

UEFS Professional Master Program in Astronomy

CAPES First Four-Year Achievements

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Abstract. Since 2000, the various actions developed by the Astronomy group of the Department of Physics of the State University of Feira de Santana (UEFS), aimed at the dissemination and popularization of science in schools, culminated in 2007 with the creation of the Specialization in Astronomy, and in 2013, with the creation of the Professional Master in Astronomy (MPAstro). From the first moment, the target audience is directed to teachers of basic education, as well as higher education with graduate education, preferably in the 6 areas of knowledge: Physics, Chemistry, Biology, Mathematics, History and Geography. After 4 years of operation and the graduation of 2 classes (18 students), we present here an extract of MPAstro from the point of view of the projects and educational products developed. The MPAstro explores both the interdisciplinary characteristics that Astronomy has, and the flexibility that it presents in questions related to university teaching, research and extension actions.

Resumo. Desde 2000, as várias ações desenvolvidas pelo grupo de Astronomia do Departamento de Física da Universidade Estadual de Feira de Santana (UEFS), voltadas à divulgação e popularização de ciências nas escolas, culminaram em 2007 com a criação da Especialização em Astronomia, e posteriormente, em 2013, com a criação do Mestrado Profissional em Astronomia (MPAstro). Desde o primeiro momento, o público alvo é voltado aos professores da educação básica, assim como do ensino superior com a formação graduada, de preferência, em 6 áreas do conhecimento: Física, Química, Biologia, Matemática, História e Geografia. Após 4 anos de operação e o egresso de 2 turmas (18 discentes), o presente trabalho se destina a apresentar um extrato do MPAstro além dos projetos e produtos educacionais desenvolvidos. O MPAstro explora tanto as características interdisciplinares que a Astronomia possui, como a flexibilidade que a mesma apresenta em questões relativas às ações de ensino, pesquisa e extensão universitárias.

Keywords. Astronomy education – Teacher formation – Outreach

1. Introduction

The students' lack of interest in basic education through studies related to science has global dimensions (Yano, 2011) which presents itself as a worrying scenario observed in schools, going against the current moment in which society is immersed in an environment deeply immersed in technology. In addition to this the school performance evaluation indicators such as PISA¹, ROSE² and ENEM³, which without restrictions show major deficiencies in basic education students'.

Since 1971, the Antares Astronomical Observatory (OAA) has been developing a role of disseminating the sciences to the visiting public; mostly elementary and middle school students. One of the good points was that in 1992 the OAA was incorporated at the Feira de Santana State University (UEFS), Bahia, Brazil, as an Organizational Development Unit, linked directly to the superior administration of the University. In 1997 the research and extension activities were coordinated by the professors of the UEFS physics department aided by the monitors (students from the Physics Course).

Using the structure of the OAA, the PECS project "Education, Science and Society: Teaching and Outreach of Astronomy" was structured and financed in 2003 by the Vitae Foundation, which would allow a greater projection and amplitude of the actions aimed at arousing interest in Science & Technology.

The various actions developed by the Astronomy group of the Department of Physics at UEFS, aimed at the outreach and

popularization of science in schools, culminated in 2007 with the creation of the specialization in Astronomy (lato sensu) to teachers of basic education formed in one of these areas: Physics, Chemistry, Biology, Mathematics, History and Geography.

This specialization project aimed to contribute to the academic training of physics, chemistry, biology, mathematics, history and geography teachers of the public and private teaching networks of the State of Bahia. The course covered theoretical and observational, classical and modern themes of Astronomy, which allowed the teacher-student to understand the main scientific contributions of this interdisciplinary science to humanity. Concomitant to this, in a partnership with the Anísio Teixeira Institute of the Bahia State Department of Education, two continuing astronomy courses were held for teachers of basic education in the state. In the two editions of these courses about 400 teachers of the public basic education system were involved in all regions of Bahia.

In 2009 the MACT (Antares Museum of Science and Technology) was inaugurated. Nowadays, at the MACT, there are 07 permanent exhibitions: "Espaço Natureza"; "Bedengó"; "Dinossauros e Pterossauros do Brasil"; "Era dos mamíferos: a Aurora da Humanidade"; "Stonehenge", "Relógio Solar" and "A Conquista Espacial". We have also a planetarium and a auditorium for school attendance.

Finally, in 2013 a further step is taken to strengthen the area of Astronomy with the creation of the Professional Master in Astronomy (MPAstro). It was approved at CAPES with the concept 3.0 in 2013 March and at 2013 August we started the first class with 10 students selected from 50.

¹ <http://inep.gov.br/pisa>

² <http://roseproject.no>

³ <http://enem.inep.gov.br>

Table 1. Subjects Distribution per semester

Semester	hour/semester	Subjects	hours/week
First	09h	Professional Practice	03h
		Astronomy: a general vision	03h
		Astronomy Instrumentation	03h
Second	08h	Computer Applications in Astronomy Teachings	03h
		Development and Production of Teaching Materials	03h
		01 elective (depending on the goal of the Dissertation (TFC))	02h
Third	07h	A History of Astronomy	03h
		02 electives (depending on the goal of the TFC)	2x02h
Fourth	03h	Special Topics	03h

2. The professional Master's degree in Astronomy (stricto sensu)

There was a latent feeling that academic masters in teaching do not meet the needs of teachers who are in the classroom. In this context, the particular case of those who need the specific contents of Astronomy, as well as the relations of this with other areas of knowledge.

The experiences in teaching, extension and research resulting from the teachers' activities in the OAA, as well as the Interdisciplinarity Lato Sensu Course in Astronomy, together with the demand for specific contents, mainly coming from teachers of the basic education, culminated in the Stricto Sensu in Astronomy (Professional Master's Degree) – MPAstro⁴.

With the Astronomy interdisciplinarity natural character we can select our target audience teachers from the following areas: Physics, Chemistry, Biology, Mathematics, Geography or History and also Professionals from Science Centers and Museums that work with Astronomy in their daily lives.

It aims is to contribute to the training of teachers and improvement of science teaching, having Astronomy as the main subject. We have also the goal to explore the interdisciplinarity characteristic of Astronomy and to extend the professional qualification of the teachers in the different levels of education - Fundamental, Middle and/or Higher. At the end of the course, the academic title received is "Master in Astronomy Teaching".

The MPAstro is a part-time program in which the majority of the teacher & student must maintain their professional activities, not departing from the schools where they teach. For this, all the activities of the Master course are concentrated in two days of the week (Friday and Saturday).

The MPAstro concentration area is "Teaching and Diffusion of Astronomy Description" having the research line: Interdisciplinarity Teaching of Astronomy and the Scientific-Technological Diffusion. We have 11 themes linked to the research line. They are:

1. Conceptual Astronomy Mistakes in the Classroom
2. History of Astronomy
3. The Big Bang: The Origin of the Universe
4. New Technologies applied to Teaching Astronomy
5. Elements of Applied Physics and Mathematics in Astronomy
6. Textbooks on Teaching Science and Geography
7. Brazilian Space Program
8. Chemical Evolution of the Universe: Formation of Chemical Elements and First Molecules
9. Production and Use of Didactic Materials in Astronomy

10. Outreach in Astronomy

11. Solar Energy: Uses and Applications

After 4 years of operation and the graduation of 2 classes (18 students), we have our first CAPES evaluation at this year. We present here an extract of the MPAstro besides the projects and educational products developed in this professional stricto sensu program that must to be related with 1 or more of the 11 themes mentioned above.

3. The master course characteristics

The total duration of the MPAstro is 30 months, i.e., 24 months with, if necessary, extension of 6 months. The course composition are: 7 compulsory subjects, each one corresponding to 45 hours (3 hours per week for 15 weeks) and 3 electives (2 hours per week).

Beyond the subjects and the electives, the students need to participate in the "update seminars" (75% presence) and in the "qualification seminars" (each 6 months; mandatory presence).

The Subjects Distribution per semester is presented in the following table (Table 1). At the fourth semester the student must finish the TFC. If it is not possible he/she need to request for an extension for up to 6 months not exceeding the total of 30 months.

4. Some results

Throughout the training process, it is sought to provide the students with the maximum tools from an instrumental, observational and experimental point of view, enabling them to take knowledge that has been solidly established in the classroom.

Over the four-year period of MPAstro's action, the demand for the program has been steady, around 50 candidates per selection (Table 02). The selections, in order to contemplate the diversity of the target audience, are concerned with accessing basic knowledge and exploring the ability to interpret and apply elementary concepts needed in basic science education. Until 2015, 10 annual vacancies were offered. After that, 12 annual vacancies are being offered and the average defense time is around 27 months, that is very good according to CAPES. One of the main results is that, during the course, the students are constantly encouraged to develop materials for direct application in the classroom as well as the socialization of the projects and their results in scientific events.

Concerned to events, at 2016 August we organized the "20 Seminário Nacional dos Mestrados Profissionais da área de ensino da CAPES" (2nd National Seminar of Professional Masters

⁴ <http://pg-astro.uefs.br>

Table 2. MPAstro demand

Year	Applications	Approved	Registered/Vacation
2013	50	36	10/10
2014	42	22	10/10
2015	49	28	10/10
2016	47	31	12/12
2017	59	37	12/12

of CAPES' teaching area). The event⁵ was organized by the MPAstro/UEFS and it took place from August 7 to 9, 2016 in the dependencies of the Anísio Teixeira Institute/SEC/BA, in Salvador. There were both oral and banners presentations. The participation of MPAstro's students was very representative and we count on the participation of coordinators of the various regions of the country as well as the students of the courses *stricto sensu* professionals from the CAPES teaching area.

5. The projects and educational products developed

As a requirement of the CAPES teaching area, associated with any dissertation must have an educational product. Since 2013 August until 2017 February were developed at MPAstro 18 projects and educational products related to these projects⁶.

Following we can see the titles and a brief abstract of each project:

Handling of astronomic images with the use of Aladin for Astronomy Education. *Abstract:* The software Aladin was used to visualize and manipulate astronomical images developed by CDS of Strasbourg and to elaborate teaching activities involving astronomical concepts, such as distance, brightness, image manipulation, colors as well as to explain the nature of different objects showing their images in different filters, among others. In the total, it were elaborated four activities that were applied to students of the 6th year of elementary school, high school and undergraduate ones for the Engineering and Pedagogy courses. All activities and the results of their evaluation with students are detailed, discussed and analyzed; a teacher guide is also provided. The results show that in the four activities, the students have a significant learning supporting the use of such methodology. Also, it was elaborated two memory games, based on Java platform, with the images of some astronomical objects. This research also made the translation of Aladin to Portuguese.

Educational process in the teaching of sciences and biology in the perspective of Astrobiology. *Abstract:* From astronomy topics listed in Elementary Education curriculum and finding that there is deficiency in teacher's training on basic knowledge of this science, it is proposed to draw up a paradigmatic grounded in scientific conceptions, to be used in Basic Education. The paradigmatic material was thought to be developed in comic format in view of the official documents governing the Brazilian education when it is proposed the use of different languages in teaching. We have consulted the bibliography and have used the methods of qualitative and quantitative research. For the preparation of the paradigmatic, there was a concern to support it at assumptions of the Theory of Meaningful Learning. We justified the preparation of the paradigmatic and themes chosen

⁵ <https://sites.google.com/site/ensinocapes/>

⁶ They can be found at <https://sites.google.com/a/uefs.br/mp-astro/dissertacoes> and <https://sites.google.com/a/uefs.br/mp-astro/produtos-educacionais>

from discovering that there is little use of this science, which is interdisciplinary in basic education, since their subjects are part of the Basic Education curriculum, so they are attractive and offer possibilities to change the way education is conceived, pointing to the development of transdisciplinary proposals.

Proposal for paradigmatic material on the origins of the Universe and life. *Abstract:* This work is a proposal of educational process, developed through applied research in order to seek the improvement about teaching Science and Biology in Basic School implementing current themes and concepts, interrelated to cross-cutting issues, going back to the origin of life, living beings, their interaction with the physical environment and the prospects for life elsewhere other than Earth. The project had as target students from elementary and high school from two public schools in the district of Feira de Santana-BA.

Kepler's laws of the planetary movement in the teaching books of physics of the 2014 national book program: a study based on conceptual, didactic-methodological and historical aspects. *Abstract:* The Physics textbooks constitute the main teacher's working tool, although surveys indicate the need to prepare own teaching materials prepared by the teacher and the use of the textbook as support. We conducted a study of Kepler's Laws of Planetary Motion in Physics textbooks recommended by the National Textbook Program (PNLD in Portuguese) in 2014. The main objective is to verify how that content is addressed in these works. We use as conceptual, didactic-methodological and historical aspects analysis criteria. They are linked to that recommended by the PNLD Guide, the National Curriculum Guidelines for Secondary Education, and academic papers that focus urges that a History of Science in teaching Physics. The methodology was qualitative in nature.

Astronomy in middle school. Science and the Ludic: challenging and educating. *Abstract:* This work presents the results of the use of a didactic material called Experimental Activity Kit (KAE), which was intended to draw up an Experimental Activities Manual (MAE) for teaching astronomy, physics and mathematics. This material was influenced by the teachings of David Ausubel about meaningful learning and Lev Vygotsky, with the theory of acquiring knowledge through practical activity in a social environment. In order to measure the knowledge acquired by the participants in the training process, we perform pre and post-tests with questions that allowed extract important results and conclusions. The results of the exams and evaluation of the methodology, submitted to a content analysis, indicated that students who saw reasoning as emerging through the assembly of the kits developed higher cognitive functions and showed greater interest and excitement in class, confirming that experimentation is one of the factors that most pleased the students during the lessons.

Teaching of Astronomy mediated by information and communication technologies (ICT): proposal of approach and analysis. *Abstract:* We are experiencing a period of transformation of teaching and learning techniques in school as an institution. Beyond its "walls", new technologies are developed and gradually incorporated into the daily lives of people. These same educational institutions try to keep up with changes upgrading themselves technologically acquiring equipment such as computers, tablets, televisions and internet connections so that teachers can use these media in the classroom. Despite this, the reflection on the best approaches to use these technologies

for education is set aside.

Insertion of cosmic background radiation in middle school through the use of skyviewer and planck applications mission in virtual reality. *Abstract:* The Cosmic Background Radiation (CBR) is considered one of the great discoveries of modern astronomy. Their study is to better understand the Universe and the refinement of observational techniques. Satellites Cosmic Background Explorer (COBE) and the Wilkinson Microwave Anisotropy Probe (WMAP) mapped more accurately the distribution of the cosmic background radiation. The present work is to develop a process of teaching and learning by introducing modern astronomy by analyzing the CBR Sky maps obtained by COBE and WMAP satellites using Skyviewer and Planck Mission in Virtual Reality.

Construction of a digital game connected with the scientific disclosure of Astronomy. *Abstract:* The purpose of this work in Astronomy at the Universidade Estadual de Feira de Santana, Bahia, is to offer a pleasant alternative to the introduction of contents related to astronomy in the classroom. With this in mind, we designed a digital educational quiz of questions and answers, applied in computers, with the theme of astronomy, inserted into three groups with three different methods, having as target the students of 1st year of Rotary Public School in Feira de Santana, Bahia, during some physics classes. We realized that different classes can be stimulated in different ways still getting almost identical results. It was noticeable in this work that the motivation in part of the students and teachers makes a difference for a change in education, thus making significant proposition for everyone involved.

Bromélia: multifunctional bench for Astronomy Laboratories. *Abstract:* This project aims at the development of educational kits for science laboratories, with a focus on astronomy. We intend to provide critical experiential opportunities that will facilitate learning. This will clarify concepts sometimes misunderstood solely by lecture and make connections between diverse disciplines, such as Geography, Physics, Mathematics, Biology and Chemistry. In specific, the proposed kits to the areas cited are: Seasons, Lambert-Beer and Pasnpermia. In this paper we will emphasize the Chemistry and Geography kit, as well as display the details of a kit to assemble electrotechnology to evaluate the proposed methodology.

Geometry and Astronomy: a proposal of didactic sequence for interdisciplinary education. *Abstract:* This work presents a proposal of work for students of primary and secondary education with the main work tool a Didactic Sequence, seeking to solve a major difficulty learning reversed in the low-income mathematics discipline in the first unit. This work seeks to improve viewing issues and application of geometry in a real trouble showing how the geometry was used for the solution of issues in Astronomy. This work was applied to the class of third year of the Technical Course in Agriculture of the Territorial Center for Professional Education at Chapada Diamantina involving 32 students after the low-income index identifying the first unit, which brings in its curriculum proposal notions of Geometry / Initial trigonometry, in order to help the teacher making pleasant and interesting the lesson for students.

The teachers of sciences and their practices: a didactic proposal for the teaching of the contents of the year's seasons. *Abstract:* In this work, we analyze the understanding of Science, Geography and Education teachers of São Miguel das

Matas, Bahia, about teaching and learning process of Seasons content that has been reflected on the construction and using of a didactic material (model System Earth-Sun), developed from a workshop with teachers who teach science classes in elementary school. The methodology has been based in questionnaires, videos and experimental demonstrations. The results showed that many science teachers have difficulties regarding to the understanding of the Seasons content. As a result, we can say that a didactic workshop in Seasons concept could make better the understanding of this content.

Study of eletromagnetic radiation in the light of Astronomy, in the context of physics lessons, in the 3rd series of middle school. *Abstract:* This study was to investigate how the introduction of modern physics in high school, mediated by the study of astronomy, may favor the practice of teaching and learning of physics, from the perspective of the Theory of Meaningful Learning (TML), through the use of Sequence Didactic . It was developed in a senior high school class, in a public school from Santo Antonio de Jesus town, State of Bahia, and entitled "Knowing the Universe Through the Colors". The same had as its central theme Electromagnetic Radiations and constituted both an instrument and product of this research. This research has been prepared under qualitative and quantitative approach, from which have developed a descriptive understanding work of the investigated object. Finally, this study shows a very positive result of the methodology chosen and can say that the Didactic Sequence elaborate contributed to a meaningful learning of concepts covered in Modern Physics, mediated by Astronomy, enabling students to build knowledge that can serve as anchors for future concepts.

Workshop of rocket: interdisciplinary aspects among astronomy, astronautics and physics. *Abstract:* This work discusses aspects of Astronautics and Astronomy in the Science and Physics classes of Elementary and Middle School in public and private schools in Feira de Santana. Astronomy is an interdisciplinary and necessary science in the curriculum of Brazilian schools. As such, we have a workshop where students build and launch rockets made of low-cost materials such as PET pickups and PVC pipes. The meaningful learning (Ausubel, 1976) was the theoretical reference of this study. Therefore,, we started the work by collecting information from the students through questionnaires to create a profile about their knowledge about astronomy and, after that, we propose activities where students are able to develop skills for understanding the physical phenomena that can be observed during the launch of a rocket, such as Oblique Motion and Newton's Laws. The workshop was very positive, arousing students' interest in participating in the Brazilian Astronomy and Astronautics Olympiads and obtaining better grades in the disciplines of Science and Physics. The students also realized the importance of astronomy in the development of humanity.

Didactic book and ludic activities: a relevant combination for the teaching-learning of the contents of Astronomy. *Abstract:* This work analyzed the combination of textbook Geography with ludic activities in the teaching-learning of Astronomy contents in the 6th year of elementary school. Geography is an example of discipline that presents astronomy content in primary and secondary education. Thus, it presented the pedagogical importance of textbooks for teachers and students, as well as the playful in contemporary educational practice may be potentiating the resource development and student learning in the school environment. The theoretical

basis for the study of recreational activities such as mediation and learning tool for this research work was based on the theory of sociointeractionist of Lev Vygotsky Semonovich. Our research approach is qualitative and quantitative, as we believe that there is an interdependence between quantifiable indicators and qualitative aspects and so they complement each other. For the development and completion of research we seek tools that made it possible: observe and analyze facts or relevant tools, collect and analyze statistical data that contributed to the target audience of the teaching and learning process.

The use of educational video and play as an instrument of teaching and dissemination of Astronomy. *Abstract:* Currently, due to the various technological options, the vast access to information and the demotivation of some students, much is discussed in the literature about the way of teaching so that it becomes diversified and attractive. The teacher / classroom model with traditional teaching has leaved to be the main medium in the teaching-learning process. Faced with this new educational paradigm, the need arises to seek strategies that increase the interest, the motivation and consequently the level of learning of the students. In this sense, we have the ludic forms of teaching, such as the application of didactic games, which are increasingly present in the school environment. From this context, a didactic game, entitled "Space Track" and an educational video called "Unraveling the Universe", was created.

Basic Astronomy as a starting point for the introduction of concepts of physics in middle school. *Abstract:* This work is the result of a research that aims to analyze strategies of teaching Physics using Astronomy as a motivational agent for its learning, establishing a relationship of transversality between Physics and Astronomy. The teaching methodologies included teaching strategies for scientific research, observation and practical experimental activities, executed in a high school in the city of Salvador-Bahia in the years 2015 and 2016. All research work was based on the theoretical principles of John Dewey, which advocated participatory learning where ideas should be shared - and this is only possible when there is no barrier to free expression of thought -, and David Ausubel's Theory of Meaningful Learning, according to which to have meaning it is necessary that the new knowledge has connection with what the student already knows. As a product of the construction work, we have as final production the elaboration of a practical manual containing the experiments in which shared the methods and procedures employed.

The teaching of physics in the light of Astronomy: a pedagogical practice research and experimental. *Abstract:* Scientific Literacy is one of the big challenges in contemporary world. This project promote a diffusion of this manner of learning though practice in Physical class and Basic Education Science, as well practice of experiments involving basic astronomical tools, observation of astronomical phenomena, planetarium sections, presentations, participations in Astronomy and Astronautic Brazilian Olympiad, science fairs and confection of didactic material for Teaching Astronomy are some activities include on this project.

The educational products related to each project already produced are: Didactics sequences; Facebook Pages; Products for the blinds; Educational workshops; Electronic games; Multifuncional bench for laboratories; Activity manuals; Board games; Educational Portals; Educational videos; Comics; Book for children and Models.

6. Conclusion

The MPAstro explores both the interdisciplinarity characteristics that Astronomy has, and the flexibility that it presents in questions related to university teaching, research and extension actions. Throughout the training process, the teacher will be able to provide the maximum tools from an instrumental, observational and experimental point of view, enabling the teacher-student to take knowledge that has been solidly established in the classroom. All the educational products are validated by the defense judges.

Acknowledgements. We are so gratefull to Vitae Fundation that provided financial support in the beginning of the research activities at the Antares Observatory at 2003 that culminated in the MPAstro at 2013.

References

Yano, C., 2011, Revista Ciência Hoje, 282, 2011