

# DESIGN-BASED LEARNING IN TEXTILES FOR HIGHER EDUCATION

Benny Malengier<sup>1</sup>, Ion Răzvan Rădulescu<sup>2</sup>, Mirela Blaga<sup>3</sup>, Radek Polanský<sup>4</sup>  
and Zoran Stjepanović<sup>5</sup>

<sup>1</sup>*Ghent University, Technologiepark-Zwijnaarde 70A, Ghent, Belgium*

<sup>2</sup>*INCDTP, Str. L. Patrascanu 16, Bucharest, Romania*

<sup>3</sup>*Technical University "Gh. Asachi" – Iași, Str. D. Mangeron 29, Iași, Romania*

<sup>4</sup>*University of West Bohemia, Univerzitni 2732/8, 301 00 Pilsen, Czech Republic*

<sup>5</sup>*University of Maribor, Smetanova 17, Maribor, Slovenia*

## ABSTRACT

Jobs in design and development of textiles require high end software and techniques, and higher education has problems providing adequate training for this, as the possibilities are large, and institutions don't have experts on hand for all options. Distributed design-based learning (DBL) can aid in this, as the experts can come from a larger group, and the focus is on the output, not the specific software used. Design-based learning (DBL) is a modern concept of education for technical disciplines. The learner starts the educational process using end-user applications, and gains understanding of the theory by conceiving projects and solving real-life situations. We present a tool developed for textiles, OptimTex, where 5 modules have been worked out in which textile design software tools are used: weaving, knitting, virtual prototyping of clothing, embroidery and experimental design. Each module tackles 4 to 5 cases, each divided in a four element structure: example, theory behind the example, software, and quiz. Each module was developed by a different group of experts, and follow up of students is done distributed by each group.

## KEYWORDS

Textile, Design-Based Learning, e-Learning

## 1. INTRODUCTION

There has been a shift to a wider use and an increased importance for E-learning and Open Educational Resources (OER) in all fields of education (Grosbeck 2020). The need of online education has accelerated the development of new concepts and practices in e-learning. One of the significant improvements is the shift from OER to Open Educational Practices (OEP). Several educational processes have been enhanced by OEP during the pandemic restrictions in 2020-2021. OER is a content centered approach, with focus on creation and re-(use) of resources, while OEP is a practice centered approach, with focus on interaction between teachers and learners using OER for education (Ehlers 2011).

Another modern educational concept is Project-Based Learning (PBL) and Design-Based Learning (DBL). With PBL, students start learning an educational theme and include the achieved investigation and results into a project. This concept is focused on the students, not on the curriculum, and relies on authenticity of real-life applications of research (Markham 2011, Blumenfeld 1991). DBL on the other hand, implies understanding and application of knowledge in constructing a device or output, often based on STEM disciplines (Darling-Hammond, 2008).

Modern textile applications integrate multiple functionalities as well as electric conductive components. The so-called wearables or smart textiles represent a growing niche of products, able to provide to the textile producer competitive advantages. However, the design of such textile products requires an interdisciplinary approach (textile science, electronics, informatics etc.), as well as appropriate numerical software. Numerical software for textiles have gained in the last decades a great significance, enabling estimation of the fabrics properties in the design phase, such as: drape, mechanical properties (bending, tensile strength), electric conductivity and even ageing. As such, the use of software supports the manufacturing of a smart textile

product, with saving of resources, energy and time, needed to test the properties of the real manufactured products. Moreover, the use of applications for design in textiles is a highly demanded skill within the world-of-work, offering to the skilled worker better prospects for employment.

Considering textiles education at higher education institutes, a limitation in the courses is training with state-of-the-art software tools and production machines, while industry has a high need for profiles with these skills. Often this training is limited due to teachers being only fluent with one or two of these tools. Combining skills of different institutions, and gathering the knowledge in an online e-learning tool can offer a solution. PBL or DBL are very suited for this, as the aim is to obtain practical knowledge to use the software tools. PBL is more suited when only one or two applications are considered, while for a broad training, DBL is ideal, as students can aim to obtain outputs with all software covered. The scientific literature suggests that students learn more deeply and perform better on complex tasks, if they are challenged with real-life projects and activities (Darling-Hammond, 2008). The concept of DBL for engineering education is characterized by opening up the space for multiple and non-unique answers in providing engineering design solutions (Gomez Puente 2014). Solving of engineering design problems includes analyzing, abstracting and synthesizing knowledge in order to achieve innovative solutions by integrating knowledge from various disciplines.

Main aim of this paper is to present the ongoing work in creating an e-learning course with DBL suited for textile engineering students aiming to support training with state-of-the-art textile applications.

## 2. OPTIMTEX APPROACH TO DBL

As most higher education institutions specialize only in some of the tools textile students should be fluent in, an Erasmus+ strategic partnership was set up between research and educational providers in textiles on European level, *Software tools for textile creatives - OptimTex*, with the aim to prepare HEI students in design software for various textile disciplines: weaving, knitting, virtual prototyping of clothing, embroidery, experimental design and a guide on how to apply this knowledge into enterprise practice. This partnership is ongoing, and the OER e-learning instrument will be fully available in 2022.

Training within the field of textile software gains a lot of importance nowadays, and, as the software solutions and textile technology are continuously evolving, adaptation of training materials is an underling need. Regarding the training methods, a common established concept - especially during current pandemic times, are the blended courses, which combine classroom courses with e-learning courses. By combining the advantages of both methods, a more efficient learning process is ensured (Grossek 2020, Radulescu 2017). Classroom courses have as main advantages the close connection between the tutor and the trainee with direct contact and consulting availability, motivation within the learner's community and deep studying. On the other hand, e-learning permits consulting of the educational materials in proper timeslots, with 24h access and at any location with internet connection. Moreover, e-learning has some special features, such as easy access to multimedia content, for explaining the functioning of the textile machinery or the use of design software for a smart garment.

Interactivity in e-learning between tutor and trainees is ensured by synchronous and asynchronous communication instruments, such as chat or forum. E-learning also enables self-assessment of the acquired knowledge by quizzes and offers the possibility of generating mathematical equations with changing parameters for endless versions of tests, such as the WIRIS add-on in Moodle.

As indicated, our tool is aimed at textile creatives, which includes both HE students and young professionals in the industry. This target group aims to upscale their skills in order to become competitive in the world-of-work, and having a broad understanding of software for textile design offers an excellent opportunity in this regard. Not only students require more training of this kind, there is also a tremendous need within the textile industry for highly qualified personnel who has mastered textile design software. While students of one Faculty of the partnership have as learning focus only one textile technology domain, creating a joint e-learning instrument with educational content in all of the five textile technology domains (weaving, knitting, virtual prototyping of clothing and experimental design), the students will have the possibility to learn from each of these domains, and to benefit from the expertise of other partners.

## 2.1 The e-Learning Instrument

Within OptimTex, five educational modules are being developed which cover the main textile technologies to design and manufacture e-textiles, smart textiles, and technical textiles with support of software programs. These are joined with e-learning methods, see Fig. 1. The educational modules, consisting of text, pictures, graphs, and videos, are going to be implemented in e-learning format, by two formats: as e-learning content on the Moodle platform ([www.advan2tex.eu/portal/](http://www.advan2tex.eu/portal/)), and as a special instrument including a HTML5 navigation button for quick and illustrative access to the structured content (<http://www.optimtex.eu/instrument.php>), see Figure 1.

As the covered subjects are very broad, a careful selection is done of the material to include, so as not to overwhelm students, limiting a full module to 20-25 pages of text. The decision was taken to further divide each module in 4-5 design cases. These are then worked out in depth, and they are chosen so as to cover an as broad as possible subject area of the topic. Next, each design case was structured on four elements, in a design-based learning approach (Radulescu 2021): 1/ Example of a special e-textile product, requiring design by software; 2/Theory behind the example one must master to execute the use case; 3/ Applications supporting the design process; and 4/ A Quiz consisting of multiple choice tests for self-assessment.

With this strict structure, the material can be presented to the students in a very organized way, making use of e.g. a HTML5 navigation button. The teacher, or student, can create their own learning path in this way, considering only the use cases relevant for a specific course, or only the use cases of interest for a job application. This approach was introduced to help the trainees understand the theory by real examples. The approach illustrates very well the practical meaning of theory, supports easy understanding, and is in line with the modern concept of DBL (design-based learning).

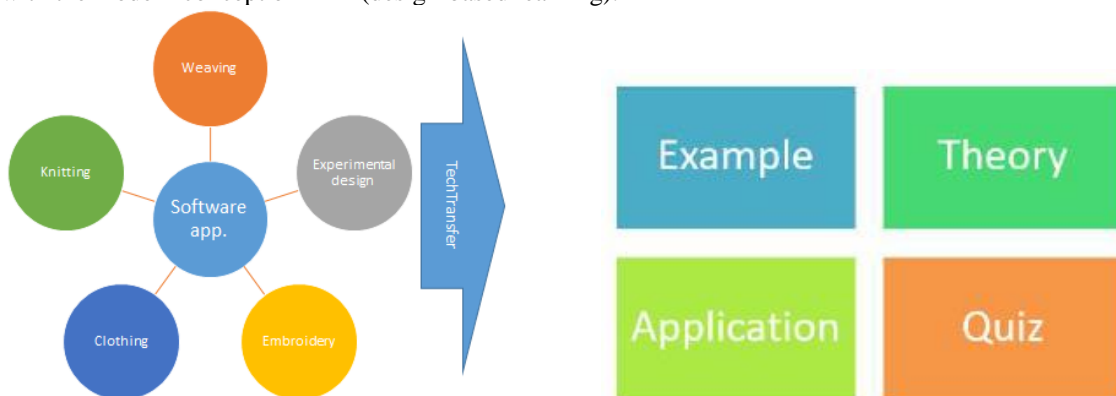


Figure 1. Left: concept of the modules in the project, Right: Structure of a module

The application part is structured in such a way that the students must perform specific tasks with the application in order to master it. The teacher can then link the content to a creative design the students must create. During the first year the proposed e-learning solution envisages support for three Intensive Study Programs (ISP), to be organized within the project. For one week, one of the partner Universities will host a group of 20 students (with 12 mobility students) and one tutor from each partner. Focus will be shared on the specific expertise of the host University, while practical work on the specific textile domain will be organized. As such, the e-learning instrument is specially conceived to support the DBL approach within these three ISPs, to be completed by the practical work in creating technical textiles or e-textiles. The output of these ISPs will serve as examples to other lecturers who want to use the e-learning instrument.

## 2.2 The e-Learning Content

The content is divided in 5 modules, each divided in 4-5 use cases. Each use case again divided in 4 parts. For the part of using the applications to obtain a design output, extensive use is made from video resources. This is done as learning a software via text is complicated for students, and would make the OER very page heavy. A hard limit on 20-25 pages of text for a module can be kept like this, allowing to keep the material manageable for the teachers and students. As example of the build up of the content, we present briefly the content of two of the modules.

### 2.2.1 Weaving Module

The weaving module starts with applying basic weaving theory to create uniform woven fabrics. In this the TexGen software (Brown 2021) is used to create a draft plan and a visual representation. In this way all the standard weaving terminology is trained. As TexGen is open source, this software is ideal for use in an OER. The second use case is the addition of special yarns into woven structures, like conductive yarns, or hairy yarns, with the possibility to create visualizations of the resulting structure. In this way students learn how yarn properties will influence the final fabric structure, and obtain a glimpse of large variety in yarns.

The complexity of the use cases increases gradually, with the third use case covering 3D woven structures, for example the structures created to obtain non-crimp composites, see Figure 1. The aim of creating these structures is to perform engineering simulations, for example with a Finite Element Analysis Software like Abaqus, so the fourth case covers the simulation of a woven structure with Abaqus. In this, the student edition version of the software is used, allowing all students to perform their own experimentation. Finally, to train actual design for a woven structure, the creation of a Damask woven structure is considered as last case, where demo versions of ArachWeave are used, or the new open source online tool AdaCAD.

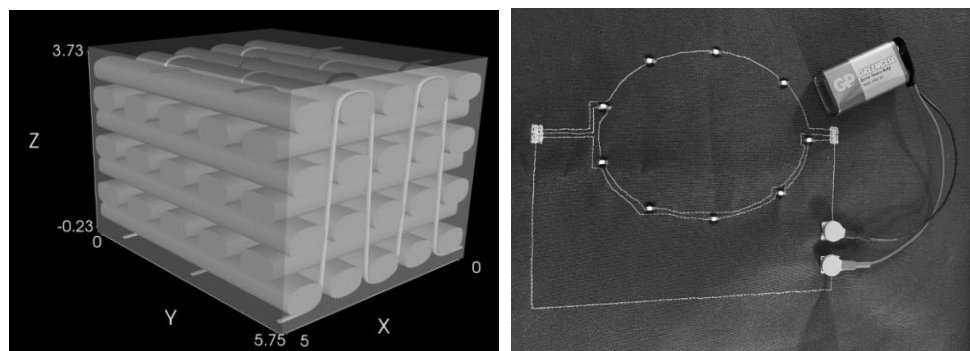


Figure 2. Left: 3D woven structure as generated by TexGen; Right: Embroidered illuminated fabric

### 2.2.2 Embroidery Module

The embroidery module focusses on intelligent textiles. Also here, fully open source software is used so the module is accessible to all students: Inkscape and its extension Ink/Stitch, inkstitch.org, which can generate output files that embroidery machines can use. First, conductive paths are considered together with patches where electronic elements can be soldered. As next case, textile-based heating elements are designed, followed by illuminated fabrics, see Figure 2. Finally, a textile-based water sensor is considered as use case, explaining all steps to design, and create this electronic component with textiles.

### 2.2.3 Promotion of the Content

The content as created will be applied in 3 ISPs, with a total of 36 mobilities for students. Apart from this, multiplier events with participation of 115 young professionals in textile are going to be organized in the second project year, in order to support textile creatives and to demonstrate our innovative approach for textile software training through DBL. All content will be made available through [www.advan2tex.eu/portal/](http://www.advan2tex.eu/portal/) where already different OER in the field of textiles are available. One of these is an OEP created during the Skills4Smartex project ([www.skills4smartex.eu](http://www.skills4smartex.eu)). The DBL created in the current OptimTex project will complement the content available, and offer extra possibilities to young textile creatives to improve their skills under the guidance of the lecturers with up-to-date software in design of technical and e-textiles.

## 3. CONCLUSION

OERs and OEPs have gained a lot of importance in the last decade, and certainly during the pandemic restrictions. Apart from allowing to reach a diverse group of students, OER also allows to collaborate over institutions, pooling resources and experience, so as to improve the education. When considering the training

with state-of-the-art textile software tools, hands on experience is very important. Design-Based Learning is a modern educational concept which is ideal for software tool training, with focus on creating practical output. In order to support OEP and DBL for students in technical fields, an e-learning instruments is under construction, which links practical use cases of software tool use with textile theory knowledge. The DBL approach is meant to drive the educational process complementary to the official curricula. The students are required to perform the example designs through the application use-cases given under expert guidance (live or through the videos accompanying the content), to do the quizzes to test their theory, and then to build on the skills they learn to create their own designs.

## ACKNOWLEDGEMENT

This project has been funded with support from the European Commission under the Erasmus+ Programme. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein. The authors would like to acknowledge the support of the Erasmus+KA2 projects, "Software tools for textile creatives", acronym OptimTex, grant agreement number 2020-1-RO01-KA203-079823.

## REFERENCES

- Blumenfeld et al, 1991. Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning, *Educational Psychologist*, 26(3&4), pp 369-398.
- Brown L.P. et al, 2021. Modelling the geometry of textile reinforcements for composites: TexGen, Chapter 8 in *Composite reinforcements for optimum performance (Second Edition)*, Woodhead Publishing Ltd,
- Darling-Hammond, L, et al, 2008. *Powerful Learning: What we know about teaching for understanding*, John Wiley&Sons, San Francisco, USA.
- Ehlers, U., 2011. From Open Educational Resources to Open Educational Practices, *eLearning Papers*, 23/2011.
- Gomez Puente S-M, et al, 2014. Exploring the effects of design-based learning characteristics on teachers and students, *International Journal of Engineering Education*, Vol. 30, No. 4, pp. 916–928.
- Grosbeck, G. et al, 2020. *Ghid pentru aplicarea Practicilor Educaționale Deschise în timpul pandemiei de coronavirus. Utilizarea Resurselor Educaționale Deschise în conformitate cu Recomandările UNESCO*, Smart Learning Institute of Beijing Normal University (SLIBNU), Beijing, China
- Markham, T., 2011. Project Based Learning. *Teacher Librarian*, 39(2), pp. 38-42.
- Radulescu, I.R. et al 2017. Blended Learning for innovation in textiles, *International Conference on Intelligent Textiles and Mass Customisation (ITMC2017): proceedings*. Ghent, Belgium
- Radulescu, I.R. et al, 2021., E-Learning instruments for design based learning in textiles, *ELSE2021 international conference in e-learning proceeding*, Bucharest, Romania.