Preface

This preface combines the prefaces of the WELL4SD 2020 and the IMHE 2020 workshops. All editors would like to thank the authors for their patience to put the proceedings together. We are living in interesting times.

Wearable Enhanced Learning (WELL)

Wearable technologies – such as smart watches, glasses, and e-textiles – are just starting to transform the way we work and learn, delivering a more immersive user experience. These devices are body-worn, equipped with sensors and conveniently integrate into leisure and work-related activities including physical movements of their users. Wearables bear the potential to substantially reorganise the way we learn, removing restrictions in time and space, capturing data directly from the body of the learner and embedding learning directly in real world contexts by using in-situ contextual information to support learning (Buchem, Klamma, & Wild, 2019).

Wearable Enhanced Learning (WELL) is beginning to emerge as a new discipline in technology enhanced learning in combination with other relevant trends like the transformation of classrooms, new mobility concepts, multi-modal learning analytics and cyber-physical systems. Wearable devices play an integral role in the digital transformation of industrial and logistics processes in Industry 4.0 and thus demand new learning and training concepts like experience capturing, re-enactment and smart human-computer interaction (Buchem, Klamma, & Wild, 2019).

Wearable Enhanced Learning is also an emerging area of interest for researchers, educators, companies, start-ups and grassroot movements, which provide and/or apply wearable sensors and devices. These stakeholders can exploit key pedagogical affordances of wearable technologies, such as the integration of data streams into daily routines, immersive educational experiences, in-situ guidance, hands-free access to contextually relevant information, unobtrusive and contextualised feedback as well as integration of Augmented Reality (AR) and Virtual Reality (VR) technologies to enable forms of wearable enhanced learning which help to achieve Sustainable Development Goals[1] (SDGs), including, for example, contributing to securing quality education during the COVID-19 pandemic (UN SDG #3 and #4), providing the learning and training for resilient infrastructure construction and low-emission transport (UN SDG #9), or supporting the knowledge exchange connected with the switch to a circular economy (UN SDG #12). For example, wearable technologies such as smart watches, smart clothing or specific wearables with microprocessors attached to the body can be exploited to improve equity and social justice for learners with disabilities who may use wearable technologies to

[1] https://sustainabledevelopment.un.org/?menu=1300

engage with the environment with greater success and to be included in learning opportunities to a greater degree (Anderson and Andreson, 2019).

However, the specific challenges related to wearable technologies including fragmentation, scalability and data integration as described by Buchem, Klamma & Wild (2019), need to be addressed strategically in order to support Sustainable Development Goals. Fragmentation in Wearable Enhanced Learning means that research and development that belongs together is carried out in isolation, that products and markets are scattered and that stakeholders are not exploiting the potential of wearable technologies for learning. Standardization, lighthouse projects, best practices, roadmapping, adequate support for practitioners including interdisciplinary teacher training as well as more inclusive user studies related to the adoption in view of privacy concerns and to the validation of long- and short-term effects of using wearable technologies on learning outcomes (Buchem, Klamma & Wild, 2019). The second challenge, scalability, is related to current research and development not being designed for scaling-up or not even for replication. Scaling-up of wearable-enhanced learning to support development goals requires more extensive resources, large-scale projects, industry collaboration, cooperation among different stakeholder groups, open and participatory design, agile methods of development inclusion of wearable enhanced learning formats in the development of curricula as well as strategies to address the not-invented-here syndrome and current resistance to wearable technologies in education (Buchem, Klamma & Wild, 2019). The third challenge, data aggregation, is related to wearable devices generating large quantities of data about users on different levels, making the data available to users with different speeds, in different formats with different sizes and frequencies. The different modes of data aggregation have implications on how wearable learning scenarios are designed, for example to what extent they can support conversational learning and seamless learning, or how well can interfaces between the learners and the datasets be created for diverse users (Freitas and Levene 2003). For example, unique opportunities for teaching and learning emerge when wearable sensors are used as part of the Internet of Things ecosystem to capture behavioural and biological data about the users in dynamic environments (Ojuroye and Wilde, 2019). Additionally, solutions (e. g. wearable data fusion, educational data mining, and academic analytics) need to be designed in response to critical data aggregation challenges such as legal issues (e.g. recording informal interactions, spontaneous capture in real-time), data privacy and security (e.g. revealing learning behaviours and exposure of sensitive information). Some of the questions here are how to predict learner effort and how to infer predictions of effort from the available data about to support teachers in identifying learners struggling or not engaging with learning taking into consideration reliability and accuracy of data gathered through different devices and sensors (Moissa, Bonnin and Boyer, 2019).

Wearables are a powerful new technology for learning bringing both potentials and challenges which have to be reflected in the designs and implementations, especially in view of Sustainable Development Goals. Wearables enable new connections to learners, educators, communities, learning contexts and environments. Practical experience and evidence from research are necessary to assess the impact of wearable technologies on learning both inside and outside the formal education as well as at global education context (Traxler, 2019).

WELL4SD Workshop and Papers

These proceedings of WELL4SD: Wearable Enhanced Learning in support of Sustainable Development, are the documentation of the WELL4SD workshop which took place as part of the 15th European Conference on Technology Enhanced Learning[2] on 15 September 2020. The WELL4SD workshop[3] was the offspring of the Special Interest Group on Wearable-technology Enhanced Learning (SIG WELL)[4] which is part of the European Association for Technology Enhanced Learning (EATEL)[5].

The workshop was based on the insights from the Springer book titled "Perspectives on Wearable Enhanced Learning (WELL). Current Trends, Research, and Practice"[6], which was edited by the workshop organisers. The WELL4SD workshop addressed a number of critical issues related to current quality, equity and ethical issues which were identified and pinpointed by the authors of the book chapters. The aim was to present an overview of current developments in the field drawing upon the synopsis provided in "Perspectives on Wearable Enhanced Learning (WELL)" from the perspective of Sustainable Development Goals and Quality Education. This included a discussion about potentials and risks of WELL in view of the access to equitable quality education and promotion of lifelong learning opportunities for all. Since wearable technologies are oftentimes applied in the field of health, potentials and risks of WELL for individual and collective well-being were specifically addressed by the workshop. The workshop also focused on the skills necessary for the design and use of wearable technologies for learning in context of primary, secondary and tertiary education as well as learning at the workplace in context of industry 4.0 and in relation to lifelong learning.

The WELL4SD workshop provided a synopsis of the insights from the field of Wearable Enhanced Learning in view of the Sustainable Development Goals and initiated a discussion about the future of WELL in view of current global challenges and quality education.

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[2] http://www.ec-tel.eu/

[3] https://ea-tel.eu/special-interest-groups/well/well4sd-wearable-enhanced-learning-in-support-of-sustainable-development

[4] http://ea-tel.eu/special-interest-groups/well

[5] https://ea-tel.eu/

[6] https://www.springer.com/gp/book/9783319643007

The three papers included in the WELL4SD proceedings are:

Holographic Learning – the use of augmented reality technology in chemistry teaching to develop students' spatial ability by Eva Mårell-Olsson and Karolina Broman. This paper reports on a study exploring how university students perceive the use of wearable augmented reality (AR) technology (AR glasses and applications) in chemistry courses in higher education. The aim of the study was to explore and understand how students of organic chemistry perceived opportunities and challenges of wearable AR technologies especially in context of enhancing the transition from a 2D representation of a molecule to a 3D structure visualised using AR glasses. Two groups of students in organic chemistry were given the opportunity to 'see' a holographic 3D structure of a molecule using AR glasses such as Microsoft HoloLens 1. The students described their immersive learning experience and how they perceived the holographic 3D molecule as a very real object in the room. The specific added value reported by students was the support to visualising in 3D. Students reported that the amount of information in the 3D object was larger compared to a 2D representation. The challenges reported by students primarily concerned the narrow field of view of the AR glasses, and the training required to use the device properly. The recommendation for future research by the authors of this paper is not only to extend the number of participants in similar studies but also to conduct designed-based research with an interdisciplinary collaboration between teachers of different disciplines. According to the authors, this would enable the combination of specialised advanced know-how within domains such as technological, pedagogical and content knowledge. In addition, the combination of both AR and VR technologies with application of 3D representations such as molecules or protein structures could be very valuable for students. Moreover, combining AR and gamification designs aimed at increasing student motivation to learn would also be a useful step towards an immersive and engaging education in the STEM fields.

BewARe – Wearable- and Augmented-Reality-Enhanced Movement and Mobility Training for Promoting Health and Well-being of Senior Patients by Ilona Buchem, Christopher Kümmel, Dennis Ritter and Kristian Hildebrand. This paper describes the design approach for promoting health and well-being of elderly people with hypertension with the help of wearable and augmented reality technologies, which are applied in the bewARe project founded by the German Ministry of Education and Research. The bewARe system enables movement, coordination and reaction training and is based on research in the field of geriatric medicine. The use of wearable sensors and AR glasses makes it possible to record the environment of the senior user, to derive information from it and to return it to the user in a supportive manner. The use of the trainer avatar and gamification elements aims to increase motivation, change behaviour and strengthen adherence and persistence in context of physical training. The paper describes how the bewARe system can support a non-drug, at-home therapy for elderly patients with hypertension in conjunction with medical diagnosis and guided rehabilitation programs and in this way contribute to the sustainable goal 3 by focusing on good health and well-being for all at all ages. The authors point out that the design of complex systems with diverse wearable technologies, such as wearable sensors and AR glasses used in the bewARe system, poses specific challenges for the design as a number of components have to be brought together to deliver an engaging and enjoyable experience. The complexity of such systems as well as current limitations of available technologies bear some further challenges and risks for end users, especially the elderly, including the need to use specialist equipment, difficulties in distinguishing between real and virtual elements, the need for one-to-one assistance when using wearable and AR technologies, as well as concerns related to safety and security. The recommendations of the authors include the need to identify possible ethically problematic effects of wearable technologies and to develop ways to explicitly address them. The authors recommend using such analytical toolkits as the MEESTAR model for the ethical evaluation of socio-technological arrangements to explore diverse ethical dimensions of wearable technologies for learning including care, self-determination, security, justice, privacy, participation, self-understanding. Such ethical evaluation allows the designers of wearable enhanced learning to anticipate risks and reflect on the role of users in the broader context of digital sovereignty and self-empowerment.

Improving the Quality of Students' Vocabulary Knowledge through the Calm Application on the Samsung Galaxy Watch by Natalia Marakhovskaa. This paper describes the implementation of the pedagogical model for promoting students' vocabulary knowledge acquisition in English as a foreign language which integrates a wearable smartwatch and mobile apps such as the Calm Application, an app for sleep, meditation and relaxation, available on Samsung Health. The pedagogical experiment described in the paper is based on the Relaxation Action Learning approach. The approach focuses on learning new vocabulary while listening to the Calm Sleep Stories (Relaxation Phases) and practising vocabulary use in various languages and communication activities (Action Phases) on the Samsung Galaxy watch. The author reports that providing the acquisition of the learning material in a state of relaxation, and rotating the relaxation and action phases involved all channels of information perception and helped to enhance student cognitive processes. The results from the study demonstrate the effectiveness of the model for teaching and learning foreign language vocabulary. The study confirmed that the use of relaxation exercise and positive affirmation enhanced student performance, especially for students with lower abilities. In this way, the results of the pedagogical experiment presented in the paper enhance the existing rationale for using wearable technologies in education for diverse learners. The author concludes with the observation related to valuable side effects of the experiment – the students could not only learn vocabulary in a relaxed way but they also extended their understanding of wearables and the role of wearable technologies for learning, in particular as means for facilitating learning processes and enhancing education quality. However, the author observes that wearable technologies, such as the Samsung Galaxy watch are still not affordable for all students, especially the ones with low and middle incomes.

The three papers included in the proceedings correspond to the potentials and challenges Springer book titled “Perspectives on Wearable Enhanced Learning (WELL). Current Trends, Research, and Practice” and address Sustainable Development Goals especially in relation to the potential of wearable technologies for enhancing learning for diverse groups of learners such as the elderly users and learners with lower cognitive skills as well as designing learning for all in technology-rich learning environments. At the same time the three papers emphasise the current challenges and limitations related to the application of wearable technologies for learning including high costs, the need for specialist equipment, the need for one-to-one assistance for teachers and learners and previous training to apply and use wearable technologies, as well as concerns related to safety and security. As a conclusion it can be argued that different technological, pedagogical and ethical aspects have to be taken into consideration when integrating wearable technologies into learning and/or designing new learning opportunities with wearable technologies. This includes not only design approaches but also policies to address these issues. Future research should focus on finding appropriate methods to address current limitations and to exploit the unique affordances of wearable technologies for learning. Studies with larger numbers of participants and scalable solutions in the field of Wearable Enhanced Learning are needed to understand how wearable technologies can best enhance learning in different learning contexts.

Support for Mentoring Processes in Higher Education (IMHE)

Mentoring is the activity of a senior person (the mentor) sharing domain knowledge to a less experienced person (the mentee). Mentoring support is based on a trustful, protected and private atmosphere between the mentor and the mentee. The goal is to develop a professional identity and to reflect the current situation. At universities, mentors are senior academics or skilled employees while mentees are mostly students with different competences.

Because intelligent tutoring systems aimed at cognitive aspects of learning in a selected domain, they were applied especially in areas, where the domain knowledge can be well formalised. But in higher education also metacognitive, emotional and motivational aspects play a key role. One of the challenges is recognizing the learner's affective status and reacting accordingly in order to make learning effective and efficient. Compared to tutoring, the mentoring process is more spontaneous, more holistic, based on the needs and interests of the mentee, focusing on psychological support, underpinned by empathy and trust. The relationship is more complex, interactive and based on emotions (Risquez & Sanchez-Garcia, 2012).

Although intelligent learning environments lead to better learning outcomes than teaching by a single teacher in a conventional seminar or classroom, the real impact of AI on higher education is still rather small (du Boulay, 2019). The artificial intelligence in learning systems is usually too limited to recognize complex cognitive processes and give targeted advice. In order to promote the metacognitive abilities of the learner, systems usually rely on the human intelligence of the learner and stimulate metacognitive processes (Lodge et al., 2019).

Since higher education institutions work with limited resources, socio-technical infrastructures are carefully designed to support processes using distributed artificial intelligence to be able to scale (Klamma et al., 2020). The available information technology can analyze the extensive learning data sets from the system logs, sensors and texts in order to reveal various aspects of learning progress and, if necessary, the need for intervention. The aim is to relieve the teachers and, at the same time, to improve the quality of teaching. It is important that the learners decide for themselves which data are made available for which purposes. Finally, it is important to achieve a symbiosis between man and machine, so that people will be supported there where they need and want it.

IMHE Workshop and Papers

In the past there was a series of three International Workshops on Intelligent Mentoring Systems (IMS 2016-2018), fostering scientific discussion among researchers and practitioners to establish the state of the art and shape future directions around main themes associated with intelligent mentoring systems (https://imsworkshop.wordpress.com).

In our International Workshop "Intelligence Support for Mentoring Processes in Higher Education" (IMHE 2020) we aimed at one particular domain (https://las2peer.org/first-international-workshop-intelligence-support-for-mentoring-processes-in-higher-education-imhe-2020-at-its-2020). We wanted to look at various aspects of mentoring at universities and investigate how they can be technologically supported, in order to specify the requirements for intelligent mentoring systems. This should help us to answer such questions like:

- How can we design educational concepts that enable a scalable individual mentoring in the development of competences?
- How can we design intelligent mentoring systems to cover typical challenges and to scale up mentoring support in universities?

- How can we design an infrastructure to exchange data between universities in a private and secure way to scale up on the inter-university level?
- How can we integrate heterogeneous data sources (learning management systems, sensors, social networking sites) to facilitate learning analytics supporting mentoring processes?

A blind peer-reviewed process by three reviewers per paper with expertise in the area was carried out to select the contributions for the workshop. As a result, 4 submissions were accepted. The following four papers were included in the IMHE 2020 proceedings.

TecCoBot: Technology-aided support for self-regulated learning - Automatic feedback on writing tasks via Chatbot by Norbert Pengel, Anne Martin, Tamar Arndt, Roy Meissner, Alexander Neumann, Peter de Lange and Heinz-Werner Wollersheim. The paper is a collection of different research strands within a large project about scaling mentoring processes in German universities. It deals with analysis and design of mentoring processes, focusing on the generation of automatic feedback on the comprehension of texts read by students. Scalable mentoring can be facilitated by knowledge diagnostics, which provide feedback and knowledge diagrams that are automatically generated from prose texts through computer language analysis. TecCoBot is a chatbot offering writing assignments and providing automated feedback on these. It also implements a design for self-study activities.

Flexible Educational Software Architecture: at the example of EAs.LiT 2 by Roy Meissner and Andreas Thor. This contribution presents an e-assessment management and analysis software for which contextual requirements and usage scenarios changed over time. The application works and is maintained by service composition, to support the functionalities for learners and teachers. The authors describe a microservice architecture of a digital environment for e-assessments. One of the modules connected to EAs.LIT is a "mentoring workbench". The paper presents an exemplification of how a micro-service architecture can be applied to the case of an e-learning system, providing an implementation of proofs of concept.

Analysis of Discussion Forum Data as a Basis for Mentoring Support by Jakub Kuzilek, Milos Kravcik and Rupali Sinha. This study proposes a way to utilize big data analysis to support the mentoring process. The authors applied the text and sentiment analysis to process a large corpus of data collected from university discussion forums. Despite certain limitations of this work the reported results indicate this approach could raise mentors' awareness of the activities in discussion forums, which would make the mentoring support more scalable.

From a Conversational Agent for Time Management towards a Mentor for (Study) Life Priorities: A Vision by Viktoria Pammer-Schindler. The paper presents a vision of having a conversational agent that leads reflective conversations both on operative, short- and midterm time management, aimed to build intelligent mentoring technology. Conversational interfaces become more and more human-like because text-based and voice recognition technology continues to improve.

The IMHE 2020 workshop took place as part of the 16th International Conference on Intelligent Tutoring Systems (https://its2020.iis-international.org) on 9 June, 2020. The online format attracted more than 30 participants, which were interested in the improvement of the interaction with mentees via chatbots and conversational agents, but appreciated also automatic assessment and affect recognition in the developments towards intelligent mentoring support.

As a follow up activity the IMHE 2020 chairs initiated the Research Topic "Intelligence Support for Mentoring Processes in Higher Education (and beyond)" (https://www.frontiersin.org/research-topics/14009/intelligence-support-for-mentoring-processes-in-higher-education-and-beyond) in Frontiers of Artificial Intelligence.

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References

Anderson, C. L. and Anderson, K. M. (2019). Wearable Technology: Meeting the Needs of Individuals with Disabilities and Its Applications to Education. In I. Buchem, R. Klamma & F. Wild (Eds.) Perspectives on Wearable Enhanced Learning (WELL) Current Trends, Research, and Practice. Springer Nature, Cham, Switzerland, pp. 59-79. DOI 10.1007/978-3-319-64301-4

Bower, M. and Sturman, D. (2015). What are the educational affordances of wearable technologies? *Computers & Education*, 88, 343–353.

Buchem, I., Klamma, R., & Wild, F. (2019). Introduction to Wearable Enhanced Learning (WELL): Trends, Opportunities, and Challenges. In I. Buchem, R. Klamma & F. Wild (Eds.) Perspectives on Wearable Enhanced Learning (WELL) Current Trends, Research, and Practice. Springer Nature, Cham, Switzerland, pp. 3-35. DOI 10.1007/978-3-319-64301-4

du Boulay, B. (2019). Escape from the Skinner Box: The case for contemporary intelligent learning environments. *British Journal of Educational Technology*, *50*(6), 2902-2919.

Freitas de, S. & Levene, M. (2003). Evaluating the development of wearable devices, personal data assistants and the use of other mobile devices in further and higher education institutions. *JISC Technology and Standards Watch Report* (TSW030), 1-21.

Klamma, R., de Lange, P., Neumann, A. T., Hensen, B., Kravčík, M., Wang, X., & Kuzilek, J. (2020). Scaling Mentoring Support with Distributed Artificial Intelligence. In *International Conference on Intelligent Tutoring Systems*. Springer, Cham, pp. 38-44.

Lodge, J. M., Panadero, E., Broadbent, J., De Barba, P. G., Lodge, J., Horvath, J., & Corrin, L. (2019). Supporting self-regulated learning with learning analytics. *Learning analytics in the classroom: Translating learning analytics research for teachers*, pp. 45-55.

Moissa, B. Bonnin G. and Boyer, A. (2019). Exploiting Wearable Technologies to Measure and Predict Students' Effort. In I. Buchem, R. Klamma & F. Wild (Eds.) Perspectives on Wearable Enhanced Learning (WELL) Current Trends, Research, and Practice. Springer Nature, Cham, Switzerland, pp. 411-433. DOI 10.1007/978-3-319-64301-4

Ojuroye, O. and Wilde, A. (2019). On the Feasibility of Using Electronic Textiles to Support Embodied Learning. In I. Buchem, R. Klamma & F. Wild (Eds.) Perspectives on Wearable Enhanced Learning (WELL) Current Trends, Research, and Practice. Springer Nature, Cham, Switzerland, pp. 169-187. DOI 10.1007/978-3-319-64301-4

Risquez, A., & Sanchez-Garcia, M. (2012). The jury is still out: Psychoemotional support in peer e-mentoring for transition to university. *The Internet and Higher Education 15*(3), pp. 213-221.

Traxler, J. (2019). The Bigger Picture. In I. Buchem, R. Klamma & F. Wild (Eds.) Perspectives on Wearable Enhanced Learning (WELL) Current Trends, Research, and Practice. Springer Nature, Cham, Switzerland, pp. 455-463. DOI 10.1007/978-3-319-64301-4