**CWF in Blog: Challenging Weekends in Family Around Mathematics**

Sofia Ramos and Lina Fonseca  
*Instituto Politécnico de Viana do Castelo*  
*Viana do Castelo, Portugal*

**Abstract**

Family and school should provide children with necessarily different, but connected, learning environments. The effective relationship between these educational instances promotes school success and the quality of this relationship is particularly important when referring to mathematics. This school content is often "unloved" and the conception that “if parents didn’t like mathematics, then it is natural that children will not like it” is still alive and accepted. To try to break this cycle it is important that school and family join forces to motivate pupils to learn mathematics and develop their mathematical creativity. A case study was conducted with a 4th grade class, who were proposed weekly mathematical challenges to be solved at weekend with family.

**Key words:** family-school partnership, homework, mathematical challenges, creativity.

**Introduction**

The relationship between family and school is important to support enthusiasm and successful integration of the pupils in the school context (Christenson & Sheridan, 2001). This relationship is not always reinforced based in good reasons. Many parents go to school or are invited to visit it only when there are conflicts with their children, developing a dyad school-family with a very negative charge. This is not the real family-school partnership (César, 2012). The main family concern is often with marks: certifying if the daily homework is done, ignoring content and form; and getting information about the marks of their children.

In a primary school, with a 4th grade class (8-9 years old), a routine exploration of mathematics was detected, very much based on memorizing rules described in the textbook; with little meaningful participation of families in school life and in monitoring of students' academic journey - parental concern is mainly focused on preparing students for national exams in order to obtain good marks.

Some questions arose in this context: What could be done to change this situation? How can we challenge students? How can we change negative conceptions about mathematics? How to involve family and students? Must we ask for more home work? Challenging children and family?

To answer this situation, a weekly dynamic was created: presenting a mathematical challenge to be answered during the weekend and necessarily done in collaboration with parents or other family members. A case study, with the 4th grade class, was designed in order to understand if the students’ attraction to mathematics and their creativity can be enhanced by the cooperative resolution (student-family, S-F) of weekly mathematical challenges. The following research questions were defined: Does the cooperative
resolution (S-F) of weekly mathematical challenges enhance the family-school partnership? Does the cooperative resolution of weekly mathematical challenges promote the appeal of students for mathematics and the development of their creativity? Which evidence of involvement, do students reveal in relation to mathematical challenges? What aspects of creativity do students show on the resolution of mathematical challenges?

Family-school partnership

School has been called educational family because it represents an important support for families in the education of their children (Almeida, 2005). Because of that, families usually place excessive expectations in schools and what schools have to offer (César, 2012; Roy, 1997; Vieira, 2006). School does not properly understand the difficulties faced by families in today’s society. This situation creates misunderstandings and a complicated family-school partnership (César, 2012; Roy, 1997).

Family and school have different, but complementary, educational missions (Roy, 1997) each of them should promote the action of the other. For this, they have to accept and value their differences and their distinct roles. Callender and Hansen (2004) and Epstein (2002) advocate the importance of their sensibility and flexibility to develop a mutual understanding and positive learning environments. The school-family partnership is a formal alliance, teachers and parents work to achieve common objectives and share results and benefits of this mutual investment. This work puts students in the centre of the process, because the main objectives are related to their success also giving benefits to all actors (Epstein, 2002). If the partnership is real, then students feel it and they will be motivated to produce their own successes (Epstein, 2002).

“Studies confirm that parents care about their children, but need good, clear information from educators in order to remain involved in their children’s education” (Epstein & Sheldon, 2006, p. 117). Different situations may imply the involvement of families in school and the academic career of their children. Schools should offer different and better possibilities in order to create a real involvement and participation of parents in school life.

In Portugal, schools are not prepared to meet families and allow their active participation (César, 2012; Villas-Boas, 2007). The contact with families only happens in periodical meetings, with all groups at same time. These are not situations of real involvement. But that is the reality of the majority of schools (César, 2012). Teachers justify themselves with a lack of time, but Villas-Boas (2007) said that some of them are not really enthusiastic about having families at the school.

Homework

Epstein (2002) considers that homework could be an opportunity to connect family and school. Distinct ideas about the importance of homework are known. However, this practice is much ritualized nowadays (Gil & Schlossman, 2003; Henriques, 2006), and because of that, many times, the most important purposes of homework are lost and these tasks have adverse effects (Henriques, 2006). So, this practice can sometimes lead to the development of problematic situations between family and school. The most imperative difficulty of families is to help children with mathematical tasks. This happens as a result of their conceptions and self-image as mathematical learners, but also because of the frequent changes of the teaching methods and of the curriculum contents (Cesar, 2012). To overtake this problem, families appeal to extra actors: study
centres and tutors. To deal with this issue, it is urgent to find answers which promote the involvement of families with their children in order to embrace these home tasks. Real involvement will only be achieved if parents were to feel the support of the school (Villas-Boas, 2007).

**Mathematical conceptions**

Conceptions have been theme of studies because of their importance to explain the actions of human behaviour. They are a set of elements, ideas, preferences, meanings, or beliefs which influence the actions of each person (Lemos, 2005). They are the result of individual experiences and can be imported by the social environment from an early age, and persist over time. That is why Ponte (1992) refers that conceptions are at the same time an individual and a social construction. They act like a filter and can even be a blocker element to new realities, experiences, and new understanding.

Each person sees mathematics based on their personal experiences and the dominant social representations (Machado & César, 2012). If their mathematics learning was marked by a positive relationship, their mathematics image will also be positive. If their mathematics relationship is carried out in a stimulating environment based on an atmosphere of appreciation and understanding of the discipline, it will also contribute to a strong and lifelong relationship. Mathematics has been taught since long time in school. During this time it has been seen as an inaccessible subject, restricted to some kind of people, associated to numbers, facts, memorized rules and procedures (Boavida, Paiva, Cebola, Vale, & Pimentel, 2008; Fonseca, 1997; Machado & César, 2012). These conceptions have been transferred through generations, and they are reflected in the learning of mathematics and in the results obtained (Borasi, 1990; Ponte, 1992).

For a long time students have seen mathematics as a science with pre-determined resolutions to well-structured tasks (Borasi, 1990). This is a narrow view of mathematics. Although this image seems to represent a moment in the past, these conceptions are still present in many classes nowadays (Boavida et al., 2008). Teachers should present students and families with a renewed understanding of mathematics, promoting an image associated to comprehension and utility. This can be made by the suitable choice of tasks.

**Mathematical challenges**

Challenging tasks promote enrichment and meaningful learning (Taylor, 2009). Perhaps in practice, students are challenged very often, but only to participate in competitions which occur outside the classroom. This environment of challenge is not linked many times to formal learning. This is due to the lack of time to teaching practices and the extent of the formal curriculum (Taylor, 2009).

Task selection is one of the competences of the teacher. He/she should select tasks that promote communication to share ideas and resolutions, and the development of critical and creative thinking (Boavida et al, 2008; Pehkonen, 1997). Challenging tasks contribute to this learning. They are open-ended tasks, situations which can be interpreted in different ways, with different possible resolutions and solutions, where the resolution process is not immediately accessible to promote real involvement and motivation for all students to learn. Mathematical challenges may be related to different subjects and also should be accessible to all students (Ponte, 2009). Apart from
selecting diverse and motivating tasks (Lemos, 2005), the way they are introduced and explored in the classroom by the teacher is essential to keep students involved in its resolution with motivation (Ponte, 2009). This promotes learning with comprehension.

Ponte (2005) refers two dimensions when he categorizes different tasks: structure level and difficulty level or challenge level. Crossing these characteristics, tasks can be exercises, problems, explorations and investigations. The first is the closest kind of task. Problems are also considered more closed than explorations and investigations. The two last are really less structured. Problems and investigations are normally more difficult and the last one is considered the more complex, and more time-consuming of all. Other characteristics used in this categorization can be the duration of the resolution and the context. Tasks can be also projects and games.

Many authors refer that problem resolution favours development of logical reasoning. If tasks are less structured they can also promote characteristics such as persistence, real involvement in finding diverse solutions inside or outside the classroom, divergent thinking and creativity (Dante, 1991; Pehkonen, 1997).

Creativity

Creativity is an ability which is highly valued nowadays. It is believed that someone creative will be more prepared to adapt to the rapid changes of the world. For this reason, creativity is being studied from different areas, considering this as an ability which can be developed in schools. In spite of this, there are many attitudes that go against the development of this capacity. At home and school, children are early confronted with a set of rules and prohibitions that emerge as the first barrier to the development of their creativity, their courage to create something new, to innovate. This background inhibits creativity (Alencar, 1989; Sheffield, 2009). So it is necessary to change the future scenario of schools, not continuing to stimulate students just in specific activities. It is necessary to involve the whole school and everyone who participates in it.

The most significant approaches in the teaching of creativity are those that include cognitive and emotional functions, properly-structured tasks and motivation that involves students in interaction with other students and with the teacher (Torrance & Torrance, 1974). Creativity can be intentionally developed, but the teacher has to promote the self-image of the students, allowing them to have success moments. These learning environments encourage them to share their ideas, ask mathematical questions to find new answers, transform, evaluate, argue, and defend their own ideas (Sheffield, 2009). These are crucial abilities to promote the development of creativity (Alencar, 1991).

Creativity was a neglected ability in mathematics and the same is still true of many teachers. However, the exploration of maths is full of creativity potential (Movshovitz-Hadar & Kleiner, 2009).

Creativity involves divergent thinking and is expressed by three dimensions: fluency, flexibility and originality, and it is related to problem solving and problem posing (Sheffield, 2009; Vale, Pimentel, Cabrita, Barbosa, & Fonseca, 2012). In addition, some other criteria might be used when the evaluation of creativity is intended: the depth of understanding, the quality of expression of thinking, and the extent of the problem. Open-ended and weakly-structured tasks can promote these abilities. Teachers have to adopt an open attitude to creative answers and they should encourage students with
creative tasks (Vale et al., 2012). Challenging tasks usually require creative thinking because they can be resolved from different points of view (Sheffield, 2009).

**Methodology**

Taking the above into account as well as the purpose of the study and their questions, a qualitative case study was designed. The participants of this study were 25 students of the 4th grade level (8-9 years old) and their relatives who participated in the mathematical challenges.

A weekly mathematical challenge was proposed to be resolved during the weekend together with family members. In this study, the concept of family is broad. The relatives with whom children could solve the challenges were: mother, father, brothers, sisters, grandparents, uncles, cousins, godparents, etc. A blog was created to share and disclose the resolutions. Children and their families could share their own proposals and have access to all resolutions on the blog. In each submission or when students bring their resolutions to the classroom they must tell with whom he/she resolved the challenge.

Data was collected from weekly challenges, observation of the participants in the presentation and discussions in classroom, audio and photo records, questionnaires (students and families) and interview surveys (parents and teacher).

Data analysis was organized in three categories. Categories were based on the problem, literature and empirical data: family-school partnership; involvement of the students on mathematical challenges – through the number of answers presented for each challenge and their satisfaction of each challenge; mathematical creativity – through some literature’s criteria. They are the answer’s fluency, flexibility and originality and the deep of knowledge presented in each answer.

The goal of this intervention is to develop a family-school partnership, promoting children’s attraction to mathematics and promoting the creativity of children through cooperative resolution (children-family) of mathematical challenges. To this effect, 11 mathematical challenges were devised, related to different mathematical areas. These challenges were used to introduce or practise the mathematical content to be explored in class, during the following week, when their resolutions would be presented and discussed in a large group.

The challenges were presented on Friday afternoons using different ways (e.g. hidden messages, puzzle problems) to break with the traditional image of homework. The challenges were accessible to all children and families and connected them to the other subjects in the curriculum, beyond mathematics, and with real life. Their purpose was also to show children that mathematics is everywhere around us.

**Examples of proposed challenges**

Next we will present some of the challenges that were proposed to that group and some of their resolutions.

**Challenge 3**

This is a green piece of paper that should be folded so that children could read the hidden message. In each fold they found another message which indicates the following fold to be done.
At the end they can read: *Find all the polygons hidden on this paper. Can you find them around you?*

*Figure 1. Presentation of Challenge 3.*

The problem solvers revealed fluency and flexibility in their answers. They were able to found polygons in different contexts. These evidences reveal the involvement of the resolvers: students and relatives. They proved to be attentive to the mathematics around them.

*Figure 2. Examples of polygons found around them.*

Fifteen families answered this challenge. In total they presented 109 correct answers, and sixteen of them were answers in original contexts.

**Challenge 6**

In this challenge students had to construct a traditional children's game named “Quantos queres?” (Figure 3). There were presented mathematical guidelines to help the solvers in this construction. Then they had to pose mathematical tasks to be after solved by other students, their colleagues.

Posing problems is normally a hard task to students (Vale et al., 2012), however all the students liked very much this challenge. It had the major number of responses. This challenge gave to them the possibility to play with math. Because of that they didn’t resist of make it, and the majority of the students considered it the funniest challenge.
Figure 3. Presentation of Challenge 6.

**Challenge 7**

This challenge was devised in order to work with fractions and to learn about them. Students had to find out what the black painted fraction on the tetrahedron surface was. Then they had to paint that fraction on the cube’s surface.

Figure 4. Presentation of Challenge 7.

Different tetrahedron models were given to the students in order to enrich the discussion in class. However, two or more students worked in the same model to allow distinct views of the model and to promote discussion. This fact allowed the sharing of different resolutions and their comparison in class as is shown in Figure 5.

These resolutions were based on different views from the tetrahedron. They enabled to establish more natural activities about equivalent fractions. Mathematical visualization tasks promote to work abstract contents at an earlier age.

Thirteen families answered this challenge. Six correct results were obtained and all of them were original.
Challenge 11

Challenge 11, the “blanket” of challenges, was devised for solvers to represent all of the challenges that they had attempted in a portion of the blanket (Figure 6).

Students had to interpret different expressions and find out how many squares they needed to illustrate a certain challenge. Thirteen families answered this challenge, but only nine had a correct result.

The participants used distinct forms to represent the challenges (Figures 7 and 8).

Almost everyone identified the fractions as 1/10 of the blanket.

The majority of students represented this fraction on horizontal lines. However, five of them were original because their representations showed the depth of the different challenges (e.g. Figure 7).

Others were more creative in the occupation of different parts of the blanket (Figure 8). They revealed fluency because they represented the challenges in different ways. They were also flexible in the way they decided to occupy ten squares of the blanket (Figure 8).
They used different representations of ten: diagonal, triangular, and others. This family was original because it found a unique mode of representation.

Figure 6. Presentation of Challenge 11.

Figure 7. Example A of the resolution of Challenge 11.

Figure 8. Example B of the resolution of Challenge 11.

Conclusions

Results show that a challenging intervention can improve family-school partnership. The participant families kept in communication with the researcher every week. Some of them never had communicated with the teacher until then. Challenges can bring families to school even if in a virtual way – via email and blog – as happened.

In the case of families that already had some involvement with the school, the weekly mathematical challenges have created a more productive relationship between family and school. In those families a closer relation was also developed with mathematics. They came in contact with a more challenging image of mathematics, one that is fun and useful. “Like this, mathematics can be fun; I like this challenge very much.”(student
L) “Thank you teacher for giving those challenges, they can be a way to motivate my daughter towards mathematics.” (mother L); “Before, we hadn’t nothing to do in family, now we have the challenges, I always do the challenges with my sister. She gives me many ideas. It’s funny.” (student M).

Some families had a well-defined team work. In those cases, parents were as involved as students. “This weekend we exceeded our expectations. My daughter and I, we had fun with the mathematical challenges.” (father Q) “Sometimes, the father is more anxious than the daughter to see the new challenge.” (mother Q).

Through this work methodology, the teacher researcher was closer to the families involved and was more aware of their necessities and fragilities, which helped the work in the classroom and the relationship with the students became easier. These results show evidence that the proposed methodology can meet the main goal: creating a more proactive relationship between family and school in which it is possible to obtain benefits for all involved: students, families and teacher.

The satisfaction of the students in face of the challenges shows their commitment in this work methodology. They seemed to enjoy all the challenges, but the one that was the most satisfying was, without no doubt, Challenge 6. In this challenge, twenty-one families took part, the maximum number of participants. This task required a lot of effort, because they had to design mathematical tasks. However, everyone embraced this challenge because the result was a game and with it, everyone played mathematics.

The students proved themselves more creative each time, mainly improving their fluency and flexibility. Only families and students who were more involved with mathematics showed increasing originality in their answers and they tried to innovate in the way that the answers were presented.

A minority of answers was original which reveals the need of challenging tasks, which can develop creativity in children. This study was the first step of a long way.

References

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