

The contribution of interdisciplinarity in initial training of mathematics future teachers to promote knowledge and pedagogical perspectives to be used the required students learning

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Abstract

The necessary innovation of interdisciplinarity practices in education contemporary, to provide the successful development of students in learning salient of curriculum documents, it is essential this effective use of diagnostic and guidance carried out in the prospective teachers (PTs) initial training experience of Mathematics Didactics and Curriculum Assessment of the basic and secondary education.

To provide them with pedagogical knowledge for the convenience of the nature and learning process used in future teaching practices, as it is recognized that they were not yet all familiar with this comprehensive perception of the positive contribution in the use of their knowledge, this qualitative and interpretative study is focuses on the perceptions of the future teachers in the work carried out to prepare interdisciplinary professional knowledge in teacher training, aiming to understand they perceptions about how the positive the positive interdisciplinarity adopted work used by PTS in training program contribute to their necessary development of pedagogical knowledge effect when elaborate detailed lesson plans integrating pedagogy to possible use in their future professional practice.

The results of this study, based on data analysis and their reflections and work used, revealed a recognized relevance of using interdisciplinarity in the preparation of PTS in initial teaching training, showing their deepened, taking advantage to improve pedagogical knowledge, which they intend to use in their future practices. So, this study is relevant and may contribute to identifying the effectiveness evidence of successful learning of interdisciplinarity use in the preparation of professional knowledge of future teachers, for necessary international professional development in future docents teaching practices.

Keywords: Interdisciplinary Promotion in Initial Training Education; Science and Mathematics Prospective Teachers; Learning and Teaching Pedagogical Knowledge; Planning Class Lessons of Students

Resumo: A necessária inovação das práticas de interdisciplinaridade na educação contemporânea, para proporcionar o bom desenvolvimento dos alunos nas aprendizagens salientes dos documentos curriculares, torna-se imprescindível esta utilização eficaz de diagnósticos e orientações realizadas na experiência de

formação inicial dos futuros professores (PTs) de Matemática. Avaliação Didática e Curricular do ensino básico e secundário.

Proporcionar-lhes conhecimentos pedagógicos para a comodidade da natureza e do processo de aprendizagem utilizados nas

futuras práticas docentes, pois reconhece-se que ainda não estavam todos familiarizados com esta percepção abrangente do contributo positivo na utilização dos seus conhecimentos, este conhecimento qualitativo e estudo interpretativo centra-se nas percepções dos futuros professores no trabalho desenvolvido para a elaboração de conhecimentos profissionais interdisciplinares na formação de professores, visando compreender as suas percepções sobre como o trabalho positivo da interdisciplinaridade positiva adotado pelo PTS no programa de formação contribui para o seu necessário desenvolvimento efeito do conhecimento pedagógico ao elaborar planos de aula detalhados integrando a pedagogia para possível utilização na sua futura prática profissional.

Os resultados deste estudo, baseados na análise dos dados e nas suas reflexões e trabalhos utilizados, revelaram uma reconhecida relevância da utilização da interdisciplinaridade na elaboração do PTS na formação inicial docente, mostrando o seu aprofundamento, aproveitando para melhorar os conhecimentos pedagógicos, que pretendem utilizar. Assim, este estudo é relevante e pode contribuir para identificar as evidências de eficácia da aprendizagem bem-sucedida do uso da interdisciplinaridade na preparação do conhecimento profissional dos futuros professores, para o necessário desenvolvimento profissional internacional nas práticas docentes dos futuros docentes.

Palavras-chave: promoção interdisciplinar na formação inicial; futuros professores de ciências e matemática; aprender e ensinar conhecimentos pedagógicos; planificação das aulas de aula dos alunos.

Introduction

Recently, the use of interdisciplinarity has been recommended as essential to successfully develop in education school of students integrated learning, to help them to attribute meaning to modern Science and mathematics ideas, as fundamental component of human culture in international school curricular guidelines in primary and secondary education (ME, 2018), to dealing with life contexts (NCTM, 2014; Lygianne & Geraldo, 2020) [1, 2]. To answer to these demands, it is important that in this century prospective teachers can create and implement learning components of objectives, learning content and teaching methods environments that take advantage of the wide accessibility and potential to explore interdisciplinarity ideas to use in teaching practices as they are not yet familiarized. Thus, the future Teachers Training for Sustainability is currently a required trending topic, due to the need to provide educational support knowledge on the different issues covered by the Sustainable Development Goals. To reach this goal, this author have investigated the integration of interdisciplinarity and also emphasize as necessary that the initial training programs foster the development of the interdisciplinarity of prospective teachers, helping them to acquire experience to teach the effective help of their future practices. Within this context, preservice teachers have collaborative opportunities to: plan, organize, criticize, and develop abstract ideas from specific content and needs of the student and specific classroom situations, while considering the possibilities of digital technologies [3]. In this considered essential regard context, it was pertinent to carry out this qualitative and interpretative study to contribute to the scarce research in this field, by describing an innovative science and mathematics preservice teachers

education experience from the 3rd cycle of basic and secondary education in Portugal, whose aim is: to understand they perceptions about how the the positive interdisciplinarity adopted work used by PTS in training program contribute to their necessary development of pedagogical knowledge effect when elaborate detailed lesson plans integrating pedagogy to possible use in their future professional practices. Thus, this considered relevant study, may contribute to identifying the recommendations and considerations on the potential of innovative and specific adopted work of using interdisciplinarity development in the initial training experience of future Mathematics Didactics and Curriculum Assessment teachers of the basic and secondary education pedagogical aspects, as useful for their showing necessary encouragement and support for professional development of planning classes when they become familiar with this approach, to improve pedagogical knowledge and privilege educational contexts of teaching practices. This focus of the study can also be useful for supporting the scientific and educational international community.

Literature Review

From this perspective, including the need to understand and appreciate interdisciplinarity in its disciplinary essence and role as an agent of change, both social and cultural, in order to transmit it to students, and to work on interdisciplinary way, amongst other actions.

In order to providing integrate preservice teachers education for knowledge and sustainable development, it is necessary to enable they learn, clarify one's own values, to contribute and envisage more inclusive positive, sustainable and resilient future for people and the planet to think systematically to respond via applied learning and to study the dialectics between tradition and innovation [4, 5]. This model describes some essential strategies for promoting the transformation of the everyday knowledge of preservice teachers (knowledge, experiences and prior beliefs) into professional knowledge [6].

Later, UNESCO (2008) stated that it is necessary for education to be holistic, inclusive and transformative, and taking into account different objectives for teachers with the aim of promoting: the pedagogy and learning contents and results of learning the integration of sustainability issues into study plans contexts to student-centered teaching and learning oriented towards action based on interaction and exploratory learning, and social learners of any age and educational context to transform themselves and the society in which they live [7].

It is suggested that generative methods which support teachers in speculating on paths to potential futures as teachers of mathematics, can provide access to how prospective teachers negotiate issues in relation to the climate crisis and ways in which they conceive of related changes in their practices [8].

In this context, the integration of interdisciplinarity is a growing field which aims to prepare future teachers educators for their role as agents of social change by developing specific sustainability competencies [9]. As an essential part of the diverser prospective teachers training that cannot be excluded from this goal use currently to competencies which constitute the core of the curriculum, as enable the development of the ability to appro-

appropriately apply knowledge, comprehension and skills in different contexts to communicate and manage information [10]. Teacher education for sustainability is an emerging research agenda which addresses such issues as professional teacher development and the teacher's interaction, context and practice. Until recently, these interdisciplinarity issues were only exclusively addressed from the point of view of research in mathematics education. However, nowadays it is necessary to start studying them from an integrated perspective in diverse education for sustainability.

For PTs develop the necessary professional knowledge, both mathematical, didactics and curricular assessment, it is essential they must work on solving tasks in initial training to develop the necessary professional knowledge, both mathematical and didactic, to increase the recognition of the tasks characteristics of different themes of the curricular area and of the actions of teachers to support them to carry performing tasks to appropriate resolutions use in their future teaching practices [11]. Technological resources are also essential as they can facilitate connections between different areas of knowledge and also because they enrich the teaching-learning process in the classroom at different levels [12].

Methodology

Context and participants

This research was carried out in the initial training experience of future teachers, in the academic year 2023, taught by the author in the Curriculum and assessment and mathematics didactics courses, in fundamental areas of teaching specialization, in the 3rd cycle master's program of primary and secondary education at the University of Lisbon. The participants in this study were 20 and 12 future Portuguese teachers, male and female, enrolled in these courses, with no previous interdisciplinary experience in classes.

The face-to-face work in these initial training courses for future teachers included several sessions held to follow a global approach to training strategies that promote interdisciplinary knowledge and involve PTs in collaborative group work to promote analysis, reflection, discussion and argumentation eminently around the proposed fundamental themes, and also the selection of a task for the preparation of lesson plans as a common practice in this training to develop their knowledge of professional practice and teaching resources for understanding and preparing of integration of multiple dimensions of interdisciplinarity in students' future classes. The teacher and PTs meet to present the Group Work and various types of materials and resources that generate thought and discussion are exposed. The PTs who accompanying classes are responsible for organizing and executing this stage, which allows them to guide students' motivation to investigate reality. And later they share information about the content of the activities and work they develop and enjoy the analysis of the content prepared to support colleagues. The accompanying PTs execute the plan in each subject area and the reality notebooks are appreciated and given space for proposals to improve working methods.

This research study of a qualitative and interpretative nature aiming to understand they perceptions about how the positive interdisciplinarity adopted work used by PTS in training pro-

gram contribute to their recognized necessary development of pedagogical knowledge effect when elaborate detailed lesson plans integrating technology to possible necessary use in their future professional teaching practices [13]. In view of this objective, were tried to answer the following questions: (i) What perceptions did the PTs revealed about the potentialities of interdisciplinarity learning developed in their adopted work and the received support to develop knowledge to promote students learning in future practices? (ii) What PTs recognized this contribution to carry out their necessary using this resource in teaching practices to promote students' knowledge?

Data collection and analysis

The data collected and analyzed in the training classes were based on the cognitive components of interdisciplinarity of the PTS and justifications presented for the lesson plans prepared in groups that they considered as the potential of their promoted knowledge, and including the main options taken to choose the associated materials and tasks. And guidelines designed to use this essential skill for students in future classes, and a reflection on the potential of integrating interdisciplinarity in the activity for both them and the students.

In the following chapter is presented some results of the data analysis, focus on the dissemination of the study through the mentioned established comments and exemplifying perceptions of the interdisciplinarity work developed by the PTs, as they gave and express consent to participate voluntarily in this study research. But the used names of PTs are fictitious, in order to to guarantee the total anonymity and respect the participants confidentiality, guarantee ethical issues based on what is necessary for an assured investigation [14].

Results

This study was carried out in the context of the initial training program, to identify their recognition obtained in responses of elements prepared by all participants PTs relating to they recognized interdisciplinarity work carried out in these sessions, sought to know how allowed the promotion of their learning and understanding of curricular materials, mathematics integration of technologies and instructional strategies and representations developed for their teaching work. This work provided the opportunity for PTs recognize the potential of reading texts and using technological mathematical tasks to plan classes in their positive interdisciplinary learning in training, and the satisfaction of the benefits of these resources for possible use in teaching students.

The interdisciplinary projects included in this publication are suggestions for activities that teachers in schools can adopt and develop with their students in the 8th year of the 3rd cycle of Basic Education and higher education. The definition of projects took into account the interdisciplinary articulation that takes place in the existence of strong links between disciplines that will work directly or simultaneously and in references to other disciplines, when there is precedence of knowledge and procedures (CD, CN, EF, EV, FQ, Geo, Hist, Ing, LE II, Mat, Port, TIC). And the citizenship values recognized in the curricular guidelines for the design of activities give a special meaning to learning.

It is possible for interdisciplinary projects to be carried out with a good partnership between teachers or even with the entire school, depending on the amount of commitment that school management and teaching staff are willing to employ, which would be interesting to develop in a digital environment suitable for the digital version of the Notebook and disseminate it to the school community. The results of the study show that the PTs noted that allowed the highlighted positive evaluation of didactic and technological knowledge based on aspects of a cognitive nature and curriculum management prepared to appropriate teaching in their experience of training.

For example, the PTs highlighted: their revealed perceptions about what is and what it means an interdisciplinary developed knowledge as potential to support the relevant promotion of students learning; And also the recognized contribution of this developed learning interdisciplinary in their adopted work in training class to carry out their necessary using this resource in their students teaching practices.

J, A, I: Interdisciplinarity in education is the treatment of a topic with students, through activities that motivate them to develop personal thoughts, improving topics under analysis and progressing in their learning in a more sustained way to knowledge from various disciplines. In this approach, the focus is on skills and contexts in methods common to related disciplines, which contribute to the understanding of shared themes and concepts. Therefore, the work must be planned in a cooperative manner between the intervening teachers from different disciplines who develop the same project, listening to the students' research interests. And it is also the great richness of this form of work that enhances learning that characterizes curricular guidelines in the real world. As mathematics is the language of many sciences, this discipline is particularly suitable for developing interdisciplinary projects in other disciplines. The knowledge acquired becomes more adaptable to different realities.

EC, M: Interdisciplinarity is a process of connecting disciplines with the aim of giving meaning to the concepts and knowledge obtained in each one. Interdisciplinary work is important to prepare students to deal with the complexity of today's world and to become active and informed citizens. Skills for solving problems of analyzing and questioning reality, articulating knowledge and knowledge are then developed. This work not only involves students but has the advantages of greater dialogue and planning between different teachers from different areas in a more integrated formation of the student as a citizen in school coordination to exchange ideas, information and methodologies to lead to greater motivation to get closer to reality and improve learning. But interdisciplinary work is important for all areas, but particularly for mathematics because it allows the importance of its study by relating it to current and real themes.

MC, T, MA: Interdisciplinarity is what happens when knowledge from various disciplinary areas is integrated so that new, more meaningful and deeper learning emerges, as students establish connections between the various areas and with reality. The current curricular guidelines emphasize that students are expected to work on interdisciplinarity because the establishment of external connections in relation to mathematics is encouraged. Furthermore, the mathematical skills that students are

intended to acquire can also be acquired through interdisciplinary tasks, such as communication favored by collaborative work and the ability to solve problems and mathematical connections. The main people involved in interdisciplinary work should be the students choosing which questions they want to work on. Teachers from various disciplines get involved in facilitating the integration of knowledge and proposing active methodologies and gamification that favor interdisciplinarity with visits to museums and the use of digital tools.

MB, B, JD, MI: Interdisciplinarity was a methodology involved in our individual and collaborative work as teachers, in explaining a topic that covers both disciplines, transgressing the rigid lines that conventional schools establish between the various curricular units or disciplines Natural Sciences, Citizenship, History and Geography. The project in which we were involved in the work of this practice helped me to develop the task that I propose to result in interdisciplinary work designed for students to practice and develop their meaning and research independently on the topic.

MJ, LF: In interdisciplinary education, all collaborative work carried out between fellow teachers is significant, as it was important for collaboration between various disciplinary areas that complement and help the success of the work carried out in their knowledge. In my opinion, it is also important to take this approach in teaching so that students develop their knowledge in certain subjects of the curriculum worked on in interdisciplinary projects in continuous subjects. And I had the opportunity to develop an interdisciplinary activity in work carried out in the mathematics discipline, which was very important for the students because it allowed them to understand the proportionality of interdisciplinary promotion through technological resources and acquired different knowledge about the content covered in their learning.

S, BI: The construction of interdisciplinary didactic actions supports a teaching alternative that highlights the interaction and communication that exists between the different disciplines and builds the integration of coherent and meaningful knowledge. In my opinion, to carry out interdisciplinary work we must start from a topic of general interest and use tools to understand the details, and this adoption leads to deep reflections on the role of teachers, in particular, the way of teaching, which requires a constant search training. After this time I carried out interdisciplinary work studying geography and mathematics concepts and worked on them in the classroom. This experience greatly strengthened the bonds between the students in the class.

AA: The interdisciplinary approach is not based on a theme, but rather on connections and common parts between the various disciplines. Therefore, in this approach the teacher designs a learning experience, where students are invited to relate the common parts or connections between the various disciplines, to solve a specific problem. Technological resources that have collaborative characteristics can be of great help in promoting interdisciplinarity.

CA, CG: After the work we carried out in this training we are already at a good and ideal level, I experienced the experience of interdisciplinarity in graphic applicability in collaboration and

I thought it supported us in the perception and integration of common contents and organizing them to be worked on between more disciplines. Interdisciplinarity will allow the cooperation of the various curricular areas to be worked on and coordinated according to the specificities of the teachers who establish the strategies and methodologies to adopt to provide a rewarding and diverse learning experience. From my perspective, interdisciplinary work in the classroom will allow students to learn across more than one area of knowledge, allowing for a greater understanding of the real value of the learning content. The possibility of using technological resources to promote interdisciplinary work is effective in fostering and cementing learning.

AL: The interdisciplinary task that I selected in my role of guiding and motivating students to work collaboratively has as its main objective that they deepen their knowledge about the disciplines of Science, Engineering and Mathematics.

AT, C, ID, F: This way of working in master's training involves everyone in our involvement and cooperation in the interdisciplinarity framed in the curriculum, which enriches the teaching and learning process by having the ability to establish bridges between various disciplines. And given my short teaching experience, I had the opportunity to recognize how to propose an interdisciplinary project, which also involved students from various educational levels who combined efforts to develop various activities and content. There were proposals for articulation addressed in various disciplines including mathematics, geometry and statistical methods applied to the analysis of patterns. I consider that interdisciplinarity is the path to this connection, which depends on what each teacher develops and how they can contribute to common action.

RC, A, R, IM: After reading and researching the documents provided in this training, identified in them, I selected a project described in a chosen video, which is based on the curricular reality of a technical school in the USA, to comment and demonstrate how using it to illustrate interdisciplinarity in learning can be achieved. an enormous level of involvement and motivation on the part of students who benefit from this teaching and learning method and reach very high levels of performance. In addition to taking advantage of a diversity of disciplinary viewpoints in collaborative teaching, they have the opportunity to receive feedback on their work from more than one teacher and create their own specific domains. These skills acquired in the project were the result of a strong curricular articulation in the areas of Biology, Mathematics and Computational Sciences.

VD, MF, AC: In the video I saw on Teaching, about the construction, I was able to vividly witness the articulation of concepts and operations not only in Physics, but also in design (through initial projection drawings, based on each person's ideas), language (with the correct and unequivocal identification of elements and processes), presentation and public discussion of ideas, virtual simulation, algebra, accounting, inventory and purchasing, etc. It was also very curious to note that the teacher's work often involved motivation to independently adjust what they had already done. For the students, it was interesting to see the very functional division of tasks, which made many teams work in real companies. There is an opportunity here to expand students' knowledge, skills and motivations, within a normality

that so often seems to stagnate and close them down. A more interdisciplinary approach involves using what is common to the various disciplines.

AT: I believe that This task work in my training intended to support us in the work to be carried out in approaching the theme of interdisciplinarity, which contributed significantly to the ease in perceiving it and recognizing various certain themes from the point of view of the various disciplinary areas to create the various disciplines in order to better address different realities, in which an articulated vision is implied and where the various knowledge complements each other based on their differences. Each future teacher can play a very relevant role, based on their own interests and needs for relevant knowledge about the classes and we transfer the subjects to other colleagues to cooperate in what we propose. There were proposals for articulation with various disciplines, including mathematics, which is present in everything and can be approached in different ways, geometry, and statistical methods being applied to the analysis of patterns. The use of technological resources has the potential to facilitate work and communication between the future teachers involved and products of joint work.

Discussion and Conclusion

To conclude, As these PTs did not yet have in-depth knowledge of the interdisciplinarity, was confirmed being favorable this carried study as it is important in the contexts of initial training experience focused on understanding the diversity prospective teachers evidences and confirmed perceptions that recognized the importance of that allow as positive contribution of their innovative aspects of interdisciplinarity that is therefore possible to state the use to reassure the appropriate work of they knowledge and appreciation of the adequacy articulation of the content and planning classes developed by groups. It is highlighted that they deepen the understanding of this potential of several thematics and described interessant works done to also accepting the use of specific integration of technology in teaching tool students that are relevant in recent curricular objectives in teaching classrooms for carrying out significant learning of fundamental ideas related to the topics in providing work, which reinforces the important perceptions about this positive contribution use to develop mathematical, didactic and pedagogical knowledge [15]. In particular, they explicated the intention and possibility for improving processes of teaching practices when it favors to possible use and applying them to promote students' mathematical learning, However, as this study is mainly focusing on Pts of mathematics didactics and curriculum assessment, I argue a proposal to overcome another necessary study that will be performed focus on other PTs training experiences, based on their offer opportunities to plan teaching and learning situations with concrete experiences of interdisciplinary use with students, and also to put these situations planed into practice, reflecting on their implementation in the classroom, and also teacher training. Finally, this relevant carried out study assigns a central place to the characteristics of initial training models, which can contribute to consolidating the importance of the better training process to enable PTs to promote competent professional learning in promoting improvement students' learning of diverse areas thematic, using interdisciplinarity, to bring them closer to the expected reality of their future practice of students at all levels of schooling. And provide new elements to guide the scientific and

educational community to identify and understand the adequacy and potentialities of these principles for professional learning of future teachers involved in training [17- 19].

This relevant study, it is useful to recognize the effectiveness evidence of positive and important development of this use addressed interdisciplinarity practice in the preparation of professional knowledge of PTs on the training developed, as opportunities to showed they knowledge and that it can encourage them to help progressively use of the integration of specific digital technologies contexts in the teaching students course to help the effectiveness learning. And provide elements to guide the necessary international professional scientific and educational community to identify and understand the adequacy and potentialities of these principles for professional learning of future teachers involved in training.

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