



Handbook of Good practices. Virtual training tools and blended methodologies to foster smart textiles into the manufacturing sector

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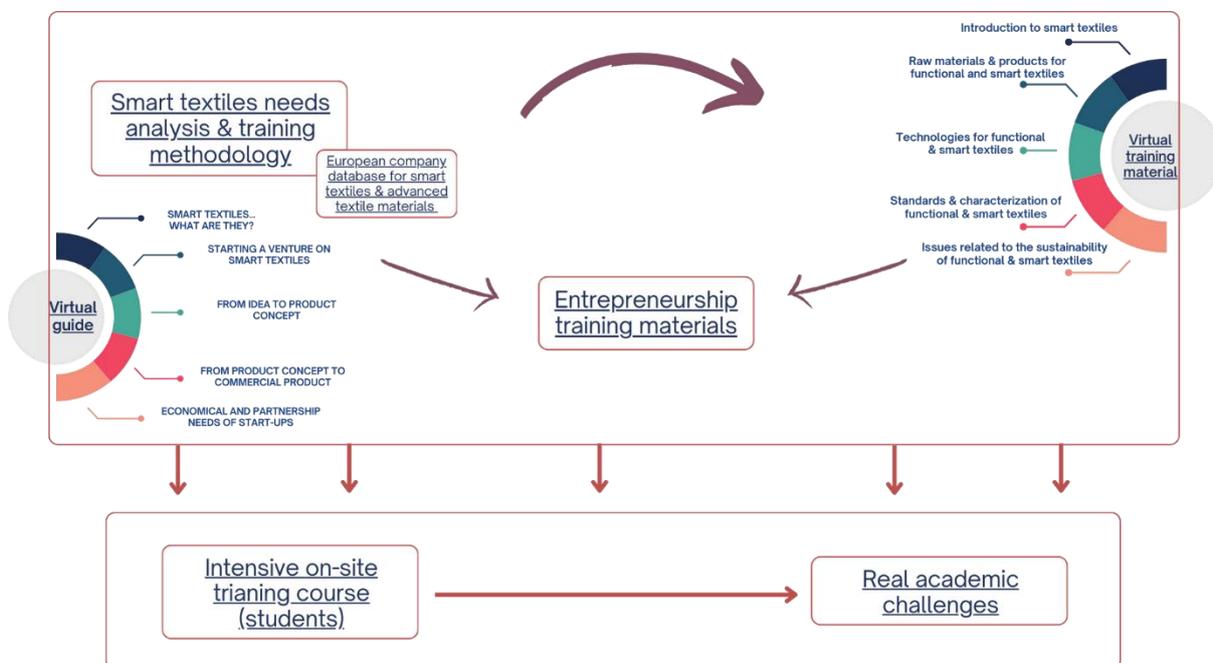
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SUMMARY

This “**Handbook of Good practices. Virtual training tools and blended methodologies to foster smart textiles into the manufacturing sector**” is addressed to academics, students, specialists from the smart textiles sector and managers from companies interested in training their staff.

It was developed in the framework of **HACKTEX project “Innovative smart textiles & entrepreneurship”**. It contains the achievements from the implementation of the project and highlights the lessons learned, the good practices that were developed and the unsolved challenges to be tackled for the replication and the improvement of the HACKTEX model that was developed and validated during the project.

The Model



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The Needs Analysis

For the development of the training material a Needs Survey was carried out in Romania, Slovenia, Italy, Greece, Spain and Sweden, with the participation of students, young specialists, university and research institutes' experts, and specialists and managers from the industry.

34
students/young
specialists

15
experts from
universities and
research institutes

17
Managers/specia
lists from the
industry



The Conclusions

Good practices

- Development of training materials based on needs identified by all relevant stakeholders
- Development of online training materials (videos, presentations, and readings) that are easily accessible any time
- Interdisciplinary approach (Technical and entrepreneurial knowledge)
- Added value of short intensive courses with physical presence of teachers and trainers with different backgrounds, with hands-on activities (blended methodology)
- Implementation of short, limited time contests (Hackathons) for students
- Database with companies producing smart textiles

Lessons learned

A. In terms of the quality of the content

- It is a good practice to link the technical aspects of the smart materials with entrepreneurial issues
- The training materials must have enhanced interactive elements and more information in graphic form. Assignments (especially for students) could be useful.
- Short summaries and key insights after completing each chapter is useful. All materials are preferred in a synthetic manner.
- The training materials must be designed according to the knowledge level of users (beginners – B.Sc., medium – M.Sc. and advanced – Ph.D.).

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B. In terms of usefulness

- Usefulness could be increased by credentials for those who attend the MOOC. This requires the study programs to include these materials as part of lectures or as separate studies.
- For textile companies, transitioning toward smart textiles requires staff training and funding. Free access to information (training materials) is extremely useful.
- Most existing training materials on different focus on students and academic studies, rather than professionals who want/need to update knowledge in the field of smart textiles.
- Usefulness could be increased by translating the materials in different languages, especially for the companies.
- Closer cooperation with the industry would increase the success of replicating the HACKTEX methodology by discussing topics of interest to the sector.

C. In terms of accessibility

- Finding suitable online courses is challenging due to time and financial constraints.
- More efforts should be made to disseminate among companies.
- Use also other languages besides English for the training material would make them more accessible.
- Market professionals appreciate the availability of free educational resources.
- Materials should be easily accessible and promoted through various platforms.

Challenges

- Maintaining the state-of-the-art level of the training materials to reflect the advancements in the sector
- Securing resources for the development of MOOCs
- Ensuring users (students or employees) take the time to complete the training
- Use of virtual reality as an alternative format
- Extension of the training material to cover more topics
- Incorporation of the Massive Open Online Courses into the standard curricula of the Universities
- Provision of credentials for the students that attend the MOOCs
- Securing resources for the implementation of the intensive short face-to-face courses
- Creation of educational platforms and training materials with a focus on market professionals

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1. CONTEXT

The European textile manufacturing industry is confronted with multiple significant problems, including competition from developing markets, ongoing digitalization, and environmental requirements pertaining to sectoral sustainability and achieving climate neutrality. Europe needs to reevaluate its position on important variables affecting its competitiveness, such as the distinctiveness of its products, the skills of its workers, and innovation as a source of competitive advantage, in order to meet the demands of the present and the future.

A broad category of sophisticated textiles known as "smart textiles" include new, improved, or dynamic functions that are achieved by high-performance raw ingredients and specific chemical and physical processing. Because smart textile products have a wide range of applications in fields like sports, construction & living, medicine, automotive & aviation, and personal protection, they can have a significant impact on the economies of EU member states. Focusing on the technical characteristics and controlled functionality of textile materials, advanced, smart, and functionalized textile materials are a developing area within the textile industry, propelled by transdisciplinary innovation in numerous end-markets. Even if the majority of the field's research hasn't yet made its way into the business, studies on this field are a response to the sector's experiences, including the decline brought on by pandemics and the necessity to adjust to Industry 4.0's requirements in order to build the sector's resilience. Higher education institutions must increase the amount of knowledge about smart textiles they teach in their engineering programs to unlock the innovative potential of the advanced textile manufacturing sector and promote the growth of innovation inside textile enterprises.

In this context, the HACKTEX project focuses on the requirements for digital education and innovative methodologies in order to address the gaps and mismatches in skills and competencies that have been discovered. These are necessary to create new opportunities that are made possible by smart textiles research into the manufacturing of advanced textiles. It will give HEIs useful techniques and resources to employ in regularly educating upcoming experts in the field of advanced/smart textiles. The industry will thereafter use the skills produced based on the digital training tools and techniques created by HACKTEX.

To address these challenges the HACKTEX initiative aimed to create essential tools for enhancing skills geared towards higher education, specifically focusing on innovation.

Its objectives include:

- Assisting higher education students in acquiring skills related to transdisciplinary innovation for smart textiles.
- Encouraging multidisciplinary collaboration among students through hands-on projects.
- Delivering knowledge, skills, and competencies via virtual learning methods and tools.
- Advocating for the adoption of best practices to enhance innovative skills.

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- Strengthening collaboration between higher education institutions in the textile industry and those in advanced textile sectors.

To meet its objectives, the HACKTEX project anticipated a series of activities and outputs as:



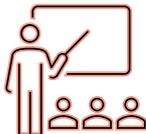
Field research addressing the needs of the sector through a survey targeted to a) experts and/or managers from companies manufacturing smart textiles or intending to jump to such a production, b) relevant experts involved in training and research (universities/research institutes) and c) students from textile engineering specializations. The aim of the survey was to conclude on and define the training methodology and the syllabus (macrostructure) of the training courses to be developed.



The setting up of the microstructure of the training, the development of relevant videos and reading materials, and the launching and dissemination of the outputs to the target groups, based on the results of the needs analysis, with the aim to provide students and entrepreneurs with the necessary knowledge and skills required expand their activities in the field of advanced and smart textiles.



The creation of a virtual methodological guide focused on smart textiles entrepreneurship, consisting of videos, presentations and readings, a tool necessary to provide knowledge on how to create, sustain and further develop a smart textiles business. Complementary to the Virtual Guide, an EU company database was developed, allowing interested parties to dig deeper and search through the smart textile companies active in the EU.



The implementation of an intensive summer education programme addressed to university students, where the methodology of training and the training materials are implemented, tested and validated.



The development of the “Project handbook of good practices & open challenges: training tools and methodologies to foster smart textiles’ in advanced textiles’ manufacturing sector”, containing all relevant information related to the project and its achievements, as well as open challenges to be tackled, with specific focus on digital skills and digital innovation in learning.

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The HACKTEX project was implemented by 8 partners from six EU countries.



UNIVERSITATEA TEHNICA GHEORGHE ASACHI DIN IASI
(Coordinator)



Romania



ASSOCIACIO AGRUPACIO D'EMPRESSES INNOVADORES TEXTILS



Spain



CREATIVE THINKING DEVELOPMENT



Greece



CIAPE - CENTRO ITALIANO PER L'APPRENDIMENTO PERMANENTE, Italy



Italy



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

UNIVERSITAT POLITECNICA DE CATALUNYA



Spain



PANEPISTIMIO DYTIKIS ATTIKIS



Greece



HÖGSKOLAN
I BORÅS

HÖGSKOLAN I BORÅS



Sweden



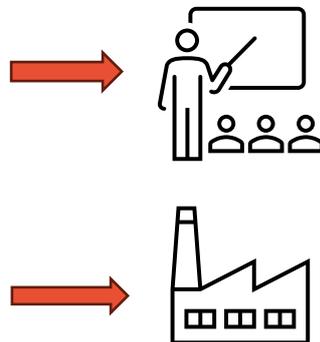
TITERA technically innovative technologies



Slovenia

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The project targets a) University students and academic experts that need to expand their knowledge and skills on advanced/smart textiles and products and b) companies that are already involved in the production of advanced textile products or are interested in going in this direction.



2. THE MODEL

2.1. Evaluation of needs

The first and very crucial stage of the HACKTEX project, was the needs analysis. Its aim was to identify the current and the future training needs of the advanced/smart textiles and products sector to develop appropriate training courses and methodologies addressing these needs.

With the aim to discover the latest situation in the field of smart textiles and products, field research was implemented with the use of online questionnaires. Three target groups were considered for the survey: a) managers (industry), b) experts (from HEIs and research institutes) and c) young professionals (students).

The core part of the questionnaires that were distributed to academic experts and managers examined the following three parameters:

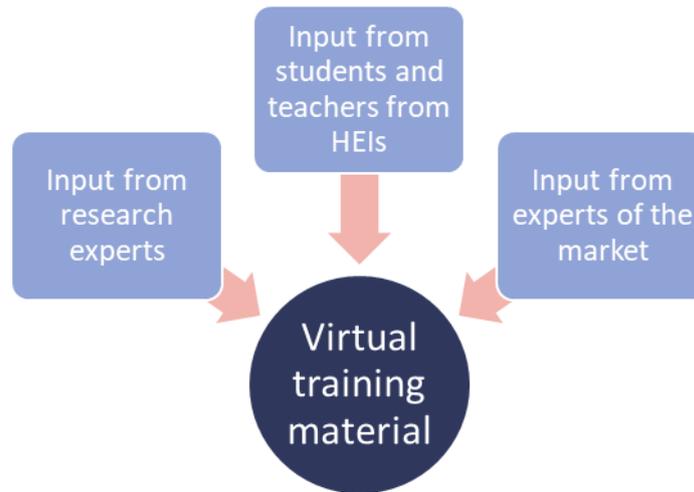
- Current needs of the smart textiles sector in terms of manufacturing and education
- Existing initiatives in the smart textiles sector in which the respondents are engaged.
- Weak points in engineering training for the field of smart textiles from the point of view of academic experts and industry

Young professionals (students enrolled in textile programs) were asked to answer only to questions relevant to the current training needs.

The questionnaires were answered by 17 managers/specialists from the industry, by 15 experts from universities and research institutes (most of them academics in universities) and by 34

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students/young specialists (most of them from technical universities). The respondents came from Romania, Italy, Spain, Greece, Slovenia and Sweden.



2.2. Training methodology – training materials

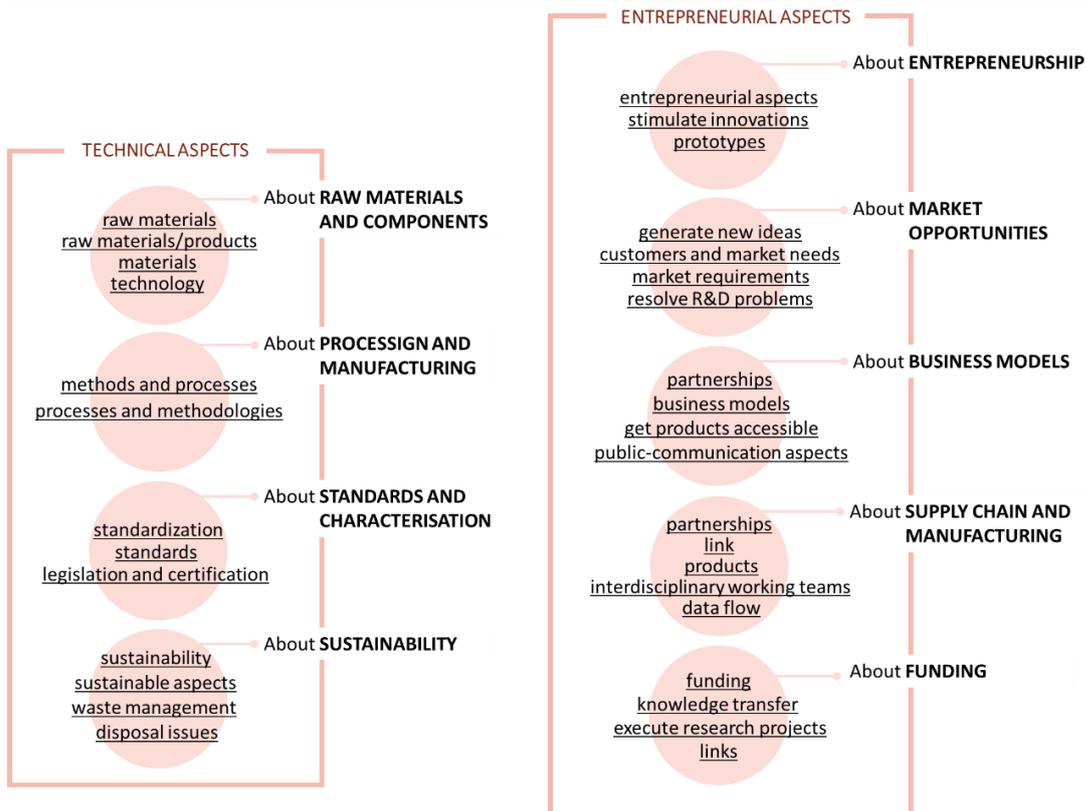
Both technical skills and entrepreneurial skills were perceived as necessary for universities and companies in the field of advanced/smart/functional textiles and their products. This led to the creation of two separate categories of training courses:

<p>Massive Open Online Course (MOOC) on technical topics</p>	<p>Entrepreneurship course (Virtual Guide and EU companies' database)</p>
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The training courses are open to all interested parties and are delivered online with the asynchronous method. The lessons can be accessed through the project's website: <https://hacktex.eu/>

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2.2.1. Technical knowledge and skills – Entrepreneurial knowledge and skills



The virtual training materials on smart textiles are developed as

- o **video lectures** for a more condensed presentation and
- o **readings** with more details and references on each topic.

2.2.2. The Virtual Guide

The knowledge to be acquired for the enhancement of entrepreneurial skills was identified and presented in the Virtual Guide, which acts as a navigation tool that links issues of concern of the project's target groups to the training materials developed.

The entrepreneurial part of the virtual training materials comprises three resources (video lectures for a more condensed presentation, presentations and readings with more details and references on each topic)

2.2.3. The Bootcamp (Intensive Summer School)

For the testing and validation of the training material as well as for the testing of an innovative training methodology, intensive courses/Bootcamp was held in Sweden for students from HEIs. The Bootcamp lasted 5 days, the fifth day being dedicated to free exploration and networking

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by the students. A prerequisite for attending the bootcamp was to study first the virtual online training material (MOOC) already developed by the partnership.

A blended approach was used for the intensive courses combining theoretical presentations by the instructors and presentations by the students relevant to the acquired knowledge, discussions and team work in small groups, hands-on experimentation and other participatory activities and workshops, visits to labs and factories, Q&A sessions, and a hackathon, an event where students engage in accomplishing a rapid and collaborative work/task over a relatively short period of time.

Combining all the elements mentioned above, the intensive Summer School offered also an innovative educational process and methodology which was tested during its implementation.

Testimonials from Trainees

The trainees that participated in the Bootcamp were very satisfied with this experience in many aspects. The Bootcamp offered an excellent opportunity for them to test and put in practice the knowledge acquired by watching and studying the virtual training materials and at the same time to be exposed to a blended learning environment where they were involved in hands-on activities and could make use of and develop their soft skills. The fourth day of the training a hackathon took place. The challenge for the students' groups was to develop a business plan so their product can be produced and commercialized.



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Testimonials from the trainers (good practices, lessons learned, key messages and impacts)

Training materials

For the trainers, the MOOC and the Virtual Guide represent a very well-organized tool which contains an overview of the whole process for the development of a smart textile product. Hence, there are sources enough to deepen in any of the topics included.

For students, the content is intuitive and logical. Through the lessons, they acquired a global idea of all the relevant topics related to a smart textile product.

The Bootcamp

The evaluation of the Bootcamp by the trainers revealed several good practices and lessons learned.

Importance of hands-on learning: Starting the bootcamp with practical group work was a success as students started to interact, discuss and enjoy the session quickly. One of the other main learning goals of the bootcamp and training materials which was triggering the creativity of the participants was achieved successfully in different days by giving them the task to generate ideas for development of smart textiles.

Skill development and application: the primary goal of the bootcamp was to equip students with new skills and knowledge that they can apply directly in their work or personal projects.

Collaboration and networking: during the bootcamp students were encouraged to collaborate with their peers, share insights, and build professional networks. Group activities and discussions could facilitate meaningful connections.

Clear communication: The instruction and objectives of each day were communicated clearly to participants to avoid confusion.

Resource allocation: Good planning and allocation of the resources, for example time, budget and personnel to effectively implement the bootcamp to support its success were parameters that led to the success of the Bootcamp. The venue and the coffee break were greatly appreciated by the participants.

Participants engagement: the sessions in which students had more interactive sessions were more appreciated, as they were engaged and motivated.

Results – positive impacts

Enhanced skills development: students may experience significant improvements in their skills and knowledge related to smart textiles and entrepreneurship. This can lead to increased confidence and competences in their professional roles.

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Networking opportunities: The bootcamp was an opportunity for students to connect with peers and trainers. This networking can lead to valuable collaborations, mentorship opportunities, and career advancement prospects.

Increased engagement and motivation: the interactive learning environment of the bootcamp kept participants engaged and motivated.

Professional growth: Both learners and trainers may experience professional growth through their involvement in the bootcamp.

Positive feedback and recognition: the bootcamp was successful, and both learners and trainers received positive feedback and recognition from stakeholders.

Negative Impacts:

Overwhelming workload for the organizer of the Bootcamp: The host University received about 30 participants from different countries. The respond to the demands of planning, delivering, and participating were overwhelming.

Disappointment of learners: A negative impact of the hackathon may be the disappointment of the learners if they do not succeed. This should be managed by the instructor, explaining that the aim is not the product, but the journey to the creation of the product.

3. HOW THE MODEL CONTRIBUTES TO EDUCATION (GOOD PRACTICES AND LESSONS LEARNED)

3.1 Testimonials from partners

In order to collect the opinions of the partners on the good practices that came up as a result of the activities of the project, a questionnaire/template was used.

The Good Practices identified were:

- Hackathon as a collaborative training activity
- Catalysing Innovation in Smart Textiles through entrepreneurial education
- Bootcamp activity combining technical and non-technical education
- Multi-integrated educational model

They revolved around three themes:

1. the Bootcamp activity with the integration of a Hackathon;
2. the combination of technical and entrepreneurial skills;
3. the methodology implemented during the HACKTEX project.

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3.1.1 The Bootcamp

The aim of the Bootcamp activity was:

- a) to consolidate and test the knowledge acquired from the virtual materials through learning and experimental activities related to materials properties, sustainability issues, resource efficient technologies and functional and smart textiles entrepreneurship;
- b) to improve the creative processes related to product development and innovation;
- c) to test a method of improvement of engineering education in the field of smart textiles;
- d) to ensure adequate skills both for engineering and entrepreneurship and
- e) to facilitate the cooperation and mutual learning between the academia and the industry.

From an academic perspective, most knowledge is often acquired through a theoretical and a non-interdisciplinary approach, through lessons taught in a class with little interaction between the teachers and the students, and lack of engagement of and motivation for the students. The learning approach is mainly based on the study of materials given in books or other written resources as notes or research papers. On the other hand, no space exists for students to develop, explore and test ideas and improve their creativity and other soft skills.

From a business or company standpoint, there exists a disparity between the demands of companies and the qualifications that students possess upon entering the workforce. The actual requirements of a company and the skills set expected of employees often diverge significantly from the training provided during higher education.

The Bootcamp activity combining theoretical and practical parts, including a) discussions among students and between students and teachers, b) exchange of knowledge, c) hands-on experiences, d) involvement in common projects, e) working in groups, f) development of ideas, g) getting in contact with different academic backgrounds, universities' students and professors as well as cultures, and h) participation in a contest (Hackathon) offered an innovative learning approach for the students and for the teachers an ingenious training methodology.

The Hackathon, a limited time contest, where participants are requested to start from blank paper and work in order to provide a final result, gave them the opportunity to work in groups and put in action the acquired theoretical and practical knowledge, towards the creation of a real application.

The students, as it is shown from their testimonials, although they found it very intensive, enjoyed very much the whole experience from the point of view of the teaching tools and approaches used as well as from the point of view of the intercultural exchange. They were given the opportunity to test and improve their soft skills as leadership, teamwork, experimentation, problem solving, time management and accomplishment of tasks.

For the Professors, the Bootcamp was and excellent opportunity to explore and experiment with new and innovative teaching approaches.

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3.1.2 The combination of technical and entrepreneurial skills

Besides a very good technical background, the bringing into life of a new product, service or business and its commercialization requires much more than pure scientific knowledge. Many factors must be considered for a successful venture. The definition of the product/service, the target market, the value proposition, the identification and acquisition of the appropriate raw materials and human capital resources with the necessary skills and qualifications, the supply chain, the marketing plan, the resources of funding and the budget are some of the parameters that should be brought together. This knowledge is usually part of the curricula of economic and business studies, while most of the times, it is totally missing from other field studies.

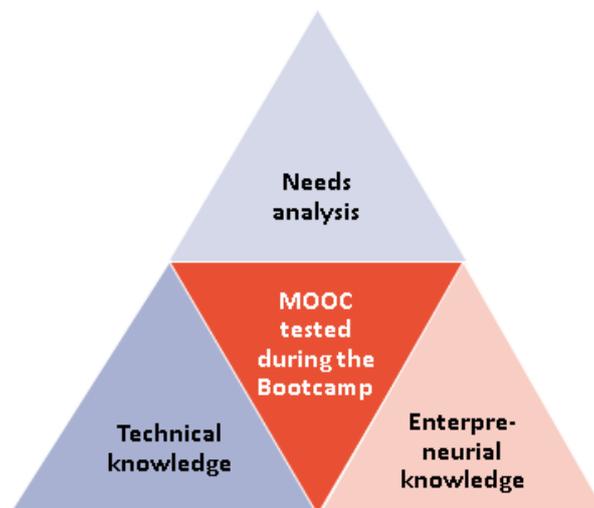
The lack of this kind of knowledge is often a source of difficulties in the communication between the management and the people working, usually in the designing and production departments of a company.

For the better preparation of young professionals of the textile engineering field and the understanding of the entrepreneurial aspects of a venture, the training material developed by the HACKTEX project combined the functional/smart textiles specialized courses with courses on entrepreneurship bridging the gap between academia and the industry.

On the other hand, from the perspective of the managers and the new entrepreneurs that want to start their own business, the specialized on functional textiles courses offer a technical basis and the necessary knowledge for understanding their properties and relevant technologies.

3.1.3 The Methodology implemented in HACKTEX project.

The HACKTEX project, proposed and implemented an innovative educational methodology for complementing academic studies in the field of functional/smart textiles.



Based on the combination of existing knowledge and state-of-the-art information on materials, technologies, concepts and teaching methods, virtual courses specialized on smart textiles were

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developed. The curricula of these courses were based on **input from students and teachers from Higher Education Institutions, from research experts as well as experts from the market**. This ensured an integrated approach to the field, covering the needs of all the stakeholders.

The **use of videos and presentations**, as the basic means of transferring of information, accompanied by readings make the lessons more attractive, keeping the interest of the learners. The use of visual stimuli and the short duration of presentations are adaptations proven to be more effective for the absorption of knowledge. The readings that accompany the videos and presentations are indispensable for those who are interested in enhancing and deepening their knowledge.

Online open access to the virtual training materials offers the opportunity not only for undergraduates but also for graduate students and experts on the market who are already involved in or are interested in expanding their knowledge and activities to the field of smart textiles to profit from this, permitting the adaptation of the learning process to their own needs, level and pace and the attendance from a long distance.

The **interdisciplinary approach**, combining input from different fields and advancements of the smart textile ecosystem and the textile ecosystem in general, and the incorporation of business-oriented subjects provide a more integrated perspective, that offers better opportunities for young textile engineers (but for other engineers as well) who want to be successful in applying for a job.

The implementation of **the bootcamp methodology** in the form of a short intensive course that requires physical participation of both students and teachers offers many training advantages. The short duration of the course permits students and young professionals to include it in their academic activities and other commitments. It's an opportunity to take part in focused workshops and experimental and other hands-on activities, to work in groups on common projects, exploring and improving their cooperative and leadership skills, to acquire time management skills, since they have to accomplish certain tasks in a limited time, to exchange knowledge and experience with students and teachers from different cultures and educational systems, to develop their presentation skills and enhance their self-esteem, feeling satisfaction from the creation of a final product.

The **inclusion of hackathons** i.e. short, limited time contests that address challenges found in real world coming from the market, motivate the students to work efficiently in groups and focus on problem solving boosting their creativity and fosters the combination of acquired theoretical and practical knowledge.

3.1.4. Lessons learned

The list below synthesis the positive and the negative lessons drawn from the implementation of the project.

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- The Massive Open Online Courses (MOOCs) are very well accepted by the students of the HEIs and they can also be attended by other stakeholders since they are open access
- The MOOCs, as short courses, can be incorporated in the standard curriculum of the universities
- Videos offer the opportunity, especially for the market actors (but not only for them), to receive quick and condensed information about different topics whereas readings offer a more detailed approach for those who are interested in deepening their knowledge
- The development of curricula and training materials for the MOOCs in order to be successful and offer state-of-the art knowledge require input about all actors' needs (HEIs, research organization, market)
- The incorporation in the virtual training material for smart textiles of entrepreneurial aspects expand the educational purposes and enhance multidisciplinary skills of students with technical background preparing them better for their entrance to the market
- Short intensive courses (Bootcamps) with the participation of trainees and trainers from different countries and universities are an element of added value to the MOOCs since they offer the opportunity to the participants to exchange ideas and experiences and the possibility of networking
- The blended learning methodology where theoretical knowledge is accompanied by hands-on practical activities is a learning
- The preparation of MOOCs as a complementary tool to the conventional text-based teaching methods is labour and time intensive activity that puts extra workload to the teachers
- Intellectual properties issues for the creation of the MOOCs have not been addressed by the project
- It is not easy to organize transnational intensive courses due to the lack of funding and time needed by the universities for the logistics.
- The cost of the materials used for the practical activities cannot always be bearded by the universities
- The physical involvement of the external experts from the participating universities of the HACKTEX project would be a challenge for replication due to budget constraints. However, digital media can be used to tackle this challenge
- The diversity in the background of the students that participate in the intensive courses and the Hackathon activity may be an inhibiting factor to their success
- For the replication of the Bootcamp outside of the HACKTEX project, there can be a difficulty to find experts that are willing to commit.

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experience highly appreciated by the students

- Teamwork provides a great possibility for students to develop their soft skills and leads to a more holistic accomplishment of different tasks and to the development of innovative solutions
- Prizes, credits or internships for the successful accomplishment of the courses and/or for the winners of the hackathons are significant incentives for the participants
- A user-friendly platform for hosting the MOOCs is of high importance
- The importance of the Hackathon practice

4. FUTURE CHALLENGES

The partners were asked to identify future challenges in relation to the project and its results. This will give insights for the future implementation of the model developed and tested through the project. It will also set the basis of improvement and further exploration of the model.

4.1 Recognition of a blended learning experience

Through the project, the usefulness and added value of the blended learning experience to undergraduate and graduate students was confirmed. Besides the HEIs, the blended learning experience, with some adaptations, could be also used for the training of people from the industry.

Regarding the academic world, such a methodology is not yet implemented at a general scale. The embracement of such a venture as a standard process and as a tool for the improvement of their curricula, is very promising and very well accepted by the students.

Recognition, accreditation, and qualifications obtained on the EU level are important matters for participants in the Bootcamp and the attendants of the MOOCs.

4.2 Training material with digital content

Digital training contents/materials provide a very useful supplement to the conventional document-based training material. It is more attractive to learners, since it is interactive and multimodal (text, video, sound, interactive activities).

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They provide a good alternative to practical training for skills on machines, apparatuses, tools, in a cost-efficient manner.

Availability and operation of digital content is generally restricted by technology infrastructure (computers and networks). These should be high end, to be able to support the digital content.

The creation of virtual training content is time intensive labour compared to the conventional text-based material. Support and maybe technical assistance should be in place for teachers.

A relevant solid and well-defined strategy of the HEI should be in place, so that content creators are encouraged to work on the creation of the digital interactive educational content, rather than remain stuck to the conventional one.

One last factor is the rules of intellectual rights of digital content. Teachers should have a clear understanding of these rules because digital content is easily copied and reproduced, and consequently easily stolen or misused.

The costs related to digital/interactive learning refer to the acquirement of funds for technological infrastructure, for software licenses and subscriptions to digital platforms and applications. Allocation of man ware resources, including multimedia and ICT technical staff is also required.

Digital applications as well as the domain of the smart textiles sector are constantly evolving, so renewal of the digital training tools and contents should be a regular process in order that it is effective as a training material. Furthermore, if it licensed under an open license (e.g. Creative Commons), and it will offer profit to the educational community worldwide

4.3 Benefits of the symbiosis between the industry and the academia on (but not only) smart textiles - Implementation of new technologies

The advantages of encouraging the cooperation between industry and academic institutions have been widely discussed and acknowledged. Students encounter the needs and problems of the market which they will be asked to solve in their professional career and the industry recognizes the profit they can obtain through experimenting and developing new or improved products and solutions if they get involved in common projects with the academic world.

The capacity to get the commitment and involvement from several kinds of stakeholders who are constrained by a series of factors such as the limited time, the human resources, or, most probably, their priorities to invest efforts in alternative training methods that do not favour the inclusion of this methodology as a structural activity in time remain crucial.

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Changing the perception of stakeholders from the market who might be reluctant to invest efforts in this kind of learning activities, making them aware of their potential and benefits remains a very big challenge to be solved.

Cross-sectorial cooperation is a very important issue with many possibilities since it can provide innovative and smart solutions. Networking during the blended training approach could offer new opportunities for development.

4.4 The replication of the bootcamp model

A question to be answered is how feasible the replication of the model (blended learning methodology) is proposed by the HACKTEX project and of the bootcamp training event as a regular way of learning.

For the learners, the benefits of participating are the development of critical thinking and problem-solving skills, getting opportunities for networking with other students, networking with industry stakeholders, searching for work experience options and obtaining potential mentorship. The professors on the other hand benefit from the networking and exchange of knowledge and expertise with colleagues from other universities and from developing their professional qualifications.

Secure of resources and international participation can be a challenge for the replication of the HACKTEX model.

During HACKTEX, the costs necessary for the physical participation and involvement of external experts in the Bootcamp as trainers and mentors as well for the participation of students from different countries were incurred by the project. The purchase of materials and kits that were used during the bootcamp were also covered by the project funds. And the same stands for the human resources that were needed to organize and support the Bootcamp.

Regarding the lack of international participation, a multidisciplinary participation of experts could be equally interesting and useful. Regarding the availability of materials and lack of budget, this could be solved by contacting companies that produce smart textile products, to see if there is any potential collaboration or agreement to facilitate such materials. Regarding the lack of facilities, this would require some collaborations of the organizers with other strategic institutions or providers.

Digital media could contribute to the reduction of the costs. Another solution could be the organization of the bootcamp locally with the involvement of university and market experts, although the added value of this solution would be less beneficial.

The model of bootcamp is sustainable over the time if experts are available. The commitment of the renowned experts in the domain to participate, as it requires extra effort and time investment, is a further constraint. At institution level, university and industry partners can replicate the bootcamp with their existing infrastructure and resources.

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In the long run, an update of the training material and the bootcamp program is necessary to stay ahead with the fast-growing innovation in the domain. The continuation, the update and the sustainability of the model could be explored through a follow-up project (HACKTEX 2.0).

Even if there is success in the implementation of the HACKTEX methodology in the framework of the project, its sustainability and replicability in time require understanding the stakeholders' priorities and needs and transform the content of the virtual training accordingly.

The participation of the industry stakeholders is vital to ensure that the blended learning experience provides benefits for the students and the industry. Challenges proposed/posed by the industry either as problems to be solved by the students or as state-of-the-art subjects for the training of companies are very important for a successful experience based on real world scenarios that bridge the gap between industry and academia.

Well prepared teachers: The use of blended learning requires additional skills from the trainers as good organization and appropriate handling of time and good communication skills are needed. A wide knowledge of the subject and the designing of experiential and other teamwork activities need extra time from the trainers.

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