

AN INNOVATIVE E-BOOK ON THE MEASUREMENT FIELD

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EUNIS09 Award

The work is entirely available until 26th of June 2009, at the address:

<http://paginas.fe.up.pt/~trestivo/EUNIS/LabIM.pdf>

Username:labim

Password:2009

1. Innovation

This work reports on a novel use of Information and Communication Technologies for composing an electronic book on the measurement field. The bi-lingual e-book “Laboratórios de Instrumentação para Medição/Laboratories of Instrumentation for Measurement” (URL - <http://paginas.fe.up.pt/~trestivo/EUNIS/LabIM.pdf>) deals with concepts, methods, procedures and hands-on activity and it combines sketches, figures, animations, videos and remote and virtual labs on the measurement area, integrating many types of multimedia within the written material. The complete electronic format used is inspired in the Confucian wisdom, “what I hear, I forget; what I see, I may remember; what I experience, I know for life”, Confúcius (451 B.C.).

A bilingual e-book concepts, methods, procedures and hands-on activity: combines text and sketches, animations figures, videos and remote and virtual labs

Concepts are normally presented and described in books. In the present e-book, contrarily to what is traditionally used for presenting concepts, they are mainly treated by exploring dedicated experiments. Those are entirely described and so, reproducible in any lab but it is also possible to reach experiments at Faculdade de Engenharia da Universidade do Porto (FEUP), remotely available and specially developed for this purpose.

This e-book vs. traditional books

Experiments reproducible in any lab, anywhere

Free access to remote and virtual labs

By accessing remote and virtual labs at FEUP the e-book users will be also in contact with this particular type of Information and Communication Technology (IT) and will become aware of the experiment instrumentation requirements for allowing this interaction – at least of some of them!

Contact with “hard” TI

The present e-book has been conceived and designed by the authors in a Task Based Learning (TBL) approach. In TBL the tasks are central to the learning activity and students may also be developing a remarkable range of different skills, which is aligned with Bologna goals. In fact, materials are integrated with lab sessions within Instrumentation for Measurement courses in engineering or sciences areas, using the structure based in:

Task Based Learning approach and Bologna scopes

- To introduce the topic (main objectives and important concepts) and to the task – (pre-task);
- To perform the task and to plan an oral report – (during task);
- To present to other colleagues and to discuss results – (end-task);
- To synthesize and to think deeply using open questions - (after task).

TBL structure adopted

For helping this last stage a set of related open questions is available, following each Chapter final synthesis.

The option for a TBL instead of a PBL (Project Based Learning) approach is related with the present teaching/learning activity with large classes.

The e-book is written in the authors native language but it also has a version in English. So, being useful for native students it is also suitable for students in general or in a mobility process. In fact, switching into the *lingua franca* version is very simple, and so just a “click” is required if the Portuguese speaking user desires to be familiar with the technical subject terminology for later searching.

Its *lingua franca* version makes it useful for everyone

In what concerns its electronic navigability, the e-book has been conceived for offering, as much as possible, a similarity to a traditional book. It is also important to add some other

Electronic navigability regarding similarities to traditional books

comments on the electronic type of navigation through the e-book. In the first contact the book offers the title in both languages. By selecting one of them the user is conducted to the corresponding version: in Portuguese or in English, Fig. 1.

Once in the chosen version the user has to click on the arrows at the bottom of each page, near the page number. With four clicks the index is reached. Here it is possible to decide where to go: preface, prologue, foreword, acknowledgements, chapter index or bibliography. From now on in addition to the navigation arrows there is a top menu. Within each chapter different sections are associated to distinct top menu levels, which offer a very easy way of swapping over from section to section, Fig. 2.

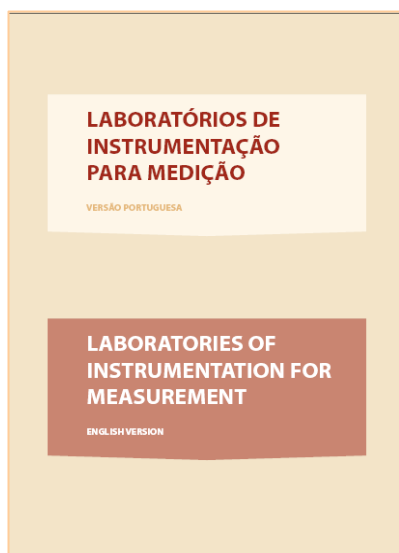


Fig. 1 – The e-book cover

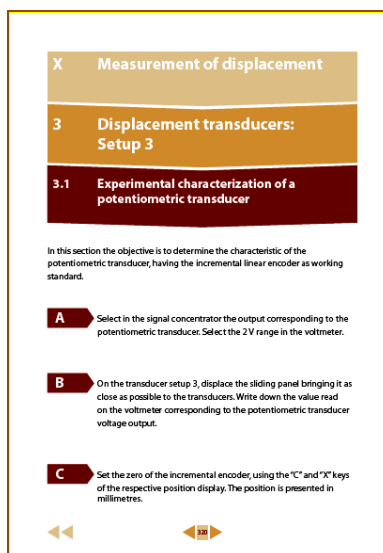


Fig. 2 – Navigation: top menu levels and double arrow

At each new level there is always a double arrow on the lower left corner for switching to the first page of the higher level subject. The structured navigation tries to recreate the fast way readers use in order to find a specific subject on a traditional book.

With daltonic individuals in mind the navigation using the top menus relies not only on the color but also on a numbering base.

The adoption of a completely electronic format, offering a more efficient and harmonious integration of a wide range of contents, also facilitates the production of new editions, even when including additional materials. It is the authors' intention to further explore other topics within Laboratories of Instrumentation for Measurement. So the electronic edition is the ideal option for easy and economic updating, as well as for updating or adding new remote experiments.

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The free access for any user to remote experiments at FEUP, completely integrated in some of the e-book topics, gives to it a **unique characteristic**.

Daltonic individuals and the navigation

Efficient and harmonious integration of contents and edition cost benefits

A **unique characteristic**

2. Pedagogy

The educational objectives of the present work, in terms of Bloom's taxonomy principles, are:

Objectives within Bloom's taxonomy principles

- to convey metrology concepts and terminology;
- to offer a basic background in laboratory and industrial measurement principles, metrology and procedures;
- to practice the evaluation of error analysis and measurements;
- to promote 'hands-on' laboratory activity;
- to develop the students' capacity for analyzing, interpreting, criticizing and reporting results;
- to encourage student initiative and imagination;
- to make student familiar with new technologies for remote access;
- to reinforce students teamwork skills, personal responsibility, self-organizing and conflict-solving capabilities;
- to improve students autonomy according with Bologna recommendations;
- to provide self-assessment of the student mastering of subjects by proposing open-ended questions based on the given materials.
- to intensify active/collaborative/cooperative learning activities;
- to attempt to teach how to learn.

Nowadays printed technical manuals are often complemented with the inclusion of a CD-ROM, which is not used very often. In the present case, taking into account the diversity of multimedia components easily available, the completely electronic format allows an easy integration of a wide range of contents: text, images, sketches, videos, animations, simulations and remote and virtual experiments. All those multimedia materials are integrated in order to invite the user to explore them.

Electronic format allows an easy integration of many types of contents

Moreover, given the contributions of neuro-linguistic programming to education, the authors consider that the format adopted is adequate to the diversity of psychological and learning profiles of the large target audience used by the developed materials.

Neuro-linguistic contribution

According with the different Kolb's learning styles and his learning cycle concepts the authors believe that the format adopted is adequate to the diversity of psychological and learning profiles of large target audiences. As a curiosity, figure 3 shows the learning styles of the first student group that has used this e-book.

Concerning Kolb's learning styles

For avoiding dispersion readers attention hyperlinked text is not used. Hyperlinks are only used at the Bibliography (Generic and Specific Bibliography) level.

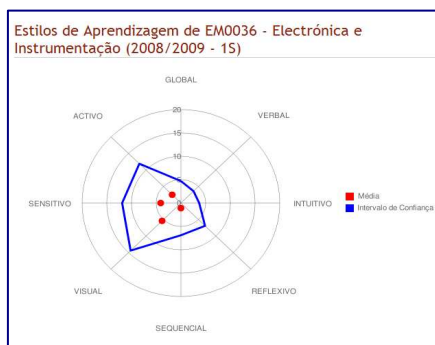


Fig. 3 – Learning styles for the first course using the present e-book

This e-book comprises 13 modules (or chapters). Each one presents a clearly defined learning objective, the essential concepts and a step-by-step guide for performing the experimental activity, various types of complementary multimedia contents and a final synthesis. A set of open questions that closes each module is intended to provide formative assessment.

E-book structure

These open-ended questions aim to encourage the users to undertake their own analysis and further elaboration of additional questions as an excellent way to achieve deeper learning. Formulating questions and finding additional problems may be the single most important tool in facilitating the learning process.

Formative assessment

The e-book also aims to contribute to the dissemination of experimental activity in engineering and science education areas and to facilitate the conception, tuning and exploration of experimental systems for laboratory training. The full technical description of the equipment is provided to make the setups easily reproducible. In addition access to remote experiments has been made available.

Experimental activity dissemination

At FEUP, several experiments have been developed in the field of Instrumentation for Measurement to be available for everyone, everywhere, 24h/day, 7days/week. Some of them specifically regard metrological concepts and measuring methodologies such as the calibration procedure of a temperature system, the straightness evaluation of a surface, and the system for mechanical material characterization. All are available at <http://remotelab.fe.up.pt/>, figure 4, and are totally embedded within concepts and activities along the e-book, figures 5, 6 and 7. In addition, the Michelson interferometer (as an example of system traceability for the SI unit of length in metrological laboratories) is also available and a simulator of the real system, with higher degree of flexibility and more interactivity than the remote interferometer itself, is accessible for free download at <http://remotelab.fe.up.pt/otherexperiments.html>.

Remote labs

Michelson interferometer: a virtual lab for free download

The authors believe that on-line experiments are a valuable complement in a blended-learning approach; they should never substitute the real hands-on activity supported by well conceived experiments.

Contribution to a blended learning approach



Fig. 4 – LIM remote lab web site

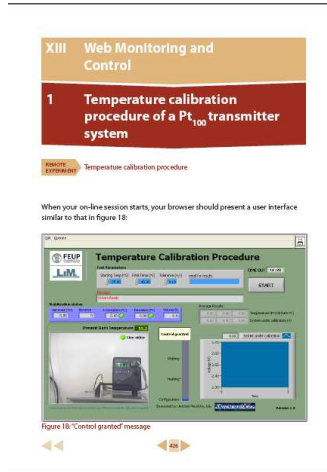


Fig. 5 – Temperature calibration procedure

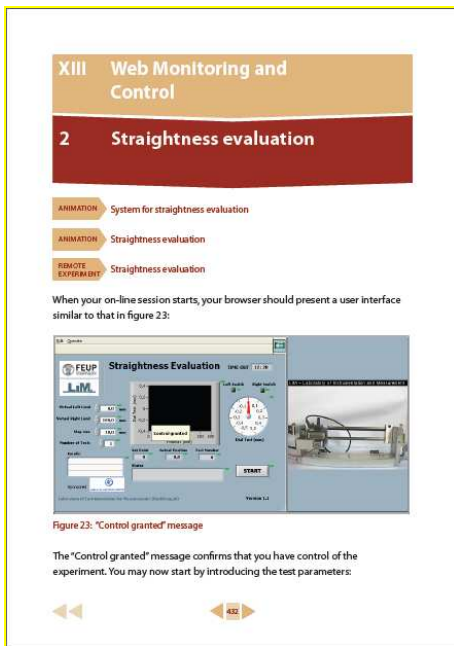


Fig. 6 – Straightness evaluation

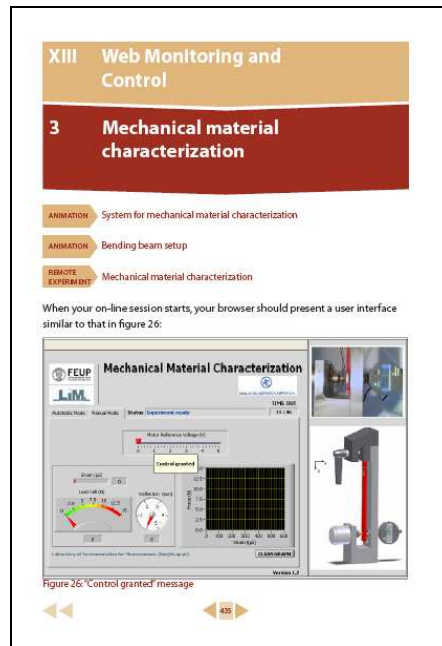


Fig. 7 – Mechanical material characterization

Remote experiments integrated with measurement concepts and procedures

The students may revisit any of the on-line experiments, any time they intend to do so, explore and/or repeat them, as a complement to the real core of the present experimental course in Laboratories of Instrumentation for Measurement. A booking system is available to permit convenient personal booking timetable. All the remote experiments include a live video feature to help to overcome the remote situation. The video is particularly important, as in the present experiments, where there are quantities and systems time varying responses, as well as movement of mechanical parts.

Available any time for every one

Bearing in mind some of the Bologna recommendations on the enhancement of engineering education, the access to remote experiments may also help to improve students' autonomy, inciting them to acquire the ability to do the experiments by themselves, and so contributing to stimulate "student centered learning". Finally, students have the opportunity to become familiar with this technology and their possibilities.

Video for better realism

In any case, there is no doubt about the pedagogical value of remote labs when well integrated in a course content, as can be confirmed by the testimony of students included

Remote labs/autonomy and Bologna

Testimony of pedagogical value

below in the usefulness and benefits section.

The authors believe that this work conception contributes in an important complementary way for both the hands-on approach generally in group activity, improving the individual skills of each element in a group, and for b-learning approach, by using remote and virtual labs or open questions for formative assessment, stimulating the work at the individual level. The formative materials along all the work should provide a personal barometer.

Helps to improve either group or individual activity

Individual barometer

3. Technology

This e-book is in a PDF format, maybe the most popular format. In fact all platforms are able to gain access and read PDF documents. It requires the Acrobat Reader but this software is usually available in the computers and, if not, it can be freely downloaded. PDF is also really good at preserving the appearance of a document and for printing out the pages of the e-book. As in any traditional book, any owner is legally allowed to use a photocopy of it for his/her use. In this copy or even in the real book, many of us use to write notes or comments. In this case, once the e-book is recorded in the owner personal pc, using a functionality of Adobe Acrobat it is also possible to record personal marks and comments within its materials. Printing the e-book pages will also allow the user to get a pretty paper format of the e-book, which has been proved to be still important for many people, even young people.

PDF documents

Preserving the appearance for printing

Recording personal marks and comments

In PDF documents it is possible to include all the multimedia contents, as animations, simulations, videos, remote and virtual labs, as well as other pdf documents as is the case of appendixes to the different issues. Figures 5, 6 and 7 are examples of pages where the access to animations and remote experiments are available.

Links to all multimedia components and extra appendixes

The e-book has also Adobe Flash applications that allow the “interaction with the contents”; those are embedded in a html page and so a browser is required. Figures 8 and 9 are examples of two interactive simulations.

Flash interactive simulations

The remote experiments accessed through the e-book are integrated in a Moodle platform and they use a web server based on LabVIEW, a video server for providing as much realism as possible and a booking system developed as an extension of the Moodle platform.

Simulation examples

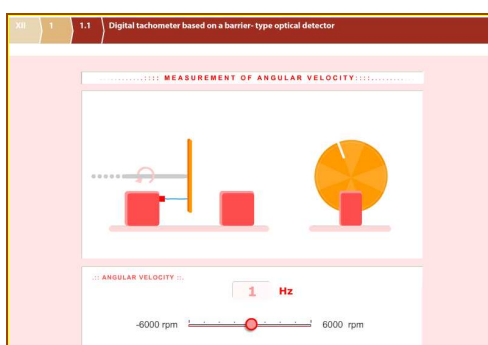


Fig. 8 – Barrier type optical detector

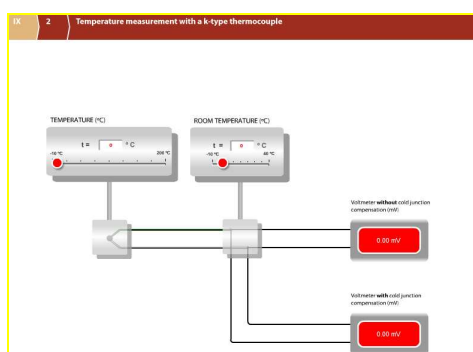


Fig. 9 – K-type thermocouple measurement

4. Usefulness and benefits

The present e-book has been tested with undergraduate mechanical engineering students as well as with postgraduate students from other different fields of science and engineering.

A dedicated questionnaire has been prepared and sent to all the registered students (121). The answers sample is of 45. On the free comments they have referred the work as very well structured, synthesized and a valuable conceptual learning material, as a very good support for training hands-on activities, thinking critically, analyzing, evaluating, predicting and solving problems in an innovative and autonomous way. They considered this e-book as a good support to relate information to their own experiences and previous knowledge, to promote understanding and even to help long-term retention. The access to online experiments has also been considered of interest for the possibilities offered, especially due to the flexible 24-hour a day, seven days a week, availability as the user desires and providing contact to all of them with new technology. Some results based on the grade mean value for a set of selected questions is now included, Table I.

Undergraduate mechanical engineering students

Questionnaire and free comments

Students interest in remote labs – free timetable and contact with new technology

TABLE I
STUDENTS QUESTIONNAIRE RESULTS

Question about ...	Mean value
The e-book as a valuable learning material	95%
The use of different multimedia contents on clarifying concepts, methodologies and practices	91%
The e-book structure: chapter organization	92%
The open-ended questions on the correlated issues	83%
The electronic navigation	88%

Examples of questions and results – mean value

Considering the statistics of Instrumentation for Measurement course since its first edition (1999/2000), which are really impressive, it is possible to conclude that the failed students percentage decreases to 0,8%, figure 10, for the first course using the e-book (2008/2009), from the previous mean value of 6%.

Students performance improved

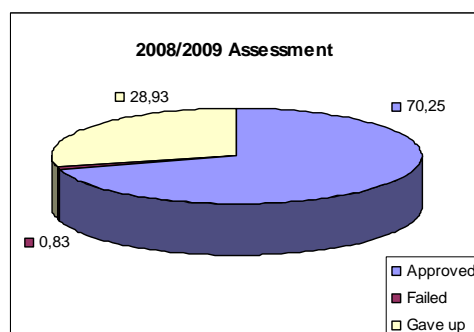


Fig. 10 – Course results

As a note, it should be clarified that the high percentage of gave up students is due to the

current free scheme of course registration.

From the pedagogical point of view this work won the E-learning in Practice 1st place in “Supporting Materials for On-line Learning” category of the 5th Competition within the International Conference ICETA 2008, Slovakia. It had also the 1st place Multimedia Contents category in Prémio ZON Multimedia, Criatividade em Multimédia, December 2008, Portugal.

National and international
awards

