Development of digital Open Educational Resource for metrology education

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Abstract. Open Educational Resources (OER) designates teaching, learning and investigation materials in any supports, digital or others, located either within the public domain or disclosed under an open license that allows access, use, adaptation and redistribution, free of charge, by third parties with few or no restriction. The general paper purpose is to submit a digital OER proposal, an educational resource called “Introduction to Metrology”, planned for a five steps life cycle production scheme: to find, to create, to adapt, to share, to use. The work applies a qualitative approach, with the survey of all educational resources identified in the International Bank of Educational Objects (BIOE), from the research of terms “metrology”, “measurement” and “measurement unit” as keywords; besides the survey of materials identified on INMETRO’s website. Five videos-type resources identified in BIOE and one text in INMETRO’s website were strategies to deliver contents. Moreover, the production of four unpublished exercises blocks with software Hot Potatoes® and CMapTools®. OER is available as a course inside Moodle®. STEM Education needs enrichment with metrological concepts to establish a common and standardized language. OER could support metrology education, therefore propose didactic sequences and activities are the way to encourage its use in the classroom.

1. Open Educational Resources
UNESCO’s Forum “Impact of Open Courseware for Higher Education in Developing Countries”, which occurred in 2002 in Paris, recommended the term “Open Educational Resources” (OER) to nominate “the open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for non-commercial purposes.” [1]

The general purpose of this paper is to submit a digital OER proposal, called “Introduction to metrology”, planned for a five steps life cycle production scheme: to find, to create, to adapt, to share and to use. [2] The description of each one of the steps contains the specific objectives of this paper and offers an explanation about the OER proposal.

The step “to find” concerns the search for resources capable of coming useful for the needs of teaching and learning processes. [3] The access to information in digital culture makes this work easier. The Brazilian digital didactic material, called International Database of Educational Objects (BIOE) was the main search site. Its purpose is to keep and share digital educational resources of free access, as well as more elaborated ones, in different formats – such as audio, video, animation, simulation, educational software, image, map and hypertext. It was a creation of the Ministry of
Education, in partnership with the Ministry of Science and Technology, Latino American Network of Educational Portals (RELPE), Organization of the Ibero-American States (OEI) and others [4]. Digital didactic materials researched at the website of the National Institute of Metrology, Quality and Technology (INMETRO/Brazil) complement the content.

The step “to create” can happen without the utilization of another resource (from scratch) or with the combination of resources found to assemble a new resource, thus expanding the concept of authorship [3]. We employ both strategies in the OER proposal. The only strategy to deliver contents is presenting objects found in two websites (videos and text type resources). Furthermore, we apply software - Hot Potatoes® and CMapTools® - to make four blocks of unpublished exercises.

The Hot Potatoes® is freeware created and developed by professors and technicians associated with University of Victoria (Vancouver, CA). Hot Potatoes® suite includes six applications, enabling you to create interactive multiple-choice, short-answer, jumbled-sentence, crossword, matching/ordering and gap-fill exercises for the World Wide Web [5]. The Cmap software is a result of researches conducted at the Florida Institute for Human & Machine Cognition (IHMC). It empowers users to construct, navigate, share and criticize knowledge models represented as concept maps. [6]

The step “to adapt” intends to adequate the resource to the specific context by correcting, improving and contextualizing the material by means of the insertion or removal of components; changing the sequence of activities; edition or alteration of images, texts, audio, video. [3] The fulfillment of this step involved the production of new exercises in order to come useful for the specifications of the qualification proposals.

The step “to share” depends on the availability of materials to the global community under an open license and is the OER’s defining step [3]. Consequently, OER is available as an open course inside Moodle®, which is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments. Built for global learning, it is easy to use and free, with no licensing fees, as open source software [7]. URL address to access the website for OER is http://ctmetrologia.acrisp.org/moodle/course/view.php?id=2

Finally, the step “to use”, which depends on the utilization of OER in teaching and learning processes [3], will be developed among groups of Science teachers and students from technical courses such as metrology and biotechnology.

The work methodology is based on a qualitative approach, with the survey of all educational resources identified in the research of the terms “metrology”, “measurement” and “measurement unit” as keywords; besides the selection of the appropriate resources among those on INMETRO’s websites.[8-10]

2. Open Educational Resources on metrology

The research of the terms “metrology”, “measurement” and “measurement unit” in the BIOE resulted in 70 educational resources related to metrology education: 3 in English, 13 in Spanish, 54 in Portuguese. The INMETRO’s website has 21 Videos [8], 183 editions of the bulletin “Inmetro Informação”, 148 editions of the internal newspaper “Na Medida”, 13 Books, 3 Manuals, 3 Folders and 18 Booklets for online access [9 and 10]

2.1 The new Open Educational Resource (OER) “Introduction to Metrology”

The overall goal of the new OER “Introduction to Metrology” is to introduce the topic “measurements”, the application areas and the importance of the metrological science. The target audience is formed by basic education teachers and students starting high school.

To plan the new OER, five videos-type resources identified in BIOE and one text in INMETRO’s website were strategies to deliver contents -“International Vocabulary of Metrology” [11]. Moreover, the production of four unpublished exercises blocks with software Hot Potatoes® and CMapTools®. Table 1 organizes the OER planning with the description of each resource – title, type, link and
contents. Figure 1 shows the concept map proposed as an exercise to build a graphic summary of all contents.

**Table 1:** Planning of OER “Introduction to metrology”

| Title, Type and links | Contents |
|-----------------------|----------|
| Measurements – Introduction Type: video (duration 4 min) http://objetoseducacionais2.mec.gov.br/handle/mec/22210 | Units and Quantity-value scale and numerical quantity value; Importance of measurement standard; Quantities: time, mass, temperature and volume; |
| International Vocabulary of Metrology: Basic and general concepts and associated terms – JCGM (VIM 2012). Type: text http://www.inmetro.gov.br/inovacao/publicacoes/vim_2012.pdf | Quantities and Units; Measurement; Devices for measurement; Properties of measuring devices; Measurement standards (Etalons); Metrology |
| HotPotatoes® interactive matching/ordering and gap-fill exercises | |
| Measurements – measurement standards ; Type: video (duration 2 min) http://objetoseducacionais2.mec.gov.br/handle/mec/22424 | Measurements; Reference measurement standard; Comparison of measurement patterns; Mass etalon. |
| International Vocabulary of Metrology: Basic and general concepts and associated terms – JCGM (VIM 2012) Type: text http://www.inmetro.gov.br/inovacao/publicacoes/vim_2012.pdf | Quantities and Units; Measurement; Devices for measurement; Properties of measuring devices; Measurement standards (Etalons); Metrology |
| HotPotatoes® interactive jumbled sentence and gap-fill exercises | Measurement; Devices for measurement; Reference measurement standard |
| Measurements - International System of Units (SI) Type: video (duration 3 min) http://objetoseducacionais2.mec.gov.br/handle/mec/22428 | Scope of International System of Units (SI); English Measurement System; Base quantities (time, mass and length) and measurement units; Definition of the second; Derived quantities; The international prototype of the kilogram; BIPM; INMETRO |
| Measurements – prefixes within the International System of Units (SI) Type: video (duration 2 min) http://objetoseducacionais2.mec.gov.br/handle/mec/22429 | Multiples and submultiples of units; Conversion factor between units. |
| HotPotatoes® interactive matching/ordering exercise | International System of Units (SI); Base quantities (time, mass and length) and measurement units; The international prototype of the kilogram; BIPM; INMETRO; Multiples and submultiples of units; Conversion factor between units; prefixes. |
| Concept map | Graphic summary of all contents |
Figure 1: Concept map proposed as an exercise to build a graphic summary of all contents. Underlined words are gaps to fill by students.
The OER proposal is a digital didactic sequence.
Types of five interactive exercises that compose the three blocks are matching/ordering, gap-fill and jumbled sentence. These exercises have the purpose of highlighting the main metrology concepts mentioned in the videos. Furthermore, all exercises stimulate the reading of the “International Vocabulary of Metrology” [11]. We intend to show this material as a potentially didactic material.

Inside the OER proposal, the fourth exercise is a concept map available as a PDF file to be printed, with gaps to be filled by students. Drawing concept map spends a long time. Consequently, this choice decreases the activity time, meanwhile presenting concept maps to the audience. Even with the spreading of digital culture, we believe in the importance of a printable document as a summary of all contents to finish digital didactic sequences.

Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred as linking words or linking phrases, specify the relationship between the two concepts. [12]

3. Considerations on BIOE
All educational resources found in the research have been submitted between the years of 2008 and 2012. The link “recent submissions” on the website shows the last submission on March 2015, which seems to have been the lifetime of the BIOE. [13]

We realized that the main difficulty on BIOE was the impossibility to make a previous selection of the resources based on the available description, thus forcing the opening of all researched resources. The description of them needs categories that describe the specific contents, rather than classification categories such as disciplines and teaching level. Curricular changes and distinct pedagogical projects make these unnecessary, while content description could expand the research possibilities, speed up the selection and potentiate the utilization of resources as the teacher can see the usage opportunities in a better and faster way. Another difficulty was finding disabled files.

Even though, at first glance, we did not find some resources identified in BIOE in other repositories, more updated and specific as portals EduCapes and the Bank of Objects in Metrology (BOM). This was the reason for the choice of BIOE as a repository for research.

EduCapes opened in September 2016, managed by CAPES’ Distance Learning Board (Brazilian Ministry of Education). [14] BOM is a digital archive of contents on metrology developed by the Brazilian Metrology Society from the financing of the National Council of Scientific and Technologic Development (CNPq) by means of the South American Program to Support Cooperating Activities in Science and Technology (PROSUL). [15]

One interesting result was the personal identification of the author “Anderson Coser Gaudio”, a professor at the Physics Department of the Federal University of Espirito Santo (UFES). He produced a series of seven videos on the topic “Measurement”. This information could be important to expand the small Brazilian community involved in metrology education.

4. Considerations on available materials on INMETRO’s website
Videos from Inmetro are available in its Youtube® page. [8] This is a problem for Brazilian students and teachers because many institutions block access to this web page. All folders and booklets elucidate the conformity assessment.

Only the book “International Vocabulary of Metrology: Basic and general concepts and associated terms” [11] we considered adequate for the target audience and overall goal of the new OER “Introduction to metrology”.

5. Conclusion
The STEM Education, which stands for Science, Technology, Engineering and Mathematics, needs to be enriched with metrological concepts that are fundamental in the modern society as it establishes a
common and standardized language, as well as procedures that ensure the reliability in measurement result.

The research identified digital educational resources on metrology available for immediate use, produced new resources in the form of activities and proposed a new resource.

It was possible to perceive the importance of BIOE, since all videos-type resources chosen were only available there. Although new digital platforms and banks with educational materials are important to disseminate scientific information, they must include all materials already identified and improve their categories for materials classification.

As an illustration, we think about the inclusion of all metrology’s OER identified on the BIOE and videos from Inmetro’s Youtube® page to BOM. Others suggestions are:

- making simple materials on metrology, as folders and booklets;
- improving the classification categories of digital objects;
- and proposing didactic sequences for their use.

The movement “Open Educational Resource – OER” can contribute to disclosure metrology by stimulating the reutilization of available materials with open licenses. However, experts must first analyse the quality of such materials in order to provide a technical approval and, mainly, propose didactic sequences and activities to encourage its utilization in the classroom.

6. References

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