Inquiry and active learning for the teaching of science at the elementary school: A teacher training diploma course

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Abstract

Due to the need to provide elementary school teachers with effective instructional tools for the teaching of science, this paper proposes a diploma course that would allow teachers to guide their students towards the use of enquiry as a tool to explore and actively understand the physical phenomena that surround them. This program is comprehensive and integrates concepts such as learning by inquiry, differentiated and project based instruction, and literacy for the acquisition of scientific skills. In addition, identified technological resources such as simulators and adequate computer assisted science learning programs are experienced and analyzed by participants in the program. This diploma course intends to generate confidence and a different view and attitude towards the teaching of physics in the elementary school classroom.

Keywords: Elementary school; Science Education; teacher training; technology in Physics Education; literacy for physics teaching.

Resumen

Debido a la necesidad de proporcionar a los maestros de escuela primaria herramientas efectivas de instrucción para la enseñanza de la ciencia, este trabajo pone un diplomado que permitirá a los profesores a guiar a sus estudiantes hacia el uso de la investigación como una herramienta para explorar y entender activamente los fenómenos físicos que lo rodean. Este programa es exhaustivo e integra conceptos como el aprendizaje por investigación, diferenciada e instrucciones basadas en proyectos, y la instrucción para la adquisición de conocimientos científicos. Además, identifica los recursos tecnológicos, tales como simuladores y programas informáticos adecuados asistidos para el aprendizaje de la ciencia, estos son experimentados y analizados por los participantes en el programa. Este diplomado tiene la intención de generar confianza y una visión diferente y la actitud hacia la enseñanza de la física en el aula de la escuela primaria.

Palabras clave: Escuela primaria; Educación en Ciencias; capacitación docente; tecnología para la enseñanza de la Física; alfabetización y la enseñanza de la física

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I. INTRODUCTION

The lack of interest of students to elect scientific mayors and pursue scientific careers has been a worldwide concern. The didactic methods used in early schooling seem to have contributed to the discouragement of students to follow a scientific academic path because as soon as they have the possibility to choose out of a series of electives, they stay away from physics or other science options. A great number of students rejects or abandons science tracks at most upper grade schools and science classes are extremely unpopulated [1].

The UNESCO [2] has stated that the main goal for scientific education is to shape citizens that can strive in a world full of scientific and technological advancements so they can, in a responsible manner, adopt adequate attitudes and make well founded decisions in order o resolve everyday problems from a framework of respect for the others, for the environment and for the future generations. For that reason, it is important to design science contents that integrate life and citizenship in their outlines.

To increase the number of students interested in scientific disciplines and to achieve the goals of science education for life and citizenship, it is crucial to promote and develop the interest and preference students have towards scientific subjects. At the elementary school they have their fist encounters with scientific competencies and knowledge so it is there where we need to start making our educational efforts.

The problem of a weak scientific education comes from beyond the elementary school classroom, though. When a

person mayors in education, to become an elementary school teacher college and university curricula require and offer only a few (only two in many cases) courses for the teaching of natural sciences; only 8.2% of the requirements for graduation at Mexican Universities [3]. It is not surprising to see how that little importance is also given to science by practicing teachers who themselves have had little training. Moreover, only three out of 22.5 instructional hours are formally devoted to the teaching of scientific content at elementary schools in Mexico [4]. A few Bachelor of Education programs in countries such as Colombia and the United States of America offer mayors that focus on Science or Ecology education for elementary schools; however, they do not have a strong demand so fewer new programs with such features are being offered.

We believe that an effective and viable way to develop science teacher competencies for the teaching of natural sciences and of physics in particular at the elementary level is through specialized training in the form of diploma courses that once completed and linked together may lead practicing teachers to complete a graduate degree.

We also believe that the scarce time and importance given to science at the elementary level is in many ways the lack of awareness of effective ways and methods that integrate contents so the time allotted to literacy or math can also review scientific content if managed properly without reducing the instructional time required for each subject matter by State standards.

The contents of the diploma course we are presenting today aim at the development of teaching competencies that were not been formally grown while teachers were at the university. Teachers need to get proficient at planning, organizing and fully implementing inquiry and active lessons and interactions in the classroom. The ultimate intention is to motivate the intellectual curiosity in boys and girls being taught so that eventually-as students become actors in their own learning processes- they learn to learn and apply that ability throughout their lives.

It has been noted that the average score in the national tests applied to aspiring teachers to obtain tenure in Mexico 2009-2010 was of 64.48% in instructional competencies [5] so the opportunities to develop teachers' competencies are great along with the fact that in the test PISA 2009, Mexico obtained unsatisfactory scores: 40% of the students in reading and 47% in science which are statistically significant below the OECD average [6][7].

This diploma course focuses on the development of teachers' knowledge, abilities and competencies that will impact the acquisition of scientific competencies of their students through the integration reading abilities, children literature and computer programs as means for the development of scientific abilities.

Based on specific goal number 12 of the educational plan, 2021 written by the IEO [8] which demands the improvement of quality education and school curricula that includes literacy and the use of computers in the teaching processes, the diploma course we are proposing includes several technology components that demand the learning and use of computer programs for the teaching of physics. Teachers experience, use and analyze computer programs such as Discovery Education: Gizmos [9] (simulators); Brainpop: Science [10] (recreational lectures and follow up activities); Kidbizz3000 [11] (reading a differentiated levels of proficiency); and Enciclomedia [12] (simulations, recreational lectures and interactive instruction). On the other hand, having experienced the programs initially, educators may get a proactive attitude, analytical thinking and confidence to use the programs with heir students or propose the use of other technological resources and innovative instructional strategies.

This Diploma program allows practicing teachers to obtain deeper knowledge of the physics topics dealt with in the elementary school programs grades 4^{th} trough 6^{th} and to acknowledge how they correlate with other areas and disciplines and topics studied both within the same grade level and across the basic education curriculum. It intends to integrate a baggage of didactic knowledge and instructional practices that go along with the most recent approaches for the teaching of the natural sciences. Current curricular programs and adopted textbooks are revised for teachers have a clear idea of what is taught at the grade level they are in charge of and at the basic level as a whole. Additionally, contents are studied and reinforced.

Moreover, the practicing teachers plan and implement lessons that include a variety of teaching and learning strategies that highlight the importance of questioning and inquiry , the solution of problems generated by the students themselves, collaborative and independent work and critical thinking. They design their lessons based on the methodologies at study and can make a full implementation of them.

II. PERTINENCE OF CONTENTS, ORGANIZATION AND ARTICULATION

Diverse Pedagogical and psychological theories applied to the field have supported most current educational programs. Constructivism is present in educational research and teaching practice; however, there is still a gap between educational theory and the practice of science education. It is the teacher who needs to be able to design instructional strategies that link curriculum, pedagogical theories and the actual practice that takes place in their classroom. Teachers need to be able to design and apply instructional strategies that are appropriate for the subject matter and simultaneously congruent with current educational approaches. Elementary school teachers need to develop competencies that promote in their students abstract, complex and critical thinking. Recently, an array of instructional systems, techniques and methodologies have been proposed thanks to the fact that science is no longer viewed as a subject matter to be dealt with by scientific communities or the intellectually privileged or experts, but common laymen. We are in need of promoting the enhancement of scientific abilities since the early childhood due to its importance both for life and work.

The pedagogical approach that sustains the diploma course here proposed is circumscribed by constructivist principles giving pivotal importance to the role of the teacher proposed by Vigotsky in the development of the proximal zone [13] and the identification of background knowledge to tend a bridge that links newly presented content as proposed by Ausubel [14].

In order to let students inquire, question, propose, research, analyze and understand the natural world that surround them [15], understanding and practice of the following programs are included: hands on minds on activities; use of children literature to generate and guide scientific inquiry (NASTA) [16]; differentiated instruction and learning styles (learning stations or centers) [17]; and production of solutions on project based science instruction [18].

III. AREAS OF STUDY

The diploma course is divided into four modules each of which includes:

1. To make sure teachers deepen their subject matter knowledge and feel confident and comfortable handling and teaching the topics, they will review and analyze the proposed sequence and complexity of the official curricular maps and expectations for each grade level (from fourth through sixth grades).
2. In order to favor reflective thinking and expand their reasoning skills regarding their natural world of their students, teachers will revisit one instructional technique recently produced and successfully utilized in some parts of the world and will link it to one of the topics of the content to teach to be able to design lessons that take advantage of the technique introduced.
3. With the intent to improve in the teachers their capacity to obtain, process and communicate information with the support of information technology, in every module teachers will be exposed, learn about and analyze the pertinence of a computer program designed for teaching of science at an elementary level. Teachers will make recommendations for the use of such programs.

IV. EXPECTED ACQUIRED COMPETENCIES

It is intended that once the teachers finish the course, they will:

- Feel confident and knowledgeable when teaching topics of physics studied at the elementary level.
- Be capable to offer quality lessons by integrating learning activities that link current didactic proposals with their students' needs and the curriculum in order to enhance scientific competencies in their students.
- Use and make evident the importance of information technology as a means for the learning of physics.
- Be able o design lessons that promote students'…
  - Inquiry and search for solutions of posed questions.
  - Collaborative work and learning to make collective decisions,
  - Use of literature as a guide to formulate scientific enquiry in order to interpret and explain social, cultural and natural processes.
  - Responsible engagement in individual center work through differentiated activities showing respect and appreciation of the diversity of capacities.
  - Effort to propose and implement scientific projects and publish them.

V. CURRICULAR MAP

<table>
<tr><td colspan="3">Module A.- Inquiry Based Methodology
Unit I. Science Education in the recent history
Unit II. Inquiry in the science lesson
Unit III. Technology component: Gizmos
Unit IV. Content study: Energy</td></tr>
<tr><td>Module B.- Literacy and the teaching of science.
Unit V. Instructional model of the 5Es.
Unit VI. Didactic use of comic strips, magazines and literature.
Unit VII. Technology component: Kidbizz3000.
Unit VIII. Content study: Materials.</td><td>Module C.- Differentiated Instruction
Unit IX. Individual differences in pedagogy.
Unit X. Learning Styles.
Unit XI. Technology component: Brain Pop
Unit XII. Content study: Change.</td><td>Module D.- Project based learning
Unit XIII. Project based instruction.
Unit XIV. Research based Pedagogy.
Unit XV. Science Fair: Young Scientists.
Unit XVI Technology component: Enciclomedia.</td></tr>
</table>

VI. CONCLUSION

This diploma course is ambitious and will certainly demand time and effort from participants; however, the nature of its contents, the innovative character of the methodologies, and the variety offered make it attractive for those teachers that have scientific interests and the will to make their students succeed academically and in life.

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