USING ETHNOMATHEMATICAL IDEAS FOR DESIGNING AN INTERDISCIPLINARY PROJECT THROUGH A WEBQUEST

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Abstract
This paper presents an interdisciplinary project that relates the results of an ethnomathematical research and the use of internet recourses. The focus of the research—conducted a few years ago—was the study of a traditional practice. This practice concerns the designing of geometrical figures—'xysta'—on houses' facades in the village Pyrgi of Chios Island (Greece). Developing this research a WebQuest was created for teaching mathematics' purposes. Our expectation of this attempt is the familiarization of our students with particular mathematical ideas—through internet structured searching—as well as the realization that mathematical ideas are met in various contexts given that mathematics and culture are indissoluble connected.

Key words: ethnomathematics, designing activity, context, culture, internet, WebQuest, 'xysta'.

1. Ethnomathematics and mathematics education

The introduction of Ethnomathematical approach by Ubiratan D' Ambrosio (1984) affected and continues to affect in various ways mathematics education. The researchers of Ethnomathematics field, among others, are interested in: the nature of mathematics teaching/ learning, legalization of mathematical cognition, discovering and use of informal mathematics—that are met in everyday contexts—in teaching mathematics.
The current trends of Ethnomathematics have categorized, by Renuka Vital and Ole Skovsmose (1997), in four main strands:

1. The pure anthropological approach[1]. It analyses the mathematics that are met in traditional cultures. These cultures have been explored in relation to: number systems, gestures and symbolism, games and puzzles, geometry, space, shape, pattern, symmetry, art and architecture, time, money, networks, graphs or sanddrawings, kin relations and artefacts.
2. The historical anthropology approach[2]. According to Renuka Vithal and Ole Skovmose (1997: 34) it challenges the traditional history of mathematics, demonstrating the contributions of cultures outside Europe to the knowledge that is referred to as 'Western' mathematics.
3. The socio-psychological approach[3]. It explores the mathematics of different groups in everyday settings showing that mathematical knowledge is generated in a variety of contexts by both adults and children. In particular, the everyday practices of different groups are investigated such as dairy workers construction foremen, carpenters, candy etc. As a result of this kind of research our understanding of the nature of mathematical has broadened.

[1] For example researches by: Ascher (1991), Zaslavsky (1973), Gerdes (1988)
[2] For example researches by: Ascher (1991), Joseph (1991) and Gerdes (1991), (Scribner, 1984), (Millroy, 1992)
[3] For example researches by: Saxe (1988), Abreu (1998) and Carraher et al (1985).

4. Ethnomathematics and mathematics education[4]. It focuses on the relationship between ethnomathematics and mathematics education (see for e.g. Pompeu, 1992; Vithal, 1992). All the above strands affect this relation. Maybe mostly affects the third one through the elaboration of the connections (or lack thereof) between mathematics found in everyday contexts and that in the formal school system (Vital and Skovsmose[5], 1997: 134).

The way culture, cognition (mathematical) and context are related is a common characteristic of all these approaches. Our research was closer to the third case since the fieldwork concerns mostly the observation of two craftsmen that used a traditional practice in order to construct 'xysta', a kind of sgraffiti on houses facades at the Pyrgi of Chios.

Furthermore our research, exploring the practice of constructing 'xysta', belongs to the designing activity, according Bishop's categorization (1988) of six mathematical universal activities (counting, measuring, locating, designing, playing, explaining). The activity of designing (Bishop, 1988: 39) concerns "*the manufactured objects, artefacts and technology which all cultures create for their home life, for trade, for adornment, for warfare, for games and for religious purposes*". An important part of designing concerns the transformation of some materials, usually from nature, in objects or anything else that is useful in a given society with particular conditions.

The designing activity exists in every culture. The type of designs depends on the people's needs and on the available materials. What is differentiated among cultures is what is designed, in what way and for which purpose. That is to say, in every society depending on its own needs —not always material—the expression of this particular activity is differentiated.

Some other writers, as for example Pinxten (1983) write about their impression by the geometrical and mathematical possibility of the designing forms that appeared in several cultures they have studied. Zaslavsky (1973), in her book Africa Counts, argues about the richly geometrical tradition of African societies, part of which is decorative patterns. She also describes the African architecture that depicts at houses in elaborate drawings.

2. The tradition of *'xysta'*

'Xysta' is a kind of sgraffiti that appears at the village Pyrgi of Chios[6]—one of Chios medieval villages. Although there are also a few houses in some other villages with '*xysta'*, these ones that appeared in Pyrgi are considered as the tradition of this place. '*Xysta'* are patterns—mostly geometrical forms—constructed by traditional craftsmen on houses facades in this village.

A few years ago an ethnographic research was conducted in order to stydy this traditional practice and to connect it with corresponding mathematical ideas that are hidden in 'xysta'. The first part of the fieldwork concerned both the observation of the patterns and the discussing with the people. The second part concerned the

[4] Pompeu, 1992;Vithal, 1992

[5] "The End of Innocence: a Critique of 'Etnomathematics' (1997

[6] Chios is a famous island not only in Greece but universally: in the past because of the ancient epic poetry Homer and in nowadays because of the mastic.

observation of two craftsmen who, for our research purposes, constructed a few patterns using this traditional practice.

For construction of 'xysta' the following technique is used. First of all craftsmen plaster the façade of the house. The plaster is put on the façade of the house, in one or two layers: the first in order to make the surface flat while the second as the base for *'xysta'*[i]. At the time the material is fresh they put a hand of whitewash. Immediately the craftsmen separate the wet surface in zones and in every zone they design the patterns they consider appropriate. Then scratch some of the parts by a fork and the patterns appeare as a result of the contrast between the whitewash and the plaster.

The main materials that are used for this procedure—depending on the time—are different kind of sand, mortar, whitewash and cement. The instruments that the traditional craftsmen use are only: a lath, a compass with two points—both with the same use—and a fork. The lath is used for two purposes: for the separation of the wall's surface in zones and for the construction of straight lines. The dividers is used for the construction of circular figures and the fork for scratching some areas of the figures in a way the one area is dark (the scratched one) and the next white and so go on.

This tradition is very important for their community and mostly for inhabitants' identity. The fact that *'xysta'* constitute a cultural practice as well as the interesting mathematical ideas that are incorporated in *'xysta'* make these an interesting issue in an Ethnomathematics' context.

In our fieldwork among others the following questions were posed:

- How is the cultural context connected with this designing tradition?
- Which are the main mathematical ideas that we can see in these patterns?
- How is the construction of these patterns a result of informal cognition that craftsmen acquire through partnership?
- How could this be used for teaching some mathematical notions or practices?

3. New technologies and mathematics education: the case of the WebQuest

The contribution of digital technologies in improvement of teaching mathematics—and not only—has been recognized by the educational community all around the world, the last decades. Especially the internet is increasingly used in teaching/learning of mathematics. However, it has been noticed that just the use of internet without a suitable designing of the teacher is a not working framework. WebQuests appears as a counter-proposal that responds to the deficiency of using internet without a definite guidance.

WebQuests are guided activities that can be used to engage students in learning about specific topics and then applying that knowledge in new ways. Dr. Bernie Dodge and Tom March, are the creators of the WebQuest design (Dodge, 2001). Dodge (1997) defines a WebQuest as "an inquiryoriented activity in which some or all of the information that learners interact with comes from resources on the internet". Although there are a number of online learning activities that depend on internet resources, Dodge distinguishes WebQuests from other webbased experiences thus: A WebQuest is built around an engaging and doable task that elicits higher order thinking of some kind. It's about *doing* something with information. The thinking can be creative or critical, and involve problem solving, judgment, analysis, or synthesis (Starr, 2005, 14, Burchum et al, 2007: 42).

A few years later March (2006) characterizes a WebQuest as:

"*a scaffolded learning structure that uses links to essential resources on the World Wide Web and an authentic task to motivate students' investigation of a central, open-ended question, development of individual expertise and participation in a final group process that attempts to transform newly acquired information into a more sophisticated understanding"*.
A WebQuest is designed in a way that introduces the student to the subject of the activity, inform him about the role he is going to undertake and to define and guide his work. In the designing of a WebQuest the teacher pose the aim and the expected results, propose the resources where students will look for the material and pose the questions that students should answer. A typical WebQuest has a particular structure including the following fields:
• *Introduction:* it concerns an introduction to the activity and to the subject in an attractive way.
• *Task*: it presents the roles of the students and defines the task they are going to undertake.
• *Procedure*: it is described how the students will perform the task. The description must include particular tools for the exploring and organization of the information.
• *Evaluation*: it concerns the way students will be evaluated through particular criteria related to the aims has posed.
• *Conclusion*: it summarizes what the students managed to do or to learn conducting the task.
• *Teacher's page*: it gives guidance to teachers for help them in scenario's application (Papanikolaou, Grigoriadou, 2005).

The best WebQuests act in a way that inspires students to see richer thematic relationships, facilitate a contribution to the real world of learning and reflect on their own metacognitive processes.
Among other the following goals and outcomes constitute the aims of the application of a WebQuest, according Burchum et al (2007: 5).
1. Improve students' technology and information literacy skills.
2. Build on students' strengths, skills, and backgrounds.
3. Introduce technologies and resources required for success in the undergraduate program.
4. Initiate and promote effective students collaboration.
5. Engage students in the learning process through student centred activities.
In Greek relating literacy Grigoriadou and Papanikolaou (2005.) remark the following points that are needed for a successful WebQuest:
(a) The educational value of the task with intent the interdisciplinary,
(b) The personal value for the students
(c) The quality of the supposed resources of the internet,
(d) The demands of time in relation to the curriculum,
(e) The accessibility and viability of the information material,
(f) The extant of the supposed issue,
(g) The innovation and the prototype of the subject.

4. (Our WebQuest) the art of 'xysta': symmetry and pattern.

Based on the research about 'xysta' a WebQuest we designed. Our aim is to use it for an experimental teaching, as soon as possible. It has a typical structure of WebQuests, constituted in two main parts: teacher's page, students' page. Here the students' part

is presented, while in the appendix the total WebQuest follows. In is in PowerPoint form with the needed hyperlinks.

Students' page

A. Introduction.

Have you ever visited Chios Island?

Have you ever heard about the 'painted village'?

Chios Island is famous not only because of Homer and mastic but also for tradition of 'xysta'.

Traditional craftsmen, using a particular technique, design, mostly with geometrical figures, houses' facades.

Which are the hidden mathematical ideas under these designs?

B. The task

In this WebQuest, we are going to study the 'xysta' and mathematics that used in their procedure. Through this activity we will realize that mathematics is a human activity connected to all cultures and human activities. After this work we will became able to construct our own designs which we could use for designing purposes. At the end we will present this work to our classroom mates.

What you should to do:

- You will find information for Pyrgi village.
- You will discover and explain what exactly the 'xysta' are.
- You will look for different kinds of 'Xysta'.
- You will find out the tools craftsmen use.
- You will study the procedure of 'xysta' construction by the craftsmen.
- You will find out the mathematical ideas that are used.
- You will construct your own 'xysta'.
- You will describe your own designs using geometrical terms.
- After this WebQuest will be finished and every group will hand its 'xysta' we put them in an album.

C. The procedure

I. You will be separate in groups with different missions

<u>Mission 1: Historians/ folklorists</u>

1. Gather information for the designing activity, as one of the six universal mathematical activities from the book Ethnomathematics (Stathopoulou, 2005). Look for the corresponding unit.
2. Gather information regarding village's history from the book of Xyda "The 'xysta' of Pyrgi of Chios" as well as from three websites.
3. Gather information regarding the history of 'xysta' from the book of Xyda "The 'xysta' of Pyrgi of Chios" as well as from three websites. It will be of interest to see when 'xysta' appeared for the first time and which their influences are.
4. You must prepare a PowerPoint in order to present to your classmates the history of village and of the tradition of 'xysta' supporting your role as historians/ folklorists.

<u>Mission 2: Architects</u>

1. Gather information regarding houses of Pyrgi architecture from the book of Xyda "The 'xysta' of Pyrgi of Chios".
2. Complete the information from three websites. It would be of interest to explore if the architecture structure of houses is related to the tradition of 'xysta'.
3. You must prepare a PowerPoint for presenting to your classmates what you think necessary to make them realize houses' architecture supporting your role as architects.

Mission 3: craftsmen

- Gather information regarding the construction of 'xysta', by traditional craftsmen, from the book of Xyda "The 'xysta' of Pyrgi of Chios".
- Complete the information from three websites.
- Find the paper number 11 and observe which the tools that craftsmen use are. Also, study the procedure of making 'xysta' through the pictorial material that is presented in the same paper.
- You must prepare a PowerPoint in order to present to your classmates what you think necessary in order to support your role as craftsmen.
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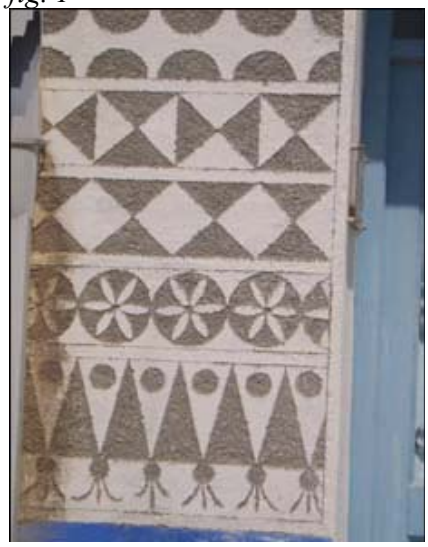
II. Discovering hidden mathematics at 'xysta'
(For all missions)

1. Study all types of symmetry that are referred in the following website. http://mathforum.org/sum95/suzanne/symsusan.html

Then:

a. *Describe in a few words these types of symmetry.*
b. Compare them with the types you have already met in textbook
fig. 1



2. The patterns that appeared in this figure constitute a combination of geometrical shapes. Could you see which shapes are?

3. In every zone, in this figure, define:
A) The motif
B) the sorts of symmetry
C) The axes of symmetry, if axes of symmetry there exist.

D) The centers of symmetry if there exist.

4. Could you make the patterns of the three first zones using only compass and rule as traditional craftsmen do?

Fig.2

5. *Could you construct the motive you can see in this figure, using only compass and rule, too?*

Individual task

Design your own patterns of 'xysta' on these three zones. You could do the same by The Geometer's Sketchpad(R) .

D. Resources

A. Offline Resources

1. Xyda, M. (2000), The *'xysta'* of Pyrgi of Chios, Alfa pi, Chios (pages 47-71).
2. Xyda, M.: 2000, "The *'xysta'* of Pyrgi", (Educational Project).
3. Xyda, M.: 2000, "The *'xysta'* of Pyrgi", (Educational Project, exercises' pages).
4. Xyda, M. (2005), Mathematics in the popular art of Chios, Pyxida, Chios.
5. Stathopoulou, Ch. (2005), *Ethnomathematics: Exploring the Cultural Dimension of Mathematics and Mathematics Education*, Atrapos, Athens (you are interested in the unite: six universal mathematical activities/ the designing activity)

B. Internet's resources: the following websites will help you to complete your task.

Architecture, history, traditions of the Pyrgi	1. **http://www.pyrgi.net/** 2. www.geocities.com/nikos_someone/index.html 3. http://el.wikipedia.org/wiki/Πυργί_Χίου 4. http://www.chioshistory.gr/gr/itx/itx23.html 5. http://www.e-xios.gr/gr/4/42.html 6. http://www.tripadvisor.fr/LocationPhotos-g189476-d196355-Pyrgi-Chios_Northeast_Aegean_Islands.html 7. http://www.mesogeia.net/trip/xios/pirgi_en.html
Pictorial material	8. www.webshots.com/search?query=Pyrgi%2C+Chios 9. www.tripadvisor.fr/LocationPhotos-g189476-d196355-

Types of symmetry	10. http://mathforum.org/sum95/suzanne/symsusan.html
Scientific papers that connect 'xysta' to mathematical ideas.	11. http://www.springerlink.com/content/hm68181657p46483/fulltext.pdf 12. http://www.math.auckland.ac.nz/~poisard/ICEm3/2.Prez%20Given/Prez%20given%20lou-prez.pdf

E. Evaluation

Your work will be evaluated in the following way:
A. For your contribution in missions your presentation via PowerPoint will be evaluated according to the standards[7]:
B. The mathematical part of your work will be evaluated under the correctness and the completeness of your answers according to the standards [8].
Γ. Your patterns will be evaluated by an artistic committee, in which your artist teacher will contribute.
The best three of them will get an award.

A rubric for the evaluation of PowerPoint

	Beginning 1	Developing 2	Accomplished 3		
Performance of every mission in this role	Students used a few of the resources	They used enough number of resources, but they didn't developed these completely	They used all the available recourses and developed them completely		
Collaboration in the group	They didn't manage to find a common language	They collaborated not equivalently	They reacted effectively giving a product in which both individual and collective contribution was obvious		
The presentation	They simply presented information	They efficiently presented the information and used PowerPoint's abilities.	They perfectly presented the information and used PowerPoint's abilities.		

[7] At this point, in the original PowerPoint a hyperlink leads to the rubric that follows.
[8] At this point a hyperlink leads to the rubric that is appeared in the next page.

A rubric for the evaluation of the mathematical part of the WebQuest

	Beginning 1	Developing 2	Accomplished 3
Question. 1	Students didn't conceived all the types of symmetry	They incompletely described these types and made the comparison	They completely described these types and made successfully the comparison
Question. 2	They recognized just a few geometrical shapes	They recognized all the geometrical shapes that were obvious	They recognized all the shapes even the ones, like hexagon that wasn't obvious
Question. 3	They answered incompletely to a few of questions	They answered incompletely to the total of questions	They answered perfectly to the total of questions
Question. 4	They constructed a part of the shapes, while they could not completely explain their construction.	They constructed all the shapes, while they could not completely explain their construction.	They constructed all the shapes explaining completely their construction.

F. Conclusions

At the end of this WebQuest you will have realized that the hidden mathematics (in other words the informal mathematics) is present in several activities. All cultures use mathematics in different expressions, depending on their peculiarities, like the example of 'xysta' at Pyrgi of Chios.

6. As a postlude

In this work we propose an interdisciplinary project based on an ethnomathematical research through a WebQuest. The research in the field—that antedated—focused in the traditional practice of 'xysta' at Pyrgi of Chios. We are interested in this practice as concerns the construction of geometrical figures involving so, mathematical notions.

Our aim through this activity is twofold. On the one hand we expect that students working collaboratively will manage to conceive and communicate mathematical notions. On the other hand we expect that they realize that mathematics—often hidden—are present in everyday contexts as well as mathematics constitute a

component of the corresponding culture, broadening in this way the notion about the nature of mathematics.

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[i] The time of hand they plaster the house's façade depends on the way as well as on the material that was used for the wall's construction. The original *xysta* were only on stony houses but now the majority of houses are built by bricks.