

FINDING OUT OF THE INCOMMENSURABILITY IN THE TECHNOLOGICAL CONTEXT

Rosana Giaretta Sguerra Miskulin¹ & Fernando Massucheto Jorge²

INTRODUCTION

With the introduction and spreading of Informatics in the society and in Education, we have come across a technological scenario, which presents us with a new logic, a new language, a new way to understand and to place ourselves in the world we live. This new scenario requires a new professional culture from the human being going through an educational process. It has therefore, become necessary to dimension the teachers' education courses again, so as to offer them knowledge and actions which are consistent with the new educational trends, which are determined by the technological advances. In that sense, it can be inferred that we, educators, do not have much choice, that is, the educational choices have already been determined by the presence of technology in the several sectors of our society. Thus, it has become imperative that we engage ourselves in critical reflections about the introduction and spreading of computers in the classroom in order to provide our students with educational environments, which are compatible with the technological development. In addition to that, we hope that these reflections can turn into concrete and real actions to contribute to teaching in a way that can live up to society's expectation.

With those perspectives in mind, a project called "Computational Environments in the Exploration and Construction of Mathematical Concepts in the Context of Teachers Reflective Education" is being developed at LAPEMMEC, CEMPEM/FE/UNICAMP coordinated by the author. This research is about the several ways of using technology in the development of mathematical concepts in the classroom, in a critical and reflective way. The objectives are:

1- To offer theoretical-methodological assumptions for reflective and informed education of future teachers in the field of Mathematics Education, regarding the understanding and use of computational environments, thus helping these future teachers to develop a critical view of how technology can be incorporated and used in the context of the classroom to help in the development of mathematical concepts.

2- To offer data and pedagogical-cognitive elements to the design of interactive environments based on Simulation computational environments, Tutorials, Problem Solving, Programming Language, AVI Constructor (Animation), Internet, among others, appropriate for the development of mathematical concepts.

3- To offer theoretical-methodological data for devising an alternative methodology based on the well informed use of technology by the teachers, thus giving a new dimension to the process of teachers education and to the process of exploration and construction of mathematical concepts.

The methodology of this research consists of a modality of action research in which the intervention takes place based on the interaction of the researcher and the subjects involved in the research. Such an interaction allows for several ways of communication, which results in a very dynamic approach. It is pointed out that the methodology that is being used with the subjects involved in the research is based on Problem Solving, in the various Computational environments: Simulation, Tutorials, Programming Language, AVI Constructor (Animation), Internet, among others.

Problem solving is being seen as a design activity (Miskulin, 1999), in which the formulation and definition of the problem itself are challenging tasks for the subject, that is, s/he constructs hypotheses, suppositions; as s/he devises his/her strategies, s/he relates them to his/her objectives and to the context in which s/he is working. These are problem-situations which contain the subject's own characteristics, without ready solutions and answers, but rather with cognitive processes which take into account guesses and risk taking, that is, abductive thinking as well as deductive and inductive thinking.

The subjects in this research are undergraduate students in Mathematics at UNICAMP (Campinas State University), undergraduate students from the Faculty of Education, graduate students of Mathematics Education, elementary and high school teachers, and university professors.

¹ Professor at CEMPEM – Study Circle, Memory and Research in Mathematics Education - Faculty of Education – UNICAMP – State University of Campinas .

² Undergraduate Student in Mathematics – UNICAMP – State University of Campinas.

ANTHYPHAIRESIS E O TECHNOLOGICAL CONTEXT

This article deals with theoretical-methodological considerations about the exploration of mathematical concepts in the technological context. It presents a project, developed in the discipline EL-654 – Didactic Applied to the Teaching of Mathematics³, whose objective consists in developing a new educational approach for the investigation of a determined mathematical theme – Anthyphaireisis, by using the following computational environments: Logo, Geometer’s Sketchpad, PowerPoint and Internet, so as to create a context favorable to the education of future teachers and researchers in this field.

A project of a home-page⁴ was developed and made available on the web, dealing with the concept of Anthyphaireisis, its etymology and applicability in the classroom; this concept is put in a historical context, recovering the dominant thinking from the time of Greek geometry and its relations with the teaching of Mathematics. We can investigate this home page through three dimensions, such as: Computational Dimension, Mathematical Dimension and a Pedagogical Dimension. We present, below a picture of this homepage.

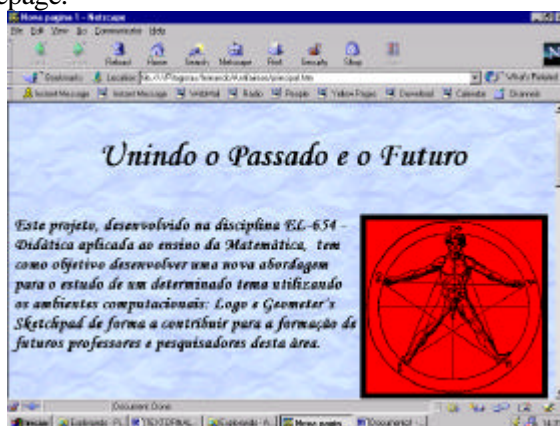


Figure 1- HOME-PAGE

COMPUTATIONAL DIMENSION

The computational contexts: Logo, Geometer’s Sketchpad and PowerPoint were used with the aim of exploring the understanding and the representation of the mathematical concept – the incommensurability of the square root of five and its application. The Internet contexts: web sites and Webquest⁵ - were used aiming at offering theoretical-methodological elements to the future teachers in the field of Mathematics Education so that they can have a reflective education and be aware of the understanding and the use of computational environments and thus develop a critical view of how technology can be incorporated and used in the classroom context to develop mathematical concepts.

PEDAGOGICAL DIMENSION

We emphasize that the availability of mathematics concepts in a computational media requires knowledge and abilities related to various computational environments and the theoretician - methodological foundation of the involved concepts. Beyond this aspect, the fact of student elaborate a project related to creation of a homepage with the objective to available the mathematics concepts make possible to him express his ideas in one interactive hypertext in which he needs to reflect and reorganizes his proper concepts, reorganizing his knowledge. It is observed that one interactive hypertext – homepage creation – propitiates to the students a propitious context to the collaborative learning and the shared knowledge.

³ A mathematics project dealing with the mathematical concept – “Anthyphaireisis” was also dealt with in the discipline MA-641- Fundamentals of Elementary Geometry with an emphasis on the mathematical aspect of the concept.

⁴ <http://www.cempem.fae.unicamp.br/lapemmec>

⁵ Web quest is a technique for learning on the Internet, developed by Bernie Dodge.

MATHEMATICAL DIMENSION

The meaning of the concept of Anthyphairesis

It is a curious and unexplained fact that the “Elements of Euclides” does not contain a precise definition about the concept of ratio, though the word *logos* is used frequently with this meaning. Book V, Definition 3 introduces it: “A ratio (*logos*) is a sort of relation in respect of size between two magnitudes of the same kind”. Definition 6, then introduces an alternative terminology: “Let [four] magnitudes which have the same ratio be called proportional (*analogon*)” (Fowler, 1979). This kind of definitions could be used to motivate the study of the concept of anthyphairesis, as a methodology for understanding the concept of ratio in the Greek context. A project like this requires a study of references that send us to another context (Ancient Greece), so it’s important that we made an historical investigation about the development of the concepts mathematics in this context. This investigation has a significance importance for the course of Mathematic because it promotes the realization of researches involving another’s subjects, like philosophy, for an example, fact that contribute for the utilization and implementation of the knowledge of the students in others areas of learning.

At the same time, this study makes us think in a different way: “thinking in a Mathematic essentially theoretician, without practice questions and with a strong connection with the divinity questions” (Miorim, 1998). We emphasize that, in now days, the process of teaching / learning of Mathematics must consider the inter-relations between the historical context and a real mathematical context. We present a picture of the place that represents a beginning of Greek mathematics.

In this project the students elaborated e presented a seminary about the theme (anthyphairesis). It compels the students to learning very well the concepts involved, for the

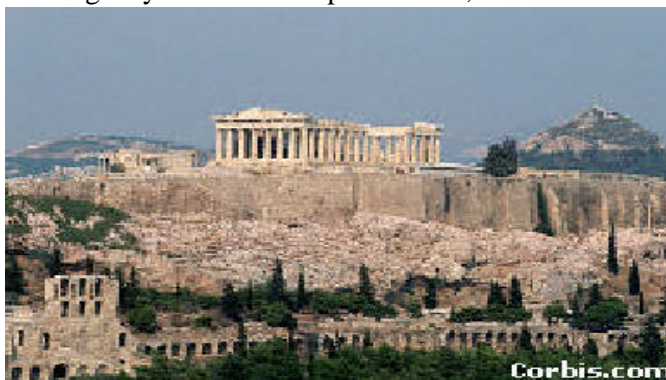


Figure 2- ATHENES - GREECE

reason that they have to transmit then, in the future, to their colleagues of the classroom. It’s interesting to say that, beyond this work of anthyphairesis make the students understand the concept of ratio, it proportionate the learning of some ideas that serve of the basis for the evolution of the Mathematics. One of these ideas is related with the discovery of the incommensurability. So, it has made a theoretician study, using the side and the diagonal of a pentagram, (see the picture below) to demonstrate that they were, in fact incommensurables.

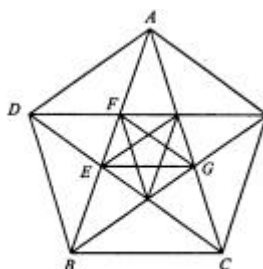


Figure 3: INCOMMENSURABILITY OF THE SIDE AND THE DIAGONAL OF THE PENTAGRAM.

This project were used in a interdisciplinary context, where the students could work with the concept of anthypharesis in a computational context, doing some activities in many computational environments, like Logo, Geometer's Sketchpad, PowerPoint and FrontPage. In the end of this course a homepage were build, including this activities and others works made in the discipline EL-654 – Didactic Applied to the Teaching of Mathematics.

Another aspect is related to a choice for using a homepage as a important context to dissemination of concepts in Mathematical Education. When we elaborate a work in a homepage we have the possibility to make it available for many people on the Web and we have the option to create hyperlinks with others homepages related to this research, where sites related to the theme anthypharesis and to the Mathematical Education, could be accessed on it.

At the same time, the homepage permit an integration with many environments, where, with only one click, the user could get into the Logo environment, can see one presentation in the PowerPoint environment, or access a work in a word document, and so on. It's a advantage in relation of the others ways of presentation and exploration of the mathematics concepts. The homepage context have the option to realize exchanges of ideas between the students and the author of the homepage using the communication tools, like emails or chats, in the case of someone want to learn something more about the available themes. By the way, it's a new way for presentation and exploration concepts in many areas of knowledge and it has many teaching / learning potentialities.

CONCLUSIVE ANALYSIS

The Technology does not consist just in another feature that the teachers use to motivate yours lessons, in another hand, consists on a powerful way that can propitiate to the students new ways to generate and to spread the knowledge. Thus being, the teachers of Mathematics must reflect on the approach of this article, creating designs in the schools that can offer chances, so that, the students learn Mathematics and at the same time, use the technology. So, the Mathematics, in the technological context, become a way to overcome the possible difficulties in the process teaching / learning of the Mathematics. Thus, the Mathematics must not be mediated with obsolete models, that do not contribute in a significant way for the development of the student, but for alternative methodologies where the student in the process of formation experiences deeply new educational processes, that make sense for him and have relation with his integration in the society. Perhaps, without a mathematical education, with quality, the student does not have chances to grow in the mathematical knowledge, important for his professional qualification in any area.

A approach of the Mathematics Education, in this technological context, deserves and needs reflections and studies, each time more intense of the researchers. Currently, with the new technologies it becomes inconceivable that the Mathematics be dealt with in a traditional way, with stanchéd contents, disconnected from one of the other, and of the real life. It is observed that these new features become, many times, the traditional resume of obsolete and exceeded Mathematics. Moreover, the new available computational environments make possible propitious contexts for the development of considerable knowledge and geometric concepts.

In this project, the Computational contexts: web sites and Webquest- were used aiming at offering theoretical-methodological elements to the future teachers in the field of Mathematics Education so, that they can have a reflective education and be aware of the understanding and the use of computational environments, and thus develop a critical view of how technology can be incorporated and used in the classroom context to develop mathematical concepts.

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