# Mathematics and Children's Literature Linked by E-Books

**Helena Camposa**
*Universidade de Trás-os-Montes e Alto Douro, UTAD, Quinta de Prados, 5000-801, Vila Real, Portugal, a CIDTFF - Research Centre of Didactics and Technology in Education of Trainers, (LabDCT of UTAD)*
*hcampos@utad.pt (corresponding author)*

**Eurídice Teixeira**
*Universidade de Trás-os-Montes e Alto Douro, UTAD, Quinta de Prados, 5000-801, Vila Real, Portugal, a CIDTFF - Research Centre of Didactics and Technology in Education of Trainers (LabDCT of UTAD)*
*euridiceteixeira88@gmail.com*

**Paula Catarinoa**
*Universidade de Trás-os-Montes e Alto Douro, UTAD, Quinta de Prados, 5000-801, Vila Real, Portugal, a CIDTFF - Research Centre of Didactics and Technology in Education of Trainers (LabDCT of UTAD)*
*pcatarin@utad.pt - pcatarino23@gmail.com*

## ABSTRACT
As a link between Mathematics and children's literature, the *e*-book emerges from the need to enrich the teaching and learning of mathematics through the use of content which illustrations are made by children from stories included in children's literature. In this paper we describe some educational experiments with some connection of these two areas that was implemented in Teacher Training with eight/nine years old pupils. The entire process of building an *e*-book created great enthusiasm in these students and motivated us to further develop this work. Throughout this educational experiment, children had always been available to do what they were asked with moments of great participation, as well as in the final discussions. With this educational experience we were able to build bridges with technology enhancing the learning of mathematics through imagination.

## INTRODUCTION
Mathematics is a fundamental component of an individual's education, taking on a significant role in their growth as free, critical autonomous citizens from kindergarten until the end of high school. A child is a curious and interested being, so it essential to explore these two aspects in tasks implemented in the classroom from the beginning of school life (Boavida, Paiva, Cebola, Vale, & Pimentel, 2008). In the last few years there have been some less encouraging results in regards to the learning of Mathematics and, therefore, the students' hardships become evident, both in national assessment tests (Ponte, 2004) and international studies (OECD, 2013). Within this context, Mathematics is considered a difficult subject by the majority of students and almost inaccessible for many Portuguese students.

In an attempt to minimize the problem created around Mathematics, the educational community, and, in particular, the Mathematics' teachers try to understand how the students, at this early age, deal with mathematical concepts, establishing connections between Mathematics and their daily life. Evidently, this being a generation of digital natives, it is fundamental to create bonds between children and Mathematics through the use of technology. In fact, curiosity and a natural desire for using gadgets and software is transversal to all children regardless of the socio-economical background (Costa, 2007). In addition, while aiming to motivate students to study Mathematics through a method different from the traditional one, in this article we present an alternative way to bring mathematical concepts closer to children, by using children's literature as a starting point. In fact, the fast motivation and increased enthusiasm demonstrated by the students who participated in this teaching experiment have led us to propose the illustration of children's stories, leading to creating e-book comics, to be used in subsequent tasks focusing on mathematical questions.

In the next section of this article we focus on the theoretical contextualization, both in regards to the importance of children's literature in children's education in this age group (between eight and nine years old), as well as to the teaching and learning of mathematical concepts using stories written specifically for children, which the children themselves illustrated and adapted into e-books. In the next section we describe the teaching experiment developed and the methodology adopted, including some tasks which were implemented. Finally, we present some final considerations on this experiment.

## THEORETICAL CONTEXTUALIZATION

From an empirical perspective, traditional teaching sees the student as a passive being (Palhares, & Azevedo, 2010), in which the role of the teacher is to transmit knowledge and the student to receive it without questioning and without participating in its construction. On the other hand, from the constructivist point of view, the student is considered autonomous and the main actor of its own development and learning (see for example , Phillips, 2000; Simons, van der Linden, & Duffy, 2000). Another important difference between the two models is the fact that in the traditional one the content is delivered without associations within Mathematics, as well as with other subjects in the school's curriculum, while constructivist teaching actively promotes interdisciplinary teaching.

Some of the topics that worry teachers and researchers, from kindergarten until university, include the advantages of using children's literature to introduce or consolidate mathematical concepts (Cotti, & Schiro, 2004; Hong, 1996), as well as students' behaviour and attitudes when digital texts are adopted (Noorhidawati, & Gibb, 2008, 2008a; Noor, Embong, & Abdullah, 2012; Shalter, 2008; Weisberg, 2011).

This article focuses on the connection between children's literature and Mathematics, by using comic style e-books created by the students, which are later explored in classroom tasks where mathematical concepts are introduced or consolidated. Despite this being a recurring topic in multiple international studies (Baily, 2006; Malathi, & Rohani, 2010; Noorhidawati, & Gibb, 2008; Woody, Daniel, & Baker, 2010; Noor et al., 2012), this teaching strategy is something completely new in Portugal.

### Children's literature in education

When children go into kindergarten they already bring some knowledge acquired throughout their development, which is intimately tied with their daily family life and based on their mother tongue. In fact, each individual's learning does not start or ends in school and this has to be able to provide him/her with enriching experiences in all fields of knowledge, while obviously developing their ability to express themselves in their mother tongue, be it orally or written.

The child's natural language is the instrument that allows each individual to access knowledge and it is present in the textbooks adopted by schools, this being the main means of communication between students and teacher.

Reading children's stories in the classroom allows for moments of discussion in which children feel motivated and encouraged to actively participate in the construction of their own development (Rodrigues, 2008).

By combining children's stories with other parts of the school curriculum, the teacher can create favourable environments for the child's imagination, promoting the introduction of new concepts, the consolidation of previous studies or the construction of mental representations with use of materials they can manipulate (Mink, & Fraser, 2005).

It is also important to highlight the children's desire in the age group included in this article, between eight and nine years old, to illustrate the stories they have read or heard, or to transform them into comic books. The choice of colours and the portrayal of the characters can also be a possible way to detect family or social problems, as well as conflicts with classmates or even cases of bullying in school (Anning, & Ring, 2004; Einarsdottir, Dockett, & Perry, 2009).

### Learning mathematical concepts based on children's stories

Learning depends primarily on the ability to construct bridges between previously acquired knowledge and the different contents of the various subjects of the school curriculum (Menezes, 2011), in order to create and develop new learning experiences that are intended to be significant.

In the specific case of Mathematics, the connections can be intrinsic by being established between different contents within this scientific area, but also extrinsic by combining Mathematics and the children's day-to-day activities, or Mathematics and the other knowledge fields, but having the learning of mathematical concepts as the main object.

The use of children's stories, whether original ones or adapted to Mathematics, is a strategy implemented in education in general and the teaching of Mathematics in studies in several countries, including Portugal (Menezes, Rodrigues, Ferraz, & Martins, 2009). Nevertheless, society still considers children's literature and Mathematics as two diametrically opposed fields, in a way justifying the lack of children's stories adapted to Mathematics-related topics. However, the underlying characteristics of children's stories can constitute a starting point and the motivation for learning mathematical concepts (Boavida et al., 2008). In fact, when children

analyse a text of a tale or a legend they recognize the relationship between the elements of the story and mathematical concepts, immediately associating what they already assimilated with something that is completely new.

Children's stories do not necessarily need to have explicit mathematical contents, but if the teacher intends to use them as a teaching resource, he/she should first and foremost choose one that is related to the students' interests. Then, he/she should model the text and its information, creating tasks that grab their attention and generate enthusiasm in their students, in order to achieve the specific aims of developing the students' mathematical reasoning.

When establishing this relation between Mathematics and friendly literature, the teacher stimulates the children's imagination, allowing them to reconstruct reality in order to find the meaning of mathematical concepts. In fact, children's stories belong in an imaginary world which perfectly portrays ideal situations that could happen in their daily lives, allowing the child to compare reality with the imaginary (Postic, 1992), as well as establishing bridges between their daily lives and the meaning behind mathematical concepts.

**Using e-books in the classroom**

Nowadays technology is an integral, practically indispensable part of the daily life of every person anywhere in the world, and school cannot ignore that fact. One of the main goals of using technology in schools, and specifically in teaching and learning Mathematics, lies in the possible changes that may occur in students' motivation, enthusiasm and dedication regarding tasks of mathematical nature (Hoyles, & Lagrange, 2010).

Regardless of their socio-economic background, from an early age children show more interest in handling mobile phones, tablets, computers, consoles, which all come with a variety of software. This way, these devices grant students with the opportunity to experiment with new way of learning and interacting with the world around them, acquiring the autonomy to navigate the internet with the available tools (Costa, 2007).

An e-book is a book in digital format, which is presented like the printed edition; it is easy to read on a laptop, tablet or even a smartphone. However, the digital edition can have elements that make its reading even more alluring, such as having interactive images or including links that lead to other books, editions or websites. Note as well that it is physically impossible to transport hundreds of books. This way, by permitting the use of tablets, smart phones or computers in class, the teacher allows his/her students to access several e-books, enabling students to acquire new skills and more arguments that will contribute to better- informed and enriching discussions from the educational point of view (JISC Observatory, 2012).

This digital format is more frequently used by adults; however, according to Noor and others (2012, p.183), the e-book "has become more popular and now attracts younger users especially students". There are several studies on the use of e-book in classrooms, although most are in the context of secondary school (see for example: Baily, 2006; Malathi, & Rohani, 2010). In specialized literature we find a study on the students' perceptions through the use of e-books in pre-university education (Noorhidawati, & Gibb, 2008a) and also a study of the factors which influence the preference for e-books or not (Woody et al., 2010). Nevertheless, the use of books in this format is already being studied in some primary schools (Noor et al., 2012).

With the implementation of project *LER: Plano Nacional de Leitura* (http://www.planonacionaldeleitura.gov.pt/index1.php), which aims to encourage Portuguese students to read more frequently, books are also made available in digital format and, therefore, Portuguese children are becoming more familiarised with e-books. Our study focused on the students creating the illustrations for some of those e-books, which in turn would become a comic e-book. Based on those illustrations, the teacher created and implemented activities focusing on mathematical concepts. In a later stage, the idea of adapting children's stories in order to explicitly include mathematical concepts was also considered.

Creating an e-book is very easy, even for eight or nine year old students, like the ones in our study; all that is needed is a *Word* document, where the children's drawings are added after being digitalized and then the document needs to be converted to *PDF* (Portable Document Format). However, in case something more appealing is required, with interactive images and the introduction of voice or music, we can always use one the several software programmes available online, most of which are freeware, as long as the document does not exceed 10 pages. Evidently, with the free trials it is not possible to create e-books with many pages, but the objective was to allow the children to have an innovative experience and not to sell their work. In this case, free trial software can be used in the construction of the e-books, such as the ones found at http://flippingbook.com/ or http://pt.flipbuilder.com/.

**EDUCATIONAL EXPERIMENTS IN THE CLASSROOM**

This article describes a teaching experiment conducted in a primary school in the North of Portugal, with students ranging from eight to nine years old. The methodology used was quantitative and interpretive (Stake, 1995). The mathematical concepts are found within the theme "Geometry and Measurement" of the Primary Education Mathematics Programme (Ponte et al., 2007), while the implemented tasks of exploring and researching (Ponte, 2004) focused on concepts of volume, area, length, spatial orientation, plane figures and geometric solids.

The class consisted of 25 students, 10 male and 15 females, 11 of which attended the 4th grade and the rest attended the 3rd grade. Since it had been detected that most students had difficulties in both Mathematics and Portuguese, it was considered appropriate to develop strategies involving both subjects, while implementing cooperative tasks in small groups. At the same time, we tried to encourage these students to overcome their problems in these two areas, presenting them with challenging and innovative exercises requiring complete focus, thus reaching the initial aims.

Firstly, they analysed two children's stories from the National Reading Plan, *"Florinda das sete chaves"* and *"História aos quadradinhos"* (Torrado, 2012), with the goal of introducing children's literature to Mathematics teaching and learning.

Simultaneously, students were involved in a research project of gathering and classifying aromatic herbs, much appreciated in Portuguese gastronomy, some of which they planted and watched grow in a specific locations of the school. The project culminated in the creation of an e-book where students participated by photographing the planted herbs, or searching the internet for the ones they were not able to watch grow, and the inclusion of small explanatory texts, ending with the presentation of the material gathered in the format of an e- book. This work methodology created a great deal of motivation, enthusiasm and dedication towards the project among the children, especially in regards to the e-book which they showed off with pride.

At the same time, we were informed of the visit by children's book author José Braga-Amaral, whose books include *"Segredos da Constança"* (Braga-Amaral, 2012), which is part of the National Reading Plan and includes 10 children's stories. Since the students initiated an educational approach to comic books, the school decided to surprise the author by providing him with a gift of a comic e-book based on his book's stories, created by the students' illustrations.

Firstly, the teacher read each story once out loud for the class and they all debated its context in open class. Then, students were divided into heterogeneous pairs and each was assigned a story to convert into a comic by sing their own drawings. After this phase, the comics were collect and the creation of the e-book was started, a process already familiar to the students. Note that whenever a setback occurred the teacher would guide or suggest a new process. Before they finished this project, the students were told about the e-book offering to the author and that it would be preceded by a public presentation in a party where several elements of the educational community would be present, an idea that was met with great enthusiasm. We can see on [Image 1] an example of some of the e-books pages, with some illustrations of the comic created by the students about the story *"A princesa mata-moscas"*.

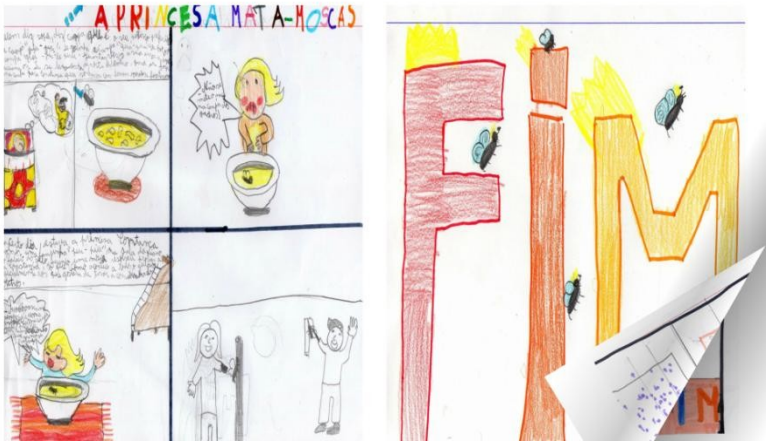


**Image 1**: A few pages from the comic e-book created by the students (Story: *A princesa mata-moscas*)

Surprisingly, the drawings showed several shapes and geometric objects, which allowed us to use these drawing in exercises where the aim focused on mathematical topics, but at the same time were an interesting connection between children's literature and Mathematics. In this context, we now present some examples of the tasks implemented in this class. Note that for each one we present some elements: the title of the task; a brief description of the topic, including the mathematical content and the objectives we tried the students to reach; the material used; and a brief summary of how the teacher managed the class while the tasks were underway, as well as how the students committed to the activities built upon the given situations.

Note that the first two tasks refer to connecting children's literature and Mathematics, which consists of the first approach to the theme. The last two were implemented after the students had finished the e-book presented to the writer José Braga-Amaral by the school. These tasks were produced and planned based on the comic e-book created by the students, which motivated a great deal of enthusiasm in the children as they felt their work had been validated in some way.

**Task 1: *Florinda das sete chaves***
*Task overview*: exercise to consolidate previous knowledge; Planar Euclidian geometry or in 3-D space; area and volume measurement.

*Material resources*: the children's story *"Florinda das sete chaves"* (Torrado, 2012); writing material; squared paper; ink and polystyrene sheets.

*Development*: after reading and interpreting the story, the teacher handed out a worksheet with questions guiding the students towards the construction of *Florinda*'s house plan, identifying plane geometric figures and calculating the area of the house plan. After they successfully finished this exercise, the previously divided students built a replica of *Florinda*'s house with polystyrene sheets, painted the interior and exterior walls, and the roof, all of which was removable in order to see the inside. After they mounted all the pieces and built the 3-D representation of house mentioned in the story (see [Image 2]).

**Image 2**: Part of Florinda's house built by the students

*Educational objectives*: in the end of the exercise the students should be able to: identify geometric shapes, plane or 3-D; define and differentiate the concepts of area and volume; identify the measurement units for area and volume and finally calculate and compare the area and volume measurements.

**Task 2*: História aos quadradinhos***
*Task overview*: exercise to consolidate previous knowledge; planar our 3-D Euclidian geometry; perimeter measurement, area measurement and volume measurement.

*Material resources*: the children's story "História *aos quadradinhos*" (Torrado, 2012); writing material; scissors, A4 sheets of paper; ink and polystyrene sheets.

*Development:* after reading and interpreting the story, the teacher handed out worksheets with questions based on the discussion between the story's heroes: a square and a triangle. At the same time, with the purpose of solving the problems, the students had to show through bends and cuts if the characters' statements throughout the discussion were true or not by using an A4 sheet of paper. On the other hand, the students were confronted with questions like: how do you calculate the area of a square? What if it is a triangle? What is the perimeter of a plane geometric shape? How do you determine the value of the perimeter? What other geometric shapes do you

identify in the story? What geometric solids do you find in the story? What is the relationship between them? Finally the students finished the exercise by building a model as seen on [Image 3].

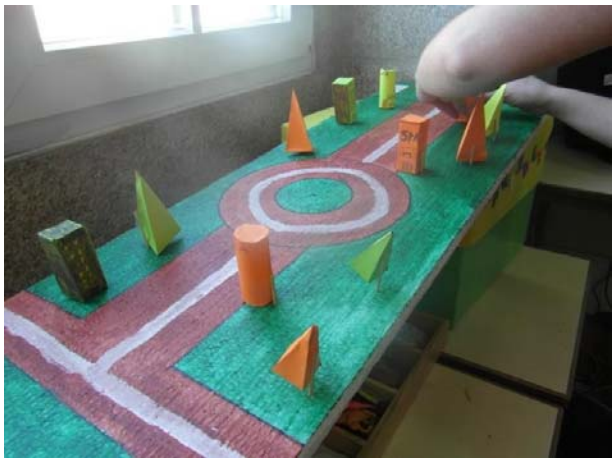

**Image 3**: Model with geometric solids build by the participants in the study.

*Educational objectives*: in the end of the exercise the students should be able to: construct models of plane figures and geometric solids from A4 sheets of paper, distinguish between terminology related to geometric plane shapes and geometric solids; identify plane and solid geometric shapes: define and distinguish the concepts of perimeter, area and volume; calculate perimeter measurements, area measurements and volume measurements.

**Task 3: *O pássaro com asas de sobrancelha***
T*ask overview:* exercise to consolidate previous knowledge; plane shapes and geometric solids.

*Material resources*: the children's story "*O pássaro com asas de sobrancelha*" included in the comic e-book created by the students; writing material, scissors and glue.

*Development*: the teacher handed out worksheets to each student with questions where they had to identify and classify geometric shapes in the comic (see [Image 4]); plan the geometric solids found, as well as cut the plane elements and assemble the pieces together in order to build each of the geometric solids.

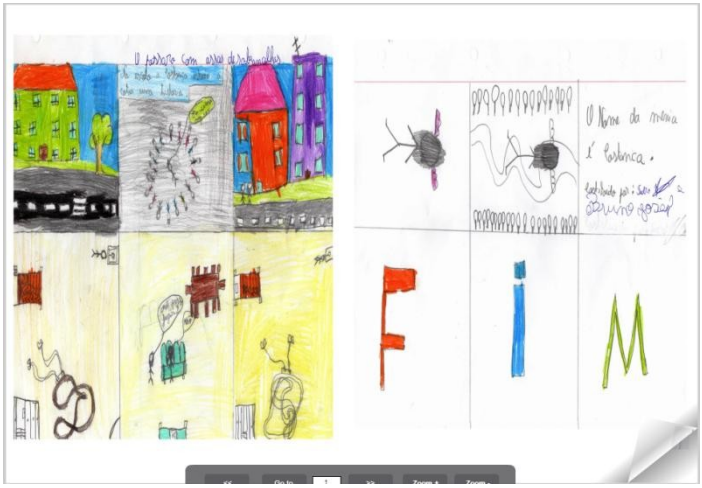

**Image 4**: Some pages from the comic e-book created by the students (Story: *O pássaro com asas de sobrancelha*)

*Educational objectives*: in the end of the exercise the students should be able to: recognize the basic geometric plane and solid shapes and solids; choose measurement units; execute estimates; create geometric constructs; draw the plan of geometric solids and, given the plan, be able to build the respective solid.

**Task 4: *O segredo da bailarina***
*Task overview*: exercise to consolidate previous knowledge; spatial orientation.

*Material resources*: the story *"O segredo da Bailarina"* included in comic e-book drawn; writing material and squared paper.

*Development*: the teacher handed out to each student a square paper sheet and a work sheet with questions related to the story, where they had to identify the relative positions of ballerina's friends in the theatre (see [Image 5]), painting each position with different colours.

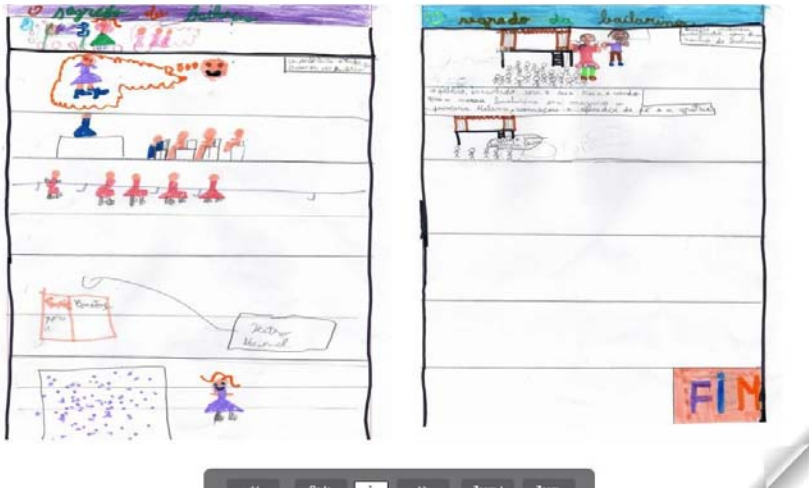


**Image 5**: Some pages from the comic e-book created by the students (Story: *O segredo da bailarina*)

*Educational objectives*: at the end of the exercise the students should be able to: describe the position of certain elements; identify directions; identify rigid movements in a plane or space; describe the localization of a given image through coordinates.

## CONCLUSIONS

Throughout this experiment the children always dedicated themselves with plenty of enthusiasm and dedication to the drawings and to the development of the comic e-book. One of the most noteworthy observations has been the positive progress reached in the reading and interpretation of the proposed stories. The children's joy, disposition and concentration to solve the given problems increased substantially in the worksheets where mathematical concepts were involved and where their drawings were present.

This connection between children's literature and Mathematics had very positive repercussions in regards to how the wording in the problems was interpreted. It made it easier, since the children quickly related them to the stories they had read and the respective characters.

The educational objectives were met to their fullest and, most of the time, the students would use the comic stories and e-book to explain some concepts to those classmates who had some difficulty.

In fact, according to this study conducted with this group of children, it was noted that the level of concentration was higher and the need for the teacher's help was reduced, while the cooperation amongst the students grew throughout the classes.

It is also important to note that the lively colours and happy faces of the characters in the children's drawings confirmed the inexistence of family conflicts or even relevant social problems (Anning, & Ring, 2004; Einarsdottir et al., 2009).

Finally, we believe that in the future it would be interesting to implement children's stories in the classroom, adapted from other well-known ones, but with explicit mathematical.

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