

## **Teaching and Learning Mathematics through Art: a multicultural approach**

Eliana M. Guedes, Regina M. Zandonadi and Diomar C. Lobão  
Departments of Computing and Mathematics - University of Taubaté - Brazil  
Prefeitura Municipal de Taubaté - Ensino Supletivo - Taubaté - São Paulo - Brazil

### **Abstract**

The environment where counseling and support activities in Mathematics take place, directly helping students and teachers with the Project "Art and Mathematics" will be presented, focusing particularly on how the relationship of shapes and geometry has been incorporated into art, providing an engaging introduction to this realm of mathematics. This project, part of the Educational Program "Rediscovering Mathematics", has been developed with adult students which attend elementary evening courses.

The principal aims of the activities are to break the barrier of myths which usually comes with the teaching and learning of Mathematics and to develop creativeness through the integration of Art and Mathematics looking for:

- the development of visual ability.
- the learning and teaching of mathematics.
- the integration between Mathematics and Art.
- the social integration.

We have been doing this work in different regions of Brazil and South America, bringing together students, teachers and tutors interested in the teaching and learning of Mathematics through Art, considering that:

- interest is one of the first rules of learning, having the world as a mediator to a process by which man learns about himself and others.
- the teaching of Mathematics, specially Geometry through Art contributes to the formative process, improving creativeness and favoring a particular type of thought, seeking new situations and being sensitive to the visual impact. Together, Art and Mathematics, form a perfect union of creativeness and knowledge, the one the instrument for the other, functioning at their highest and best.

### **1. Mathematics and Motivation**

How to motivate students, is the question that has become a leading concern for teachers of all disciplines. It is known that students who want to learn for understanding's sake and students who want to learn to get good grades use different kinds of strategies in their problem solving, and these strategies influence their understanding and their motivation to work on a problem.

How to get adult students interested and involved in math? Our goal is to find out ways of using student's interest to maintain motivation and discover what are the ordinary experiences that can become meaningful learning experiences, providing feedback that will support adult students in their individual learning goals.

## 2. Why Mathematics and Art ?

The term “learning environment” for teaching and learning Mathematics has been used by educators these last decades, attempting to engage students, both intellectually and physically, to make them become active learners, challenged to apply their prior knowledge and experience in new and increasingly more difficult situations. New approaches have been investigated to give them opportunities to engage themselves in the process of learning, rather than just receiving information. These approaches should provide a learning environment for students that build confidence in the learning and doing of Mathematics, specially adult students who attend evening classes.

We will focus on a particular but representative attempt to improve learning and teaching of Mathematics through Art, which we found out to be a strong and meaningful strategy. A brief study of the development of different cultures which are the basis of Brazilian society were studied and used to motivate students and to allow them to make relations. In this way, it was shown to them how the roots of each culture run deep in art and history, both requiring inspiration, contemplation and creativity being, Mathematics and Art two of the oldest disciplines known by man.

Considering all the topics above we could increase students interest, success and perseverance and how to input them into discussions on Mathematics content, outcome, and assessment. Another important point was how this knowledge could promote student inquiry, guided discovery, and conjecturing in their instruction through a learning process that models the use of manipulatives, computer technology, student writing, cooperative learning, and differentiated instruction, encouraging sustainable collaborations between students from different cultures and social classes.

After introducing the students into the mentioned cultural and historical topics, we found out what they did consider to be Art and how they faced the idea of joining Mathematics and Art. They have been working with Japanese and Chinese Patterns. We are presenting some examples of the Geometry of Origami, chosen by the majority of students, who worked together integrating Mathematics and Art through a multicultural approach.

This work has been developed with adult students from Prefeitura Municipal de Taubaté - Ensino Supletivo Santa Luzia - Brazil

## 3. The visual representation of mathematical ideas.

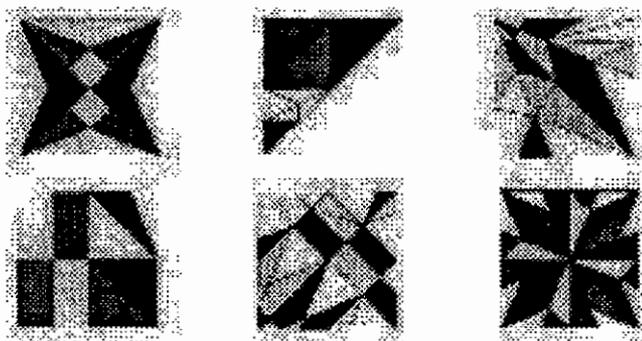


Figure 1. Creases of Origami: a study made by students from basic education.

Implementing origami and Indian design can mean rich, hands-on geometry experience for the students, giving them the opportunity to observe cultures that were already in our country before it was discovered and colonised and others cultures that are still conquering their places in our society. Both, have their roots folding papers or leaves, always making geometric models, trying to express their feelings through Art. Constructing geometric models, using the vocabulary of Geometry in context and discussing concepts as students fold figures together, certainly makes them feel special interest, being that a starting point for mathematical investigations and problem solving activities. There are innumerable mathematical skills and concepts inherent in folding, including among all:

- spacial visualisation;
- isometry;
- three-dimensional geometry,
- congruence and similarity.

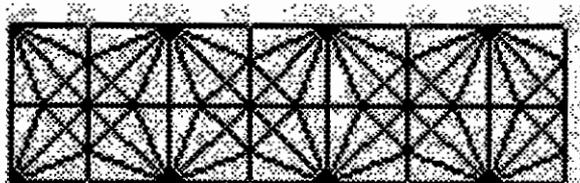
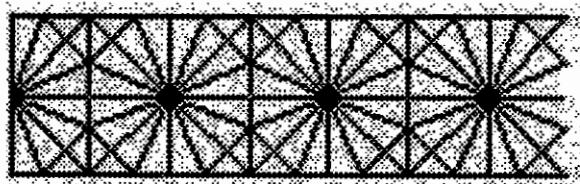
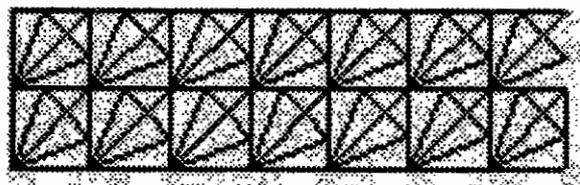
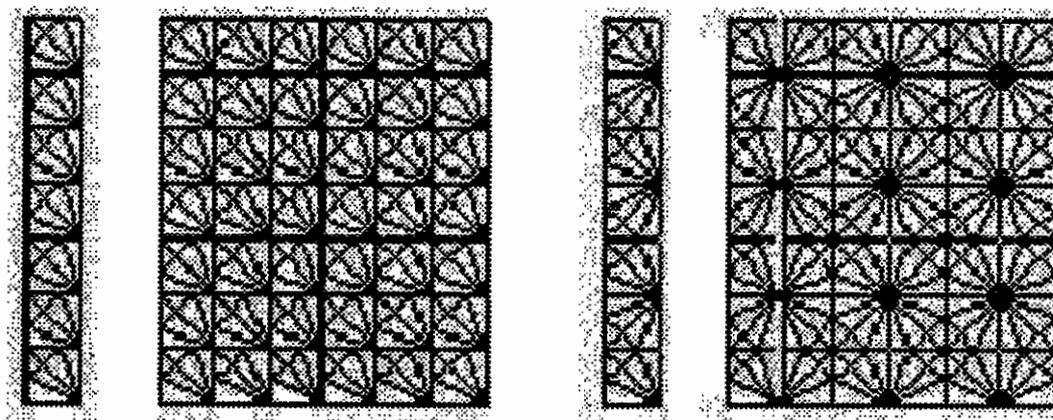
#### **4. The geometric language of different cultures.**

We are going to present the results of some activities related to Symmetry and Asymmetry, which brought together, Art and Mathematics, forming a perfect union of creativeness and knowledge, the one the instrument for the other, functioning at their highest and best. The structures presented show beauty and rich design that bring qualities of order and symmetry, improving directly the:

- development of the visual ability.
- learning and teaching of Mathematics.
- integration between Mathematics and Art.
- social integration, specially in third world countries.
- cooperative learning.
- cognitive development.
- multicultural awareness.

The creases of the crane-folding was our first work. The geometric models presented united the group in a thematic activity, exemplifying the power of collaboration and the very satisfying achievement of a group objective. A study of the creases impressed on the square sheet of paper, after the crane had been created revealed a wealth of geometric objects and properties, illustrating the mathematical ideas of similarities, lines and points of symmetry, congruences, ratio and proportions of shapes, and iterations resembling the formation of geometric fractals. This study involves moving between dimensions, the creases representing the object's 2-dimensional projection onto a flat plane, the isometric properties applied to a minimum pattern and the construction of 3-dimensional models that can help student to make relations and solve problems at their work.

The 2-dimensional models are part of a project to develop flagstones designed for paved floors and the 3-dimensional models have been used to suggest new ideas for architectural projects, both developing creativeness and visual ability.



*Figure 2. The study of reflections, rotations, translations and glide reflections done by students from the Program "Rediscovering Mathematics" and Ensino Supletivo.*

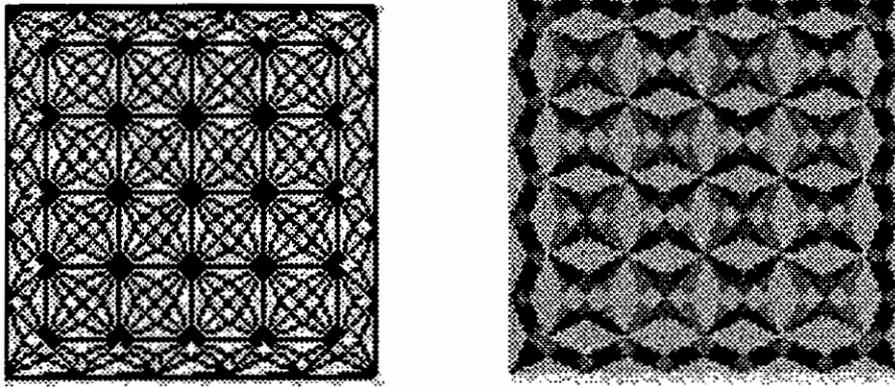


Figure 3. Geometrical Study: Flagstones and Tapestry Projects

All these examples were made and studied by adult students from the project Art and Mathematics and from Ensino Supletivo in which they learned the meaning of the words grid, tile, tessellation, mosaic and regular tessellations, the naming conventions, the geometric representations and the formulas to solve mathematics problems in everyday life.



Figure 4. Structural and Geometrical Study

The transformation that relates two congruent figures, the isometry was worked on, as well the direct isometry, translation or rotation, and the opposite isometric, reflection or glide reflection. Geometric models were obtained by applying translations, rotations, reflections or glide reflections in various combinations. By geometric model we mean a collection of geometric primitives that accurately represent the shapes designed on the surface. These geometric descriptions are used to enhance the visualization of the object and to provide for quantitative and qualitative analysis.

## 5. Discussion

All Mathematics should be studied in context that give ideas and concept meaning. Nonstandard instruments, everyday objects and *situations*, social life stories and the culture background of students should be used before others, considering the knowledge the student already has, helping to connect abstract geometric and algebraic concepts to the real world.

Everybody learns Mathematics by doing Mathematics, modeling, investigating, discovering, constructing and demonstrating mathematical theories, concepts, and

operations. The proper educational environment will assist the adult student in developing conceptual understanding, procedural skills, and accuracy allowing the development of creativeness and encouraging him/her to solve mathematical problems related to the real world. Ordinary things are basic to begin with giving all the adult students the opportunity to develop themselves, being creative, independent and conscious that to learn something they need to trust feelings and ideas, and then enable the performance of these ideas.

## 6. References

- Alsina C., Pérez R. and Ruiz C. (1989) *Simetria Dinámica*, Ed. Síntesis, Madrid.
- Alsina-Trillas (1984) *Lecciones de Algebra y Geometría*, Ed. G.G. Año, Barcelona.
- D'Ambrosio, U. (1976) *Matemática e Sociedade* – In: *Ciência e Cultura*, S. Paulo 28, pp. 1418-1422.
- D'Ambrosio, U. (1984) *The intercultural transmission of mathematical Knowledge: affects on mathematical education*, Campinas.
- D'Ambrosio, U. (1985) *Ethnomathematics and its place in the history and pedagogy of mathematics* – In: *For the Learning of Mathematics*, Montreal 5, pp. 44-48.
- Gerdes, P. (1984) *On cultural aspects of evaluation in mathematical education*, Adelaide.
- Gerdes, P. (1985) *Conditions and strategies for emancipatory mathematics education in underdeveloped countries* – In: *For the Learning of Mathematics*, Montreal 5, pp. 15-20.
- Neumann, P. and Kästner, K. (1983) *Indianer Brasiliens*, Dresden, 100 p.
- Thom, R. (1979) *Developing mathematics* – In: *Developing mathematics in Third World countries*, Amsterdam, pp. 127-133.
- Pedoc, D. (1979) *La Geometría en el Arte*, Ed. G. G. , Barcelona.