WRITING PROBLEM STORIES: DEVELOPING CREATIVITY THROUGH THE INTEGRATION OF MATHEMATICS AND LANGUAGE

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Writing problem stories is a teaching methodology whose main objectives are: allowing children to pose problems and to write stories and therefore to integrate the two main subject areas of the curriculum, language and mathematics. With it we intended to promote the development of creative writing, textual understanding, problem solving, problem posing and reflective and creative thinking. The non-routine problems were used in order to maximize varied and creative strategies of solving problems, allowing students to apply their knowledge in posing problems activities.

PROBLEM STORIES

Our study intended, in a first stage, to promote, and in a second stage, to assess the development of literacy and numeracy skills using a problems stories teaching strategy, with students primary school. Our study first was implemented in small scale by Sardinha (2005). The relevance of this study lies in the education for numeracy and literacy, as well as in a change of attitude towards mathematic and language through problem stories. Their creation implies reading, writing and posing and solving problem skills in specific context.

We pretended to analyze and reflect on the consequences of implementing this method as a way of educating for numeracy and literacy, longitudinally, articulating transversely mathematics and language. We intended to perceive the skills that this teaching method may develop in students and how this affects their long term achievement in both areas.

The construction of stories with problems (problem stories) was an activity promoted by Bush and Fiala (1993) as a new way to have students posing problems. That was done both with 5th grade students and teacher trainees. They thought that the construction of problem stories would develop creative writing and integrate mathematics with other areas, and could be done with students of every school year.

Palhares (1997) has implemented and analysed problem stories made by teacher trainees. He stipulated groups of 2-3 and that stories should have exactly four problems coherent with the story and should be intended to 8th grade students. He mentions three structure factors in the construction: the general idea for the story, the development of the story and the problems, any of which may assume the most relevant part.

Apparently there are four different and main processes of construction. One is to start with only one problem, from which the general idea of a story unfolds and during its development opportunities to include other problems may arise. A second is to start with a set of problems, from which a general idea emerges and a later adaptation of the problems occurs. Third, we start with the idea for a story and opportunities for the introduction of problems arise which may originate changes in the development of the story. Finally, there is the possibility of constructing a story and when it is finished, formulate problems coherent with it and place them strategically. He believes that the first two favour problem posing and the last two are more favourable to the construction of stories.

Sardinha (2005) has implemented the creation of stories in a 3rd year of schooling class. She created tasks not only for problem posing and solving, but also for the understanding of texts and to develop writing. She concluded that problem stories permitted the understanding of the importance of the strategic management of information in a text, considering the perlocutive effects to be attained; developed the domain of the basic moments in stories structuring; and developed several other competencies connected both with the domain of Portuguese language and with problem posing and solving. She mentions that problem stories have promoted and facilitated the use of problem solving strategies by facilitating the creation of mental images of the problem settings, together with better metacognitive actions.

Sardinha (2011) has implemented again the tasks to a new group of students of the 2nd year of schooling and continued working with them through their 3rd year of schooling. The set of tasks was remade from 2005, with a new non-routine problem and a new story rewriting activity.

In 2012, we have set up a teacher in-service training focusing on this methodology in which fourteen teachers have participated. We intended teachers to create their own tasks, starting from the sequence of tasks by Sardinha (2011), and then applied it to their students. For the first time this methodology was applied to three 1st year of schooling classes.

Integration

Pat Hagerty, cited by Evans, Leija and Falkner (2001), recommends disciplinary integration as a means to help teachers deal with the lack of time to work all curricular content in the classroom they feel. Considering that literacy is one of the first to be evaluated, he proposes the integration of all possible areas to work around literacy.

Azevedo (2009) refers that educating to literacy involves creating interaction opportunities with literacy materials that are both significant and relevant.

In our specific case, when trying to interact between literacy and numeracy through the creation of problem stories, we believe that problem solving and posing are strongly connected with the linguistic domain and therefore it makes all sense to integrate these two basic areas for a global development of the students.

Even if some may say that integration is just fashionable, we think that in the pedagogic domain it is still ill represented. And our methodology intends to achieve an effective integration between Language and Mathematics with the students being an active part in the construction of tasks and of their own knowledge.

Creativity

Van Harpen and Sriraman (2013) refer that creativity is seen has a major component of education and a buzzword of the twenty-first century. Research on creativity specifically in mathematics is sparse, according to Leikin et al. (2010). Mann (2006) points to the lack of a consistent definition of creativity.

To Guilford (1967) the creative process is based on the combination of convergent thinking, that involves aiming for a single, correct solution to a problem, and divergent thinking, that involves generation of multiple answers to a problem or phenomenon. An operative definition of creativity based on four related components is suggested by Torrance (1974): fluency, flexibility, novelty, and elaboration. *Fluency* is the continuity of ideas, flow of associations, and use of basic and universal knowledge. *Flexibility* is associated with changing ideas, approaching a problem in various ways, and producing a variety of solutions. *Originality* is characterized by a unique way of thinking and unique products of mental or artistic activity. *Elaboration* refers to the ability to describe, illuminate, and generalize ideas. As creativity is usually viewed as a process that leads to generation of original ideas, the originality component is commonly acknowledged as the main component of creativity.

Cropley (2006) shows another view of the combination of convergent and divergent thinking. For this author, creative thinking involves two main components: "generation of novelty (via divergent thinking) and evaluation of the novelty (via convergent thinking)" (p. 391). At the same time, convergent thinking knowledge is of particular importance as a source of ideas, pathways to solutions, and criteria of effectiveness and novelty.

Problems, problem posing and creativity

Kantowsky (1977) points to the difficulty in defining problem, since what is a problem for some may be an exercise for others or even a known fact for yet others. In the same direction goes Schoenfeld (1985) who stresses the relativity of the notion.

Mayer (1992) considers that we face a problem when we have an objective but we do not have immediate access to the solution, because we are facing an obstacle. Mayer (2002) adds to it that mathematical problem solving is the problem solving when a mathematical content is present, explicitly or implicitly. This definition by Mayer is compatible with Polya (1965), for whom solving a problem is to find a path out of a difficulty, a way to contour an obstacle, to pursue an objective that is not immediately achievable.

Vale e Pimentel (2004) point the difficulty in defining what is a problem. They also refer that many terms have lately appeared, to some authors they are synonyms of problem and for others aren't. The word “problem” can mean a task or a project, an activity or an investigation. In our case, the word “problem” assumes an open character in which students can use a wide range of solving processes and where they investigate to reach the solution. The authors refer to the international recommendations that value the complex mathematical processes and students creativity, stressing that non-routine activity converge in this way. According to this, they consider crucial the selection of exploratory and investigative problems that allow challenges to all students, so that they can formulate hypotheses, verify conjectures and promote debate in the resolution.

We finally used Palhares (1997) definition of problem: a problem is constituted by information on an initial situation and on the final situation that is required, or on the transformation that is required; there is an obstacle for a certain class of individuals that implies the use of some kind of reasoning to get a solution by their own means (or one solution, or the certainty that there is no solution); the class of individuals for whom there is an obstacle have to apply one or more strategies; there can be no indication on which strategy to use.

We agree with the definition of problem posing by Gonldenberg and Walter (2003) in which they refer that it is simultaneously a tool to teach mathematics through problem solving and a part of the learning. They say that for students the process of posing their own problems helps develop the ability to solve problems and to understand the implicit mathematical ideas. For Mann (2006) solutions to real problems also entail problem finding, as well as problem solving. Kilpatrick (1987) described problem posing as a neglected but essential means of mathematical instruction. The author emphasize that students need the opportunity to design and answer their own problems.

Krulik and Rudnick (1993) corroborate the essence of problem stories, because students gain experience in creating their own problems and these become increasingly sophisticated. They defend that problem solving and reasoning should go beyond what appears in textbooks. To develop students into thinking subjects, we should confront them with situations that require resourcefulness, creativity and imagination.

Jay and Perkins (1997) state that “*the act of finding and formulating a problem is a key aspect of creative thinking and creative performance in many fields, an act that is distinct from and perhaps more important than problem solving*” (p. 257).

Ervynck (1991) identified three different levels of creativity: first - contains an algorithmic solution to a problem; second - involves modeling a situation and may include solving a word problem with a graph or a linear diagram; third - employs sophisticated methods usually based on assumptions embedded in the problem, and makes use of the problem’s internal structure and insight. Since categorisation of types of solutions according to the levels of creativity suggested by the author is based on the connection between the solutions and solver's previous mathematical experiences, this categorization fits the definition of relative creativity, in general, and of originality, in particular.

Leung and Silver (1997) claim that both problem solving and problem posing are important aspects of mathematical creativity. However, Van Harpen and Sriraman (2013) consider that problem posing is also the least understood and most overlooked part of mathematical creativity, as there aren't many studies that have investigated the relationship between mathematical creativity, in the form of problem posing, and mathematical achievement, ability and/or knowledge.

METHODOLOGY APPLIED

After Sardinha (2005), we have created a specific methodology, divided in two moments, and these moments divided in three phases, and in each phase pursuing different goals for both areas, always respecting the interdisciplinary approach.

In the first year, we chose a group of five 7-years old students on their 2nd year of school (group A). In the second year, we analyzed four elements of the group A, in their 3rd year of school, and also another group (group B), a four students group of 8-years old average in their 3rd year of school, experiencing this method for the first time. Introducing a new group, we intended to compare the results of their work, in the field of posing and solving problems and in the creativity of the problem stories and their proficiency in the use of the language. Group A had contact with problems stories in the first year of the study and group B never experienced them before.

The elements of the groups were chosen according to the will of the students in participate in the study and according to the will of their parents since we did the activities in extracurricular time.

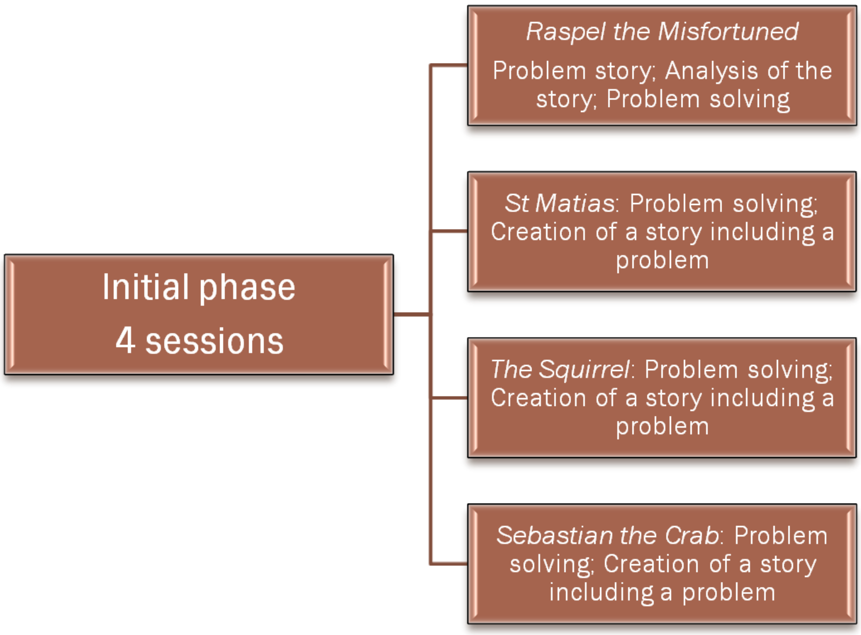
Data was collected in a natural context and we did a direct and participative observation. We used video recordings, analyzed the contents of their stories and the way they solved and posed problems and we also did interviews.

In the initial phase, in three sessions, we worked with non-routine problems, the expansion of problems statements and also the macro-textual analysis of stories.

The first activity proposed was the problem story "Raspel the misfortunate" constructed around the well known problem of the wolf, goat and cabbage. It was a story about a gnome, with a lot of bad luck, who needed to find the wish-tree to end his misfortune. In his adventure he was always with a goat, a cabbage and a wolf. At some point of the voyage he came across a river and a problem arose, how could he cross the river to get to the tree if he only had a boat with two places? Apart from this, if they were left alone, the goat would eat the cabbage and the wolf would eat the goat. How many trips must he do to cross to the other side? In the second and third activities we posed the problems: "Riddle of St. Mathias" (When I was going to St. Mathias I met a boy with seven aunts. Each aunt had seven bags and each bag had seven cats and each cat had seven kittens. Kittens, cats, bags and aunts how many of them were going to St. Mathias?); "The Squirrel" (A box has nine cabbage eyes. The squirrel leaves with three eyes per day, however he takes nine days to transport all the cabbage eyes. How do you explain this fact?); “Sebastian the Crab” (Sebastian the crab decided to go to the beach. He was in the sea, twenty meters off the beach. Each day, he walks four meters towards the beach. But at night, while he rests, the tide throws him back two meters. How many days will it take him to get to the beach?). We asked them to create a story including the problems we used.

In the development phase, in two sessions, we created a version of the Snow White Story, in which she is a participant narrator. In this phase, from the traditional story, pupils had to pose coherent problems with it.

In the final phase, in two sessions, students had to create a story and formulate coherent problems with the story. This methodology was used with group A.



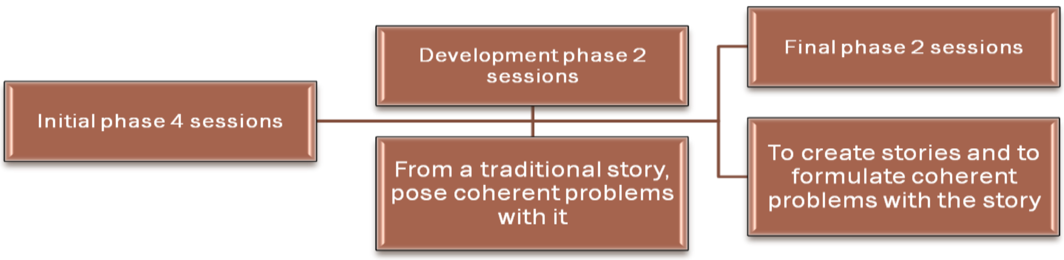


Figure 1. Scheme of the method used with the 2nd year of schooling students.

In the second moment, second year of the study, we introduced a few changes. Group B started its participation in this study without the contact with problem stories that group A experienced. We posed new problems: “Indians paths” (The chiefs of the

Indian tribes of Sioux, Oglala, Comanche, Apache, Mescaleros and Navajos gathered for a big Pow-Wow (it's how the Indians call their meetings). In the top of the hill, they put their tents making a circle. Each tent had a path to the others. How many paths were there?), "Jealous boyfriends" (Two couples of jealous boyfriends, John and Joana, Antony and Antonia, wanted to cross a river where there was a little boat. This boat took only two persons. The problem was that the boys were so jealous that they would not leave their girlfriends with the other boy, even if the others girlfriend was there. How could they do to cross the river?), and "The thinker" (André thought of a number. Then he multiplied it by two. After that he subtracted five. The result was thirteen. Which number was it?). Later we asked again for the creation of a story including problems used. In the development phase, in two sessions, students had to create their own story and formulate coherent problems with the story, like group A had already made in the first moment. In the final phase, two sessions, we asked both groups to rewrite the story, students should reflect about their work for improvement, correcting and enrichment of the problem story. So, group A just had to apply their knowledge and strategies acquired in the first year and group B had to perform the same work without any previous contact with problem stories. We intended to identify possible qualitative differences in their work in the problem posing and in the creation of problem stories.

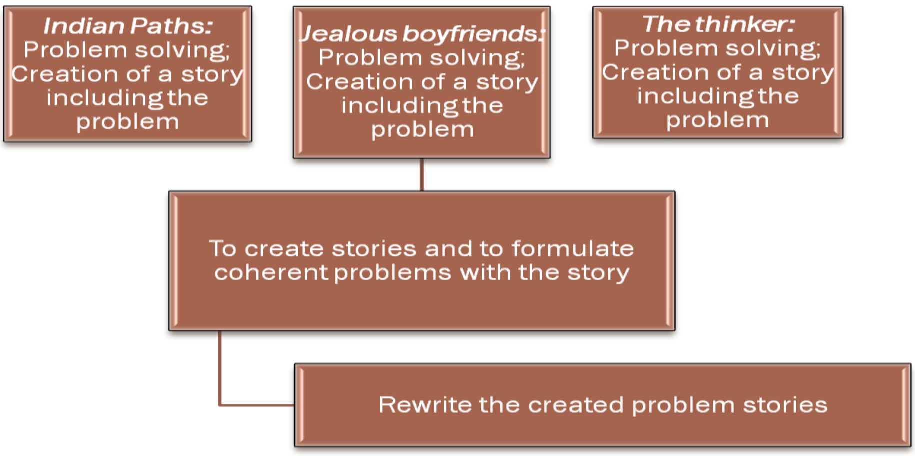


Figure 2. Scheme of the method in the second moment

ANALYSIS OF THE PROBLEM POSING

The first problem the students had to formulate was about the distance White Snow had to walk from the castle to the dwarfs' house. Students revealed difficulties expressing their ideas, so the teacher had to help them.

Teacher: So we can write a problem on measurement, using what?

Bernard: Kilometres.

Teacher: Didn't you solve a similar problem?

Bernard: Yes, we did, the turtle, how many hours did she get to arrive.

During the formulation of the problem, students chose re-contextualization of a previous problem, yet revealed difficulties in justifying why Snow White backed off in the course from her father to the dwarfs' house.

Bernard: She was a sleepwalker, she missed her daddy and slipped just a little and then perhaps it's better to think it better…

Students: Left my father's house…

Anthony: That was twenty kilometres from this one. Every day I walked 4 Km. and ay night?

Bernard: How was it? She missed her father, she was sleepwalker…

Four elements of the group drew a line with 20cm representing the 20 Km and signalled in one side what she was walking during daytime and in the other what slipped back at night and then counting. The fifth element observed that she only walked three km per day

The fifth element, observing that White Snow only made 3 km per day, added successively until reached 21, and then counted how many additions were.

Students have shown difficulties in identifying opportunities to create problems as well as in reasoning mathematically, and the formulation allowed for the students to reflect on aspects of real life, like time to travel in bus and so on.

Bernard: Kilometres!

Anthony: Kilometres!

Teacher: And how many km did they travel per hour?

Bernard: Per hour?

Teacher: You have to say it otherwise how can we know?

Bernard: Five!

Ann: Five!

Bernard: It is to get there quickly.

Teacher: Usually how many km per hour?

Several: Hundred!?

Bernard: Yes it is one hundred, yes.

Then students formulated a problem on this basis.

Teacher: How much did they travel per hour?

Daniel : One hundred km.

Teacher: Every hour they travelled 100km. and what do we want to know?

Anthony: How many km did they…

Teacher: “on a certain day the four friends went on a school study trip to the Lisbon Zoo, they left school at eight fifteen and arrived there at eleven, they travelled 100km every hour how many km did they have to travel to…

Anthony: …to get there.

Teacher: …to get there.

When solving the problem formulated, students showed many difficulties measuring the duration of the trip, and in general working with time measurements. The worst bit was working with the quarter of an hour and the distance travelled in that period of time.

To illustrate the work done, we transcribed the problem story analysed and the resolution of the problems posed by the pupils that shows how they have to be creative in the process of solving their own problems.

Problem story: An adventure in the Zoo

Once upon a time there were four friend called Daniel, Anthony, Bernard and Ann. They all studied in the same school and Anthony and Bernard were cousins. They got themselves in lots of troubles mainly because they were very curious.

One day, the four friends went in a school trip to the Lisbon Zoo. They left school at 8h15m and arrive there at eleven. Each hour they travelled one hundred kilometres. How many kilometres they made to arrive to their final destination? (1)

Upon arrival, they went to see the cages that sheltered the wild animals; they saw elephants, lions, tigers, monkeys, giraffes and many more.

In the end of the tour the four friends made a picnic with their classmates, when they saw two men loading animals in to a truck. Each man carried a cage with four baby monkeys and each one made seven trips. (2)

The four friends decide to investigate, first they went to the guide that lead them on the trip and asked him:

- Mister Manuel, do you know that men that were carrying the baby monkeys?

- Yes, I know them, they are the animal handlers!

Daniel, Anthony, Bernard and Ann didn't believe the guide and decided to spy him and the other men. They went to the back of the truck and saw the guide talking with the other two men.

- Look out, there is a bunch of kids suspecting of us.

- Let's get out of here the faster we can. - Said one of the men.

They left behind the truck, before any of the three men saw them. Then they joined their class. Meanwhile, Bernard called the police station and told them what happened.

Fifteen minutes later, the police arrived in three cars and in each car there were three policemen that arrested the three men.

- In how many ways can the policemen carry the bandits? (3)

Their classmates started thinking in the problem, meanwhile, the teacher call them to get back to the bus.

And this way ended another adventure of these four friends.

Sardinha (2011), Group A, 2nd year of primary school

Resolution of the 1st problem posed

In the resolution of this problem, students have shown difficulties in calculating the distance of the trip due to the fact that it started at a quarter past eight and not at an exact hour. They also showed difficulties in relating one hour with half an hour and quarter of an hour. The teacher had to ask them to draw a watch so that they could represent and count the minutes. This strategy helped them to overcome their first difficulties. And they were able to calculate that they travelled for two hours and forty five minutes. But then they had to calculate how many kilometers they travelled, easily they realized that if in one hour they travelled one hundred kilometers, in two hours they would travel two hundred kilometers. In this moment a new problem arose since they experienced difficulties calculating the kilometers travelled in forty-five minutes. Once again, the watch was fundamental in this task, the teacher explored the division of the unit in equal parts and the representation of these quantities in the drawing. The goal was that students identified the concept of half, third part and quarter part and made connections between the kilometers travelled in an hour, half an hour and a quarter of an hour, so that they could finally reach the forty five minutes.

The students easily calculated the distance travelled in a half an hour but showed a lot of difficulties finding the distance travelled in a quarter of an hour. Only one student solved the problem without showing too many difficulties, while the others needed the help of the teacher to understand the reasoning in order to reach the solution.

As they do this, they also get more creative in the way they solve their own posed problems because, most of times, they don't have mathematical formal knowledge to solve what they pose. So, they have to apply their informal and formal mathematical knowledge in a creative way, during the process of verification, solving the problem they posed, to get to the solution allowing them to verify if the problem is correctly posed.

IMPLICATIONS OF THE WORK ON DIFFERENT COMMUNITIES

The work developed during these years has progressively permitted more knowledge and it peaked with the teacher training course and the creation of stories in the teachers' fourteen classes. It is interesting and important to stress that students were creating stories with problems that were intended to other students, which was part of the motivation.

During the construction of the problem stories, students have created tasks and tested them. They had to verify if the problems formulated had to be re-structured, so they had to solve them and use metacognitive strategies to recognize errors committed, and trying to overcome those errors. All the work was previously developed in a research setting but in the teacher training phase the task creation was performed in a more realistic setting. Students have shown real interest with the problem posing and solving, establishing an ownership relation with the work produced. We tried to convince teachers of the students' ability to develop significant mathematical tasks, sometimes with a degree of difficulty superior to the textbooks. At the same time, students developed their mathematical communication skills when presenting their work, the errors committed and the strategies used to overcome difficulties.

CONCLUSIONS

The set of tasks assembled by us, which constitutes the core of the methodology presented, permits that each teacher may create his or her tasks as long as some basic aspects are respected, concerning the type of tasks and the type of text created to involve the problem. At first students must contact with a story with a non-routine problem that may enlarge their encyclopaedic competency and their creativity. The teacher must be participant at the beginning, retreating to a more supervision role with time.

Problem stories permit students to, after experiencing the tasks proposed in the implementation of this methodology, create their own mathematical tasks. In the process, students develop literacy and numeracy competencies, metacognitive strategies, creativity and friendly relations with these two important areas of the curriculum. The fact that students have a very active role induces extra motivation and implies some reflection on their own learning. Sharing their problem stories with peers either from the class or the school invites to more sophistication and accrued difficulty on their subsequent creations. They resort to their literacy competences to try to mislead future solvers as a way to make problems more difficult.

From the adaptation of traditional stories, in which students vocabulary is enriched with teacher's help, students use their inter-textual reference frameworks not only to interpret texts but also to formulate problems. Students should formulate problems coherent with the story plot, and initially they probably use the recontextualization of problems solved previously but progressively they will tend to develop autonomy and will formulate their own problems. At the end, the opportunity to create problem stories allows them to create their own mathematical tasks, mobilizing the knowledge and competencies acquired in the process enhancing their creativity.

REFERENCES

Azevedo, F. (2009). Literacias: contextos e práticas [Literacies: contexts and practices]. In F. Azevedo, & M. G. Sardinha, *Modelos e práticas em literacia [Models and practices in literacy*] (pp.1-16). Lisboa: Lidel.

Bush, W. S., & Fiala, A. (1993). Problem stories - A new twist on problem posing. In S. I. Brown e M. Walter, *Problem Posing - Reflections and Applications* (pp.167-173). New Jersey: Lawrence Erlbaum Associates.

Cropley, A. (2006). In Praise of Convergent Thinking. *Creativity Research Journal*, *18*(3), 391–404.

Ervynck, G. (1991). Mathematical creativity. In D. Tall (Ed.), *Advanced mathematical thinking* (pp. 42–53). Dordrecht, Netherlands: Kluwer.

Evans, C. W., Leija, A. J., & Falkner, T. R. (2001). *Math Links – Teaching the NCTM 2000 standards through children's literature*. Colorado: Teacher Ideas Press.

Goldenberg, E. P., & Walter, M. I. (2003). Problem posing as a tool for teaching mathematics. In H. L. Schoen (Ed.), *Teaching mathematics through problem solving: Grades 6 – 12* (pp.69-84). Reston, VA: National Council of Teachers of Mathematics.

Guilford, J. P. (1967). *The nature of human intelligence*. McGraw-Hill: New York.

Jay, E. S., & Perkins, D. N. (1997). Problem finding: The search for mechanism. In M. A. Runco (Ed.), *The creativity research handbook* (Vol. 1, pp. 257–293). Cresskill, NJ: Hampton Press.

Kantowsky, M. G. (1977). Processes involved in mathematical problem solving. *Journal for Research in Mathematics Education*, 8, 163-180.

Kilpatrick, J. (1987). Problem formulating: Where do good problems come from? In A. H. Schoenfeld (Ed.), *Cognitive science and mathematics education* (pp. 123–148). Mahwah, NJ: Lawrence Erlbaum.

Krulik, S., & Rudnick, J. (1993). *Reasoning and problem solving - a handbook for elementary school teachers.* Massachusetts: Allyn and Bacon.

Leikin, R., Berman, A., & Koichu, B. (2010). *Creativity in mathematics and the education of gifted students.* Rotterdam: Sense Publishers.

Leung, S., & Silver, E. (1997). The role of task format, mathematics knowledge,and creativethinking on the arithmetic problem posing of propspective elementary school teachers. *Mathematics Education Research Journal*, 9(1), 5-24.

Love, E., & Mason, J. (1992). *Teaching mathematics: action and awareness*. Southampton: Open University.

Mann, E. L. (2006). Creativity: The essence of mathematics. *Journal for the Education of the Gifted*, 30, 236–262.

Mayer, R. E. (1992). *Thinking, problem solving, cognition*. New York: Cambridge University.

Mayer, R. E. (2002). Mathematical Problem Solving. In Royer, J.M. (Ed.) *Mathematical Cognition* (pp.69-92). Connecticut: Age Publishing.

Palhares, P. (1997). Histórias com problemas construídas por futuros professores de matemática [Stories with problems constructed by future mathematics teachers]. In D. Fernandes, F. Lester, A. Borralho, & I. Vale, *Resolução de problemas na formação inicial de professores de matemática - múltiplos contextos e perspectivas [Problem solving in the initial formation of mathematics teachers – multiple contexts and perspectives]* (pp.159-188). Aveiro: GIRP.

Polya, G. (1965). *Mathematical discovery, Volume II: On understanding, learning and teaching problem solving.* New York: Wiley.

Sardinha, M. F. (2005). *Histórias com Problemas – Uma Forma de Educar para a Numeracia e para a Literacia [Stories with problems – a way to educate for numeracy and literacy]*. Tese de mestrado em Estudos da Criança – Área de Especialização em Ensino e Aprendizagem da Matemática, Braga: Universidade do Minho.

Sardinha, F. (2011). *Histórias com Problemas e a sua ligação à promoção da numeracia e da literacia no 1.º Ciclo do Ensino Básico [Stories with problems and their connection to numeracy and literacy in the 1st cycle of Basic Teaching]*. Tese de doutoramento em Estudos da Criança – Especialidade de matemática elementar, Braga: Universidade do Minho.

Torrance, E. P. (1974). *Torrance tests of creative thinking*. Bensenville, IL: Scholastic Testing Service.

Vale, I. e Pimentel, T. (2004). Resolução de Problemas. In P. Palhares (Org.), *Elementos de Matemática para professores do Ensino Básico* (pp. 7-52). Lisboa: Lidel.

Van Harpen, X. Y., & Sriraman, B. (2013). Creativity and mathematical problem posing: An analysis of high school students' mathematical problem posing in China and the USA. *Educational Studies in Mathematics*, 82(2), 201–221.