. In this case, we propose the study of the theoretical-methodological conception proposed by Del Toro and Valiente (2019), for the realization of a curricular strategy of preparation for school leadership, which comprises eight nodes of interdisciplinary articulation.

They are:

- 1) Educational policy;
- 2) Personal time planning and management;
- 3) Organization;
- 4) Control;
- 5) Decision making;
- 6) Participation;
- 7) Communication; and;
- 8) Leadership.

For the selection of contents (interdisciplinary articulation nodes), as in the case of this proposal, orientation references must be taken to ensure their relevance and guarantee a criterion of rationality in terms of quantity, i.e., that they are sufficient and necessary. In short, pedagogical training will be a continuous process and therefore, once graduated, the professional of these careers will be able to give continuity to the development of his/her professional competencies.

Conclusions

Society needs universities to conceive their training system with an increasingly comprehensive approach, which allows future teachers to respond to the general and systematic problems that arise in the educational process, where they will perform their professional pedagogical activity. This aspiration generates a consensus in the recognition of the need to take advantage of the benefits generated by the actions of curricular strategies to address a set of objectives and contents that make up the professional competencies of the current era. At the end of the day, Ecuadorian universities are committed to a continuous process of curricular changes, which will help to make them increasingly pertinent to the high demands imposed by the country's development on the training process that takes place in them.

A systematic evaluation of the implementation and results of each curricular strategy, in order to obtain information that will make it possible to make decisions for its improvement, within the framework of the institutional actions established for the

evaluation of the training process, has the purpose of contributing to the improvement of the quality of the graduate of the Physics and Mathematics pedagogical careers.