New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION

Teaching Smart Textiles to Future Textile and Clothing Engineers in A Hands-On and Gamified Way - an Insight into The Development of a New Learning Setting with Design Thinking and EMPAMOS

Bräuning, Manuela

Albstadt-Sigmaringen University, Germany

Abstract

How can we prepare the future specialists currently studying in the field of engineering, especially in the textile and clothing sector, competently and purposefully for the challenges of Smart Textiles, the combination of electronics and textiles? The aim of the project is to support students in acquiring professional skills specifically for the development of Smart Textiles products. For this purpose, a new learning environment and a construction kit are developed. The kit is designed to be flexible to the needs of the students, allowing them to experiment in the field of Smart Textiles and also to anticipate mistakes in order to learn from them and avoid them in the implementation of products. This enables the students to actively and sustainably influence the product development processes - they are actively involved in the development process in order to optimally adapt the tool to the target group. In order to keep motivation high while dealing with this complex topic, the handling is gamified. In a teaching-learning arrangement, the methods of Design Thinking and EMPAMOS were used and combined with the tools of Participant Observation and Learning Reflection. An insight into the process and the results of the work with the EMPAMOS Cards and Design Thinking is given. For example, some of the fascinating individual prototypes built using a variety of materials such as sticky notes, string, building blocks, plasticine, etc. will be explained and best practice experiences of working with students using innovative tools will be shared.

Keywords: *Engineering, Design Thinking, Gamification, Smart Textiles, EMPAMOS, Motivation*

1. Introduction

This work is based in the field of engineering studies, more specifically in the field of textile and clothing technology studies. It is about new teaching-learning scenarios and their development specifically for the field of smart textiles. In the following, the field of Textile and Clothing and Smart Textiles is explained, before the new approach with Design Thinking, EMPAMOS and a learning kit is explained, the procedure is presented and the evaluation is discussed. Finally, the future plans are presented and the paper concludes with a summary.

1.1 Textile and clothing engineering

The textile and clothing industry are both traditional and innovative. However, companies face the challenge of systematically developing new knowledge in order to remain market leaders or to move into new business areas such as smart textiles, a cross-disciplinary combination of textiles, electronics and informatics. We therefore need to ensure that the engineering workforce of the future will be highly skilled and able to meet the challenges that lie ahead.

1.2 Smart Textiles as an interdisciplinary field of the future

Smart Textiles products - products with added value - will contribute to the next revolution in textile and clothing technology and are predicted to have a high market potential. [1] Smart textiles are defined hereafter as textile products that interact with their environment and can therefore actively support the user. They are divided into I-textiles and e-textiles, where e-textiles have adapted or integrated electronic components. Although smart textiles have been developed for decades, their everyday use is still in its beginnings. Some well-known examples are smart shirts for monitoring vital signs, heated underwear or illuminated personal protective equipment. The ability to develop smart textiles is one of the core competencies of future engineers, as this market also addresses the megatrends in our society, such as digitalisation, mobility, health, individualisation and the silver

society [2]. This is why a new teaching approach is being developed together with the target group in order to foster competences for product development in this interdisciplinary field.

2. Didactical approach and methods

In order to keep motivation high when dealing with this complex topic, it is handled in a gamified way. Gamification was chosen as a method because it combines fun and social interaction. It helps to satisfy curiosity and supports learning. The methods of Design Thinking and EMPAMOS were used and combined in a teaching-learning arrangement. Among other things, motivation, creativity and cognitive skills are positively influenced.

2.1 Teaching and Learning arrangement

This research project is in the field of constructivist learning theory, which assumes that knowledge cannot be transferred from teacher to learner, but that knowledge is individually constructed by each learner. In this process, prior knowledge is active and the learner must take responsibility for his or her own learning process. [3, p.4f] In this project with a design based approach, a heterogenic group of students from the Masters in Textile and Clothing Management completed the following programme: Online introduction to Smart Textiles, self-study with a detailed script and independent research, collaborative workshop using Design Thinking and EMPAMOS methods and applying the Wearic Smart Textiles kit as well as other Smart Textiles components, elaboration of a lab work in groups, presentation and finally an individual learning reflection.

2.2 Design Thinking

Design Thinking is a human-centred problem-solving method that focuses on solving problems from the end user's point of view, thereby focusing and often accelerating the product development process compared to other methods. For this reason, the development process for the construction kit and the learning environment is based on the user-centred creativity method of design thinking, in which the needs of future users are of key importance. For this purpose, Design Thinking classically goes through three phases in the problem space and three phases in the solution space in a clearly structured process.

2.3 EMPAMOS

In addition, the EMPAMOS method from the research project Empirical Analysis of Motivating Game Elements, which includes a toolbox designed to be used as a creative thinking tool to motivate learning and work environments, was used. EMPAMOS is not about adding an extra layer of game principles to a learning process, but about using a system of game elements in an abstract way, even in non-game contexts - this is what the specific toolbox is used for. [4] It includes, among others, a set of cards on Game Design Misfits and a set on Game Design Elements which were used by the students for the analysis and to foster their ideas during the workshop. First, the twelve 'Game Design Misfits' cards are used to assess what is missing. Each card represents a typical problem or game element. A short description is printed on the front of the card and questions are printed on the back to encourage reflection. In addition, the wooden links are used to create a network that reflects the situation and stimulates discussion to find a solution. Based on the existing elements, the EMPAMOS construction kit can be used to find the game elements that compensate for the motivational deficits. In addition, the specific problems and possible optimisations were noted on coloured sticky notes.
In a further step, the 'Game Design Elements' cards, also from the EMPAMOS toolbox, were used to develop creative ideas for repairing the 'broken game' of the deficient kit or for developing gamified tasks and games. To do this, the students made a selection of cards and linked them together to create a motivating and appealing follow-up product, the basic idea of which had been developed in the design thinking process.

2.4 Workshop with students and lab work

Within the described workshop, using The Wearic Kit (a construction kit, that is intended to help people discover the potential of Smart Textiles), Design Thinking principles and the EMPAMOS toolbox, the students had in groups the following three tasks:
1. to conceptualize a product idea for the field of Smart Textiles
2. to document the weaknesses of the existing construction kit for the implementation of their idea into a prototype and
3. to realize a gamified task or a small learning game with given Smart Textiles components.

In the following 2 figures you see examples from the workshop using the EMPAMOS Toolkit and the Design Thinking approach to generate first ideas to optimize the construction kit, which as standard, contains only textile-based sensors for pressure and moisture, buttons, sewable LEDs and an expansion board with an Arduino nano-controller, whereas the board and actors are connected using conductive snap fasteners. [3].

Figure 1: EMPAMOS Misfits Cards with connections to optimize the construction kit

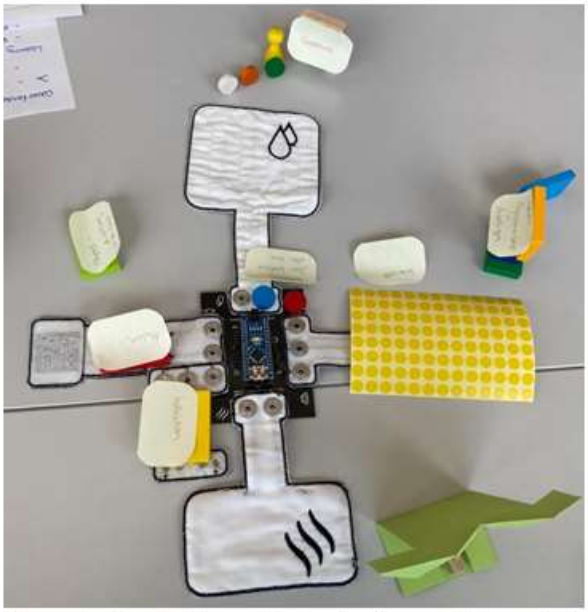

Figure 2: Symbolic prototype for the enrichment of the construction kit with new features

The workshop supported the students to fulfil the requirements of the lab work. The lab work itself is also done in groups and includes a cognitive map on one area of Smart Textiles, a cheat sheet on specific Smart Textiles components and a gamified task or game with instructions including the given Smart Textiles components. The following 4 figures show representative results from different lab works created by different student groups.

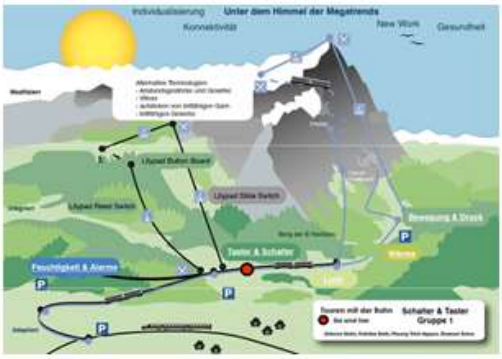

Figure 3: Example for a cognitive map on Smart Textiles buttons and switches

Figure 4: Example for a Cheatsheet on Smart Textiles Components

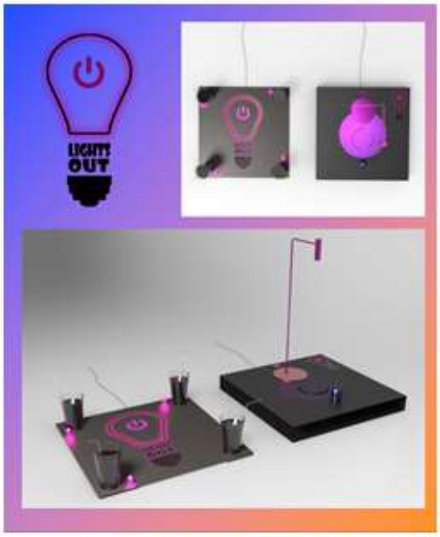

Figure 5: Example for a newly developed game with a light sensor

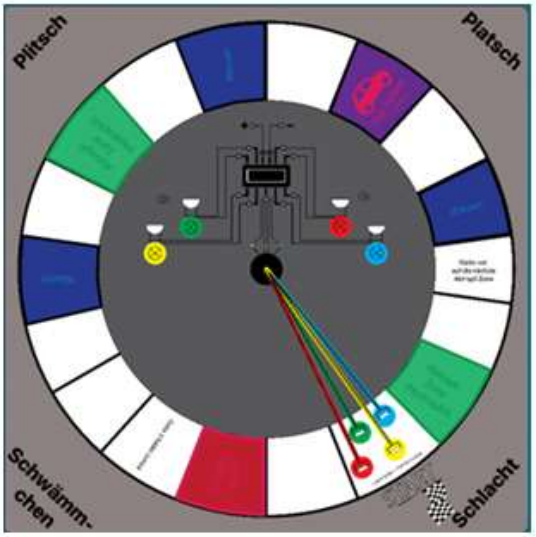

Figure 6: Prototype game plan to help understand humidity sensors

3. Evaluation

Several qualitative research methods are combined to evaluate the new teaching and learning environment. The most important are participant observation and learning reflection. In addition, the materials, especially the prototypes from the workshop and the results of the lab works were evaluated in detail. All data will be analysed using qualitative content analysis according to Mayring.

3.1 Participant observation

The characteristic feature of the 'participant observation' methodology is the personal participation of the researcher and the interaction with the persons who can be described as the research object. It is assumed that through direct participation, aspects of activity and behaviour can be observed that would not be accessible in conversations and documents - of whatever kind - about these interactions or situations. It is essential in this methodology that the researcher alternates between closeness through participation and distance in the form of reflective observation. [5] Overall, it can be noted that combining the creative, imaginative side with pure factual knowledge is very helpful for learning.

3.2 Learning reflections

In the process of reflecting on learning, students are asked to document and reflect on their learning using given guiding questions. One student mentioned "This [learning reflection] enabled me to reflect on my own work and to compare it with the knowledge of the other group participants" Concerning the new methods another student stated: "I found the EMPAMOS cards very helpful to check aspects like logic, meaningfulness, etc. of our developed games and optimize them if necessary. [...] I could imagine using this analysis tool for other projects as well and using it to check different aspects."

4. Future Plans and Conclusion

In the field of smart textiles, interdisciplinary collaboration between professionals from different disciplines is one of the most important key factors. Students therefore need to be prepared for this collaboration and, ideally, also involved in the development processes of new teaching-learning scenarios and teaching materials. The application-oriented kit and the new teaching-learning arrangement will help to expand the frontiers of knowledge, promote creativity and give students the ability to solve real-world problems. As an added benefit, it will accelerate the understanding of innovation and interdisciplinary challenges. A content analytic evaluation of the data - primarily from participant observation, learning reflections, and results from lab work - is currently underway. This will be followed by piloting and implementation of the new concept to prepare students for the challenges of structural change throughout their professional lives.

References

[1] Facts & Factors; 2022 [Online]. Available: https://www.globenewswire.com/en/news-release/2022/09/27/2523543/0/en/E-Textiles-and-Smart-Clothing-Market-Size-Rise-at-32-35-CAGR-by-2028-Value-to-Cross-US-15019-Million-Says-Facts-Factors.html. [Accessed 9 February 2023]
[2] Zukunftsinstitut GmbH, “Megatrends”, 2018. [Online]. Available: https://www.zukunftsinstitut.de/dossier/megatrends/. [Accessed 8 February 2023]
[3] P. Vontobel, “Didaktisches Design aus lernpsychologischer Sicht”, Pädagogische Hochschule Zürich, Zürich, 2006
[4] WEARIC Textible GmbH, “WEARIC”, 2018. [Online]. Available: https://www.wearic.com. [Accessed 8 February 2023]
[5] Voit, Thomas, Faculty of Computer Science - Nuremberg Institute of Technology, EMPAMOS Available: https://www.EMPAMOS.de/ [Accessed 8 February 2023]
[6] Pädagogische Hochschule Freiburg; Available: https://www.ph-freiburg.de/quasus/was-muss-ich-wissen/daten-erheben/beobachtungsverfahren/teilnehmende-beobachtung.html#c4442 [Accessed 8 February 2023]