DIGITAL TEXTBOOKS: ANALYSIS TOOL FOR SCIENCE EDUCATION IN THE FIRST YEARS OF SCHOOLING

J. Pinheiro Peixinho, R. Marques Vieira

University of Aveiro - CIDTFF (PORTUGAL)

Abstract

The tool presented for the analysis of digital textbooks - science education in the 1st Cycle of Basic Education - is part of an ongoing PhD project that aims at perceiving a proposal of technological and didactic-pedagogical criteria with the objective of the assessment of digital textbooks. In addition to this, it also aims at the design of a digital school textbook prototype for the subject area of Science based on the principles that guide Science-Technology-Society/Critical Thinking education. This tool intends to make it possible to analyse digital textbooks of the different subject areas of the 1st Cycle of Basic Education, both in terms of technological and didactic-pedagogical aspects. However, since it is framed in a project closely linked to science education for this cycle of education, it includes a specific component for the analysis of didactic-pedagogical criteria related to this subject area. It tends to serve both teachers and editors/authors so that they can carry out a thorough analysis of digital textbooks at the time of their choice/use/production, in order to promote an improvement and renewal of the teaching and learning process, thus contributing to increase the scientific and technological literacy of students in the 1st Cycle of Basic Education (6 to 10 years old). The focus of this article will be the presentation of this tool of analysis for digital textbooks, mainly its technological component.

Keywords: Digital Textbooks; Analysis tool, Science Education.

1 INTRODUCTION

The insertion of information and communication technologies in education, notably through the appearance of technological innovation programmes, has encouraged the creation of a range of digital educational resources. This growing incentive has provided the rising proliferation of educational resources with emphasis on digital textbooks in the Portuguese educational context.

It is now impossible to overlook the increasingly binding role that technology, namely digital educational resources, play as supporting tools in both teaching and learning. For that reason, the need for critical and reflexive work on the analysis of these digital educational resources is justifiable and imperative [1]. This work intends to develop standards of didactic-pedagogical and technological quality, in order to optimize the use of these digital resources in different educational environments. It is therefore necessary to develop a process of rigorous analysis and evaluation that help the various educational agents to obtain a degree of quality regarding these digital educational resources, so as to be able to develop or choose the most beneficial and appropriate one depending on their context of teaching and learning [2].

It is in this context that this proposal of a Digital Textbook [DT] tool of analysis appears, directed in particular to the textbooks of science education in the 1st Cycle of Basic Education. Its purpose is to identify the technical, technological and didactic-pedagogical specificities that textbooks should contemplate. Thus, being encouraged by the inexistence of an instrument of analysis focused specifically on the DT, we developed an analysis tool capable of fulfilling the potential of this educational resource in teaching and learning contexts.

With the progress and increasing dissemination and diffusion of technological and multimedia resources in the educational context, the DT starts to have a constant presence in the Portuguese educational context. Concerning school textbooks, they are recognized by the Law of the Education System as one of the most important educational resources. This is proof that even the Ministry of Education and Science itself recognizes the importance of the textbook as a didactic-pedagogical resource which lies in a system for evaluating and certifying textbooks, legislated since 2006 by Law N.º 47/2006 of August 28th. This system of assessment and certification of textbooks intends to 1) Guarantee access of all students in fair conditions, to a didactic-pedagogical resource, without excluding any others, that is especially suitable for the development of the skills and learning outcomes of the national curriculum in the specific socio-educational context of school 2) Ensure the scientific and pedagogical quality of the school textbooks to be adopted, certify their conformity with
the objectives and contents of the national curriculum and curricular programmes or guidelines in force, and attest that they are an adequate tool to support teaching and learning, as well as the promotion of educational success [3]. The assessment for the certification of school textbooks is operationalized by evaluation committees or by entities developed by the Ministry of Education and Science, both accredited by this Ministry [3].

The school textbook is seen as a powerful educational tool, recognized as being a curriculum guide for many teachers, influencing and structuring the course of the teaching and learning process expressively. Thus, among others, the use of the school textbook by teachers during the course of science education influences how students perceive the nature of science [4] [5].

There have been several criticisms regarding the quality of science textbooks in Portugal. Several authors have pointed out gaps in this didactic resource, such as conceptual flaws, fragmentation of knowledge, low level of abstraction, little value given to research and experimental work, decontextualized teaching, disregard for students' prior knowledge and lack of relationships between science, technology and society [4] [6] [7].

The school textbook, in a society that aims to increase quality education for all by invoking the growth in scientific literacy and technological literacy, is one of the means to achieve this goal, since it is available to all educational actors, irrespective of their cultural, socio-economic or regional status [8] [9]. For this reason, the importance and concerns of ensuring the scientific and didactic-pedagogical quality of school textbooks will have to be strongly vindicated, assuming that it is essential to have mechanisms that help the process of analysing these educational resources. After accepting that the school textbook influences almost unequivocally what is taught in the classroom and, therefore, if the textbooks restrain in a prominent way what is taught and how it is taught, then presenting significant reflections on the quality of the practices is of the utmost importance to analyse these educational resources. Not only with regard to their declarative and procedural dimensions, but also pertaining to their representative and axiological dimensions [4] [9].

It should be noted that, as previously mentioned, a system for the assessment and certification of schoolbooks is in force in Portugal, whose criteria and specifications are established and regulated by Law. Nonetheless, such criteria and specifications are intended for all textbooks without any differentiation between disciplinary areas and/or teaching cycles. With reference to digital textbooks in particular, such criteria do not list the technological/educational multimedia component.

It is within this scope of problematization of the quality of school textbooks, and consequently the development of textbooks (design, production and assessment), that follow didactic-pedagogical and technological requirements (in the case of digital textbooks) and are well reasoned, that there is a need to create this analysis tool of DT in science, which values the critical and reflexive appreciation of these educational resources.

2 METHODOLOGY

In order to meet the needs of science education with a Science-Technology-Society/Critical Thinking orientation, and considering the technological evolution in textbooks with a promising future to contribute to the improvement and innovation of the teaching and learning process, this project aims to develop a prototype of a DT where the STS/CT principles and fundamentals are integrated.

It is a type of research inspired by a real problem, in which a continuous and integrated process takes place. Such activities include design, production, implementation and assessment of an educational resource.

This project aims to answer two research questions. Here we report what one of them refers to, insofar as standards of quality: With what references and how to develop a DT of Science in the 1st Cycle of Basic Education with STS/CT orientation?

Therefore, and considering the design of the research, the development of a DT prototype involves several phases, which are dependent and articulated among themselves. We will briefly describe the phases that will answer the aforementioned question:

1. The creation of the theoretical reference to support the problematic essentially related to the didactic-pedagogical approach of the sciences with STS/CT orientation and with the technical and technological specifications of the digital textbooks;

2. The design, production, validation and implementation of data collection instruments;
3 The design, production, validation and implementation of an instrument for the analysis of digital textbooks in general, and mainly in science education.

The first moment of data collection, which is part of the second phase of the project for the development of the DT prototype, was anchored with the accomplishment of a focus group. This is described as a group of individuals nominated by researchers to debate and comment the topic under discussion, based on their experiences [10]. The focus group provides a multiplicity of visions and emotional reactions in the context of the group. It also privileges the observation and recording of experiences and reactions of the individuals participating in the group, which would not be possible to apprehend using other techniques, such as participant observation, Individual interviews or questionnaires [11]. The focus group is referred to as "[...] a research technique that collects data through group interaction on a topic determined by the researcher. In essence, it is the researcher's interest that provides the focus, where as the data themselves come from the group interaction" (p. 6) [12].

In view of the scarcity of studies that could support the empirical approach of our project, we considered that it would be important to initiate an incursion to better understand and deepen some of the technical, technological and didactic-pedagogical specificities with regard to the design and production process of a DT prototype. A focus group has the purpose "[...] listen and gather information. It is a way to better understand how people feel or think about an issue, product, or service." (p. 5) [13]. It was also intended to collect additional inputs in order to establish quality criteria for the assessment of the DT.

Taking into account the purposes described above, we decided to create two focus groups: one with specialists in educational technology/multimedia; and another focus group with specialists in science didactics. Both had internal and external participants to the University of Aveiro.

To carry out the focus group, the following steps were taken "[...] define the purpose and outcomes of the Project; identify the role of the sponsor in the project; identify personnel and staffing resources; develop the timeline for the project; determine who the participants will be; write the questions in the interview guide; develop a recruitment plan; set the locations, dates, and time for the sessions; design the analysis plan; specify the elements of the final report" (p. 10) [14].

The group of participants was formed taking into account the individuals' common characteristics, in order to ensure a balance between the consistency of characteristics in relation to the problem at hand, but at the same time the diversity of knowledge to stimulate reflection and the sharing of diverse viewpoints [19] [13] [14] [15]. The focus group, as it occurred in this study, was characterized " [...] by homogeneity but with sufficient variation among participants to allow for contrasting opinions. By homogeneity, we mean participants have something in common that you are interested in, such as the following" (p. 71) [13].

Despite trying to ensure the balance between the homogeneity and the heterogeneity of the group so as to stimulate reflection and the sharing of points of view, the choice of the participants for the two focus groups was different.

For the focus group with specialists in educational technology/multimedia, some selection criteria was taken into account, namely, the scientific area, the scientific domain and the academic and professional experience of the participants. For the focus group with specialists in didactics of the sciences, there was no direct sorting of participants, since this was done within the scope of the Open Days of the Laboratory of Science Education/Science Garden [LEduc/JC]. These open days of LEduc/JC had a central theme: "Research in Science Education". Thus, these open days of LEduc/JC had a wide and diverse audience, but composed of participants whose matter of interest was research in Science Education. Taking advantage of this multi-faceted group of individuals who participated in these LEduc/JC open days, most of them composed of specialists in science didactics, and considering that the selection criteria were previously taken care of, we carried out the focus group in this intimately conducive environment to discuss and reflect on thematic topics regarding science education.

To the participant group, we associated two moderators who essentially carried out coordination tasks, always looking for non-interference in the group dynamics: i) to question; ii) to listen; iii) to ensure that participants' speeches do not disperse in relation to the previously established objectives and the nature of the question raised; and iv) to promote the participation and interaction of all participants; v) to provide a desirable atmosphere for the sharing of ideas by all participants, without excessive interference, overlap or monopoly of speech by any of the other members [13] [14].
In the opinion of some authors, if the focus group serves non-commercial purposes, it should be represented by six to eight participants. They point out that this number of participants is encouraged by moderators to observe non-verbal reactions, to control the group, to have a greater level of interaction and to share ideas. Still, regarding the purposes of mini groups, "[...] smaller groups are preferable when the participants have a great deal to share about the topic or have had intense or lengthy experiences with the topic of discussion" (p. 74) [13].

Accordingly, given the characteristics of the participants, the objectives that we intended to achieve with the focus group and, of course, the objectives of the research itself, we decided to create mini groups, allowing more time for each participant to partake in a more in-depth discussion on the various questions asked.

In fact, in the so-called mini groups, the social environment that is created is characterized by being informal, trust-based and non-threatening. The interaction, stimulated by the moderator, allows a sharing of points of view, of people's experiences, critical and reflexive positioning, and may even interact with the intention of convincing and influencing the other's point of view or getting reactions from others participants. In addition, focus groups allow in depth and detailed discussions and reflections, especially when participants feel effectively involved with the subject and find space and openness to share their viewpoints, concepts and experiences [13] [15] [16].

According to the characteristics and specificities stated above regarding the participants, the environment and the typology of the focus group, in order to reach our goals, guidelines for both focus groups were previously built. These guidelines were made up of, for each category and size, a group of main issues that were deployed into other more specific ones to enable, if the group's dynamics allowed, further examination and development.

All focus groups were recorded in audio and video recordings, and transcribed in full later. The transcript of each focus group was then sent to all members of the same group, so that they would later be validated. After having gathered all the validated transcripts and contributions, we began to progressively design a systematization document, according to the dimensions and categories of analysis, which includes the concepts covered, the main ideas and the implications for the project. The analysis of the contributions of the focus group carried out with specialists in educational technology/multimedia and with specialists in science didactics is the subject of the next chapter.

3 RESULTS

The foundation of the DT tool of analysis, the focus of this article, was based on the analysis of the theoretical reference of support to the problematic and the results obtained with the focus groups. These focus groups, described in the previous chapter, included the participation of specialists from the area of educational technology/multimedia, as well as specialists in science didactics.

Thus, reiterating the lack of a DT tool of analysis explicitly intended for the envisioned purpose, it was necessary to add, in this research project, a phase that contemplates the development of an analysis tool of digital textbooks in science education. A tool that aims to illustrate the possible criteria that teachers (as users of textbooks) and authors/editors (as producers of textbooks) could use as guidance when assessing their digital textbooks in order to promote an improvement of the teaching and learning process.

The instrument presented for the purpose of DT analysis is organized into three distinct levels, from the broadest to the most specific: Categories, Dimensions and Indicators. The defined dimensions and categories that make up the organizing axes of the indicators, following what was proposed by Vieira [17], are presented in figure 1.
For each indicator considered, an analysis, in practical terms, is carried out successively at two distinct yet complementary levels. The valuation level, based on the information collected by the evaluator, is to carry out a qualifying evaluation with assigned quantitative levels; and the descriptive level that goes beyond a detailed description of each of the aspects considered in the analysis, the suggestion of improvements in terms of its technological and/or didactic-pedagogical potential to support teaching and learning.

As a contribution, in this article we will focus on the analysis dimensions of each of the categories of the DT analysis tool.

Category A, related to the structural aspects of DT, includes three dimensions of analysis, each with associated indicators: A1 - Cover and Back Cover; A2 - Index and pages; A3 - Trademarks, Rights and Responsibilities.

Category B, related to the DT educational/multimedia aspects, includes eight dimensions of analysis, each with associated indicators: B1 - Layout; B2 - Navegability; B3 - Legibility; B4 – Accessibility and Adaptability; B5 - Interoperability; B6 - Feedback; B7 - Edition; B8 - Customization.

Category C, related to didactic-pedagogical aspects of the DT, includes four dimensions of analysis, each with associated indicators: C1 – Language Rigor; C2 – Conceptual Rigor; C3 – Curricular Guidelines and Programmes; C4 – Evaluation of and for Learning.

Category CC, intrinsic to category C, is related to aspects of science education in the first years of schooling and contemplates four dimensions of analysis, each with associated indicators: CC1 – Scientific Knowledge; CC2 – Stages of Scientific Work; CC3 – Scientific Processes and Abilities; CC4 – Attitudes and Scientific Values.

4 CONCLUSIONS
The reasons that led to the development of this assessment tool of DT in science education resided in the need for a careful, distant and critical look at the technical, technological and didactic-pedagogical specificities of this educational resource.
In light of the above, we have briefly shared the results derived from the sharing of critical and reflective positions, designs and experiences of the participants specialized in multimedia/technology education, as well as the literature review of the specialty.

This DT tool of analysis values, above all, the purpose of helping both teachers and editors/authors to guide them in the analysis of these digital educational resources, which are capable of gaining the potentialities and characteristics of relevance in the context of teaching and learning. Like so, this tool is not intended to be merely qualifying, but rather to emphasize knowledge about the technical, technological and didactic-pedagogical aspects that DT should contemplate, formulating value judgments and reflections on the quality and usefulness of each digital resource in the support teaching and learning.

This DT analysis tool, rather than providing a final classification of the analysed product, tends to offer the opportunity for teachers themselves to conclude and reflect on the detailed value of the digital educational resource in their educational context. As a consequence, it tends to be an important tool to assist teachers in the choice of digital textbooks prior to their exploitation; and at the same time, be an important tool to guide editors/authors at the time of development, particularly in the design and production stage, of digital textbooks.

ACKNOWLEDGEMENTS

This work is financially supported by Nacional Funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., under the Project SFRH/BD/84470/2012 and Project UID/CED/00194/2013

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