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Competence Oriented Education of Future HSE Professionals: Lessons Learned

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HSE professionals are facing increased complexity and new emerging technologies in the changing world. This forces university educators to frequently alter their curricula and prepare more flexible, real-world and attractive training for future HSE professionals.
With advances in cognitive psychology, the social constructivist theory prevails as the best solution to create a more effective and natural learning environment in terms of interactivity, cooperation, competence-building and problem-solving.
We have created, altered and tested innovative teaching tools for university-level HSE education, such as virtual reality training, simulation games, online risk assessment tools, puzzles and case studies. New project-based course on HSE management as well as industry trainee program were developed to gain real-world practical experience. The outputs have been analysed and evaluated.
Students appreciated the non-transmissive and learner-centred practices, clear instructions, the gradual rise of difficulty, connection to real workplaces, feedback and opportunity for reflection and the teacher in the role of facilitator.
Future development of HSE-related curricula has to factor in asynchronous methods of learning to ensure that the students can choose their own pace. Future HSE professionals should be also able to self-reflect on lessons learned, to learn about learning and therefore to be able to define their competences and their translation more rigorously into real workplace scenarios.

1. Introduction and background

Globally, according to the International Labour Organisation *"every year, 2.78 million workers die from occupational accidents and work-related diseases (of which 2.4 million are disease-related) and an additional 374 million workers suffer from non-fatal occupational accidents"* (ILO, 2020).
The human and financial cost of each of these deaths and other injuries born by the individual, their families, communities and governments are too high. These outcomes are the genesis for why high-quality Safety, Health and Environment (HSE) university-level education is developed and why it must be fit for purpose to create professionals who are competent, confident and committed to changing these statistics.
In recognising this need, the International Network of Safety & Health Professional Organisations (INSHPO) was created in 2001 to form a global alliance for the advancement of occupational safety and health profession. In 2017 industry stakeholders, educators, government authorities across the globe signed an accord (Singapore Accord) promoting the use and acceptance of The Occupational Health and Safety (OHS) Professional Capability Framework - A Global Framework for Practice (INSHPO 2017a, INSHPO 2017b) as a common platform to develop capable, knowledgeable, and skilled OHS professionals and practitioners across industry sectors and geographic borders.

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The European Qualifications Framework (EQF) describes the outcomes that should be achieved from university learning programs at graduate and post-graduate level. These levels are relevant to the goals of producing graduates capable of professional work in the HSE domain.

While these concepts are well articulated and consistent with the professionals our universities desire to graduate from HSE programs, this is not the case in the reality of university HSE teaching and learning. There are many challenges that need to be addressed.

Learners do not come to university or to a particular subject matter with a consistent set of HSE skills and knowledge as a starting point on the learning journey. The challenge is twofold, that is, (1) to try and ensure that all learners develop a consistent set of competencies no matter their starting point and (2) ensure that learners who may have already gained some expertise in the subject matter still have an opportunity to grow during the class and understand their role in collaborating with others to help the whole cohort develop together.

Educators do not come to HSE with a consistent set of skills, knowledge and relevant experience. Dependent on their base discipline (for example, law, health, sociology, engineering), their perspectives on HSE can be very diverse. While in many ways this can be positive, it can also be very detrimental to the way the HSE curriculum is interpreted by a particular educator and in their teaching, and they can easily miss critical communication of concepts to learners that HSE is an integrated and holistic science and practice. This diversity of educator base disciplines can also lead to challenges in communication between HSE staff until they are able to acknowledge and develop a transdisciplinary communication toolbox. These issues may be further exacerbated where universities have developed disciplinary silos and staff normally would not work together across the base disciplines.

HSE professionals are included as lecturers to a limited extent, frequently across the globe, there is a perception within some disciplines that ‘anyone’ can teach HSE as it is ‘common sense’, so the value of including practising professionals is underrated. Safety is frequently not treated as a science domain with a perception that compliance is the main game. It is often missed by those who have limited experience and understanding of HSE professional practice that our science demands that regulatory mandates be questioned and tested. Each of these issues can lead to a loss of ‘competent and confident professional practice’ as the main goal of the educational experience.

Each of the issues above can lead an educator to focus on knowledge rather than on skills as it takes confidence on the part of the educator to facilitate learners, as they develop skills, with wisdom and the foresight of the ‘left field’ questions they may ask. This is particularly difficult for an educator to do if they have not practised in the HSE field.

Constructivist theory as a pedagogy suggests that learning or ‘meaning making’ occurs as individuals create their own understanding based on the interaction between what they already know and believe, and the knowledge with which they may come on contact (Resnick, 1989), ‘social constructivism’ takes the concept further suggesting that this ‘meaning making’ is a product of social interaction with others (Carlile & Jordan, 2005). When programs include predominately face to face teaching it is very easy to follow a pattern of didactic teaching that does not challenge learners to create their own knowledge through drawing on their current knowing, the experience of problem-solving and communicating with others. Lecture formats are frequently a result of the way the person designing the learning experience was taught themselves. This is further complicated when educators have come from cultures where questioning the lecturer is considered rude or disrespectful. Wu et al. (2011) suggests teaching HSE should move from a didactic lecture style to a more interactive style, with practical sessions, discussions with safety professionals and other participative ways of teaching to prepare trainees for their future roles and missions.

Without opportunities to build the ‘soft’ or ‘relationship building’ skills, (for example, critical thinking, problem-solving, decision-making, communication) purported in the INSHPO framework (2017b) they remain in the background as the learners lack an opportunity to problem solve and manage themselves and a team. Wu et al. (2011) suggest that the importance of including the companies´ requirements and expectations to the skills of the HSE professionals be emphasized. Toft et al (2010), in their project examining OHS education in Australia, found that the surveyed graduates from HSE programs valued skill development that echoed strongly with the ‘soft skill set’ valued greatly by their employers.

Real-world experience may be rare or even missing in the curriculum. It is when learners start to work on messy real-world problems that they gain insights into professional practice. Even when fieldwork is included in the curriculum it can be assessed by traditional assessment practices that do not encourage or reward ‘real world’ thinking and experience. Authentic assessment, that is, assessment tasks that mirror the tasks that the HSE professional will do in the ‘real world’ of practice offer learners the opportunity to reinforce their learning rather than devalue it in their eyes as not relevant to it contributing to their final grades.

Toft and Howard (2009) found that this ‘real world’ HSE professional practice and problem-solving that would normally occur in residential schools or fieldwork could successfully be facilitated online as an extra opportunity for learners to practise these skills.

The RiskMan project (Project title: Building competence in Risk Management of Future HSE Professionals, Erasmus+ Programme, KA2 - Cooperation for Innovation and the Exchange of Good Practices, KA203 - Strategic Partnerships for higher education) responds to the issues discussed and enables an integrated approach to HSE education based on Risk Management professional competencies and practise.

2. RiskMan approach and outputs

The main project objective was to develop relevant and high-quality competencies of university students (future HSE professionals) in the area of risk management through transnational cooperation among universities, insurance institutions, enterprises and other key stakeholders active in the field of education and training (ENETOSH network). The project aimed to support the university teachers in interactive and cooperative learning as well.
Students' competencies were developed using innovative methods and tools. The project was built on modern approaches in education, such as collaborative learning, project/problem-based learning and experiential learning. Gamification and the use of virtual reality played an important role. The focus was on minimizing lecture-style teaching and on the promotion of a collaborative atmosphere of attention and participation. Brainstorming, mind-mapping, discussions with professionals, working on case studies and project methods were used for education and training in HSE risk management. The methods were supported by tailor-made teaching tools including case studies and good practices from companies, safety games, virtual games and training.
The project targeted mainly on university students of study programs related to HSE / Safety & Security (i.e. future HSE professionals and specialists) and their teachers.
The project resulted in the following intellectual outputs to bridge the gap between theory and practice (available for download at the RiskMan website and via Erasmus+ Project Results Platform):
Teaching Toolkit: Kit of innovative teaching tools for modern, effective, interactive teaching of HSE risk management with the use of digital technologies.
Project-based Course: New voluntary course on HSE risk management developed on the Google Classroom blended learning platform.
Industry Trainee Program: Industry trainee program module on HSE risk management developed in cooperation with the STANT Manufacturing company.

2.1 Teaching toolkit

The Toolkit is in the form of a set of guides for students (task assignment) and guides for the teacher (detailed activity/lesson plan) available in PDF format. It was built on existing as well as new tools and includes tools with a basic (introductory) and more comprehensive level of difficulty. The content is driven by current approaches in HSE risk management and express the partner´s needs. The common elements for the Toolkit development were: Interaction, Gamification, Collaboration and Teamwork, Teacher as a guide (facilitator), Feedback and reflection as an integral part of the teaching activity. The focus was on face-to-face learning, even though many of the tools are available for blended learning. The Toolkit consists of 19 tools in 5 categories:
I. Case studies: case studies examples from enterprises and real-life regarding HSE risk management (1 – Project Windmill Case study, 2 - Family house: Incident case study, 3 - Case studies on musculoskeletal disorders and Ergonomics)
II. Example risk assessments: model risk assessments for selected occupational / health risks and workplace scenarios (4 – Risk analysis of making coffee in Moka pot, 5 – Root cause analysis, 6 – Chemical safety assessment for the environment, 7 – HSE Risk characterization in CHESAR).
III. Online risk assessment tools: examples of the use of freely available online risk assessment software and platforms in teaching (8 - OiRA Office, 9 – HSE Online risk assessment tools, 10 – AUVA Noise calculator, 11 – Health risk assessment of inhalation exposure to chemicals with Stoffenmanager, 12 – Health risk assessment of exposure to nanomaterials with Stoffenmanager Nano).
IV. Safety games: various games on selected HSE topics using photos and situation plans from real/model workplaces and Jeopardy on HSE topics (13 – Chemical puzzle, 14 – Hazard Hunt® by Graphito Prevention, 15 – Safe lab procedure, 16 - WorkSafeBC: What's wrong with this photo?, 17 – Jeopardy game).
V. Virtual reality games/training: example training of practical skills in hazard identification via the game with the use of virtual reality (18 - OSHA´s Hazard identification training tool, 19 – XVR training).

2.2 Project-based course

The course has been designed not only to incorporate viable tools from the first module (see the Teaching Toolkit) but to serve as a platform to teach differently by the teacher becoming a facilitator/guide in the process being co-created by students. Knowledge learning hasn't been completely dismissed but the focus has been

shifted towards competencies and skills in HSE risk management development. The course intends to fill the gap identified by the academic members of this consortium, by teaching HSE risk management in a very practical, real context approach.
Teaching materials, incl. PowerPoint presentations (which make up the “textbook”), case studies and other activities, were elaborated to enhance the teaching and learning process. The classes are divided into three parts: **Part I** is dedicated to the Risk management process and Risk assessment techniques, **Part II** focused on particular risks (Chemicals, Vibration, Noise and Thermal environment), and **Part III** on OSH management system and ALARP principle. Activities include various exercises on practical tasks related to HSE risk management (e.g. calculation of daily exposure to noise and vibrations, analysis of results from chemical analysis of workplace exposure, etc.). Three case studies were elaborated to support the project-based learning, namely: 1 – Occupational Hearing Loss, 2 – Vibration exposure assessment – Lower back pain case study, and 3 – Work Conditions Improvement of a Packing Workstation – a case study at a furniture manufacturing industry. The digital platform used for the execution of this course is Google’s Classroom.
An extra package on the **OSH project** was developed to support the existing course on Occupational risk management during the COVID pandemic. The OSH project consists of a Guide for students on the OSH project and two case studies (Hairdressers and Locksmithery).

2.3 Industry trainee program

The industry trainee program module on HSE risk management was developed to enable university students to gain practical skills in real industrial companies. The program was described and tested in STANT Manufacturing for possible implementation in other industrial companies.
The program consists of seven key elements which are: 1. Partnership with industrial companies, 2. Selection of talented HSE students via Assessment centre, 3. Selection and training of company mentors (workshop), 4. Specification of trainees´ adaptation (Individual plan), 5. Definition of trainee expected outcome (Improvement project), 6. Monitoring and (self)evaluation, and 7. Transfer to other industrial companies.
The program´s package includes many supporting documents such as the Assessment Centre concept, Individual Plan template, Design of workshop for mentors, Guides for mentors and trainees (handbooks), Pre- and post-testing self-evaluation questionnaire for trainees and Evaluation questionnaire for company mentors

3. Feedback and evaluation

Most of the outputs have been tested in real teaching/training and evaluated based on the participant's feedback via questionnaires and individual/group discussions. The focus was on the evaluation of changes in attitudes, competencies, skills, satisfaction and self-reflection.

3.1 Teaching toolkit

The teaching toolkit module and some of its tools have been tested by 40 students during selected courses at VSB-TU Ostrava, Czech Republic, from December 2020 to May 2021. Both evaluation and testing have been done online due to anti-COVID measures.
A questionnaire was specifically targeted on such aspects as innovation, support of team cooperation, fostering interaction, translation of theory to practice, incorporation of real workplaces scenarios, enhancement of managerial, critical thinking and practical skill in HSE and overall appeal of the tools.
Overall, the tools have been perceived as successful in their design and the respondents appreciated them. For the respondents, the tools helped them most in group cooperation while the least in enhancement of their managerial skills. They didn’t perceive the basic (introductory)-level tools as very innovative.

3.2 Project-based course

The evaluation of the project-based course started with a brief pre-questionnaire about student´s opinions regarding working in a team, the inclusion of real workplace scenarios and development of practical skills in their curricula, affinity towards individual studying outside the classroom and overall satisfaction.
There were a total of 20 respondents and the evaluation took place from January 2021 to May 2021 and was realized online via MS Teams. The final evaluation was done by dividing the group into two random groups and with group discussion facilitated by a neutral person with the teacher present to enhance the teacher-student cooperation. The evaluation was completed only after all students have finished the course.
The respondents were very satisfied with the inclusion of real workplace scenarios and with the development of their practical and managerial skills. This was complementary to the pre-questionnaire as well. The majority of the respondents appreciated the interactivity, inclusion of two different teachers with different backgrounds and everyone liked the two-week frequency compared to smaller weekly courses which are much more common.

Highly regarded was also the necessity to defend their project in front of a professional forum instead of the usual written and oral exam and it was stated that one of the best outcomes was to be able to create something real they could look back upon.
Respondent´s answers about the communication with peers as well as with teachers were divided. Some disliked the online environment and would prefer face-to-face education, while others appreciated it.
Almost all students stated that they felt they lacked training in soft skills and would appreciate if such training would be included in the course itself or beforehand. They also recommended smaller time allocation in one meeting to be less than 5 hours because they weren't able to focus and they would have appreciated the change of the subject or some distraction.

3.3 Industry trainee program

Students were asked to fill a pre-testing self-evaluation questionnaire at the beginning of the trainee program and a post-testing self-evaluation questionnaire at the end. Students stated that they had to communicate with their co-workers and they had to be able to ask for help to accomplish their responsibilities. They appreciated improvement in their presentation skills along with teamwork thanks to many internal presentations and meetings about real problems in the companies. This improved their problem-solving skills because they have to be able to be flexible in a shorter amount of time.
Students also stated that they had to become more independent and efficient with their time to keep up with the school and their new responsibilities.

4. Conclusions and lessons learned

At the beginning, the teaching tools were developed by individual partners based on their needs without defining common principles, approaches and guideline´s structure. That did not work out. The efforts have been purposedly changed to firstly create a generalized approach and to recognize important principles and then to develop individual tools.
Throughout the development of the project, it has been clear that all the new and innovative tools needed much stronger roots in pedagogical methodology for them to serve their purpose and to enhance the HSE-related curricula. Even the best tools and technologies cannot contribute to learning when they are not facilitated, supported and incorporated by lecturers and teachers.
This has led to the acknowledgement of the importance of quality training of HSE teachers in actual teaching, didactics and pedagogy where most of the lecturers are experienced and skilled in their HSE domain(s), but many of them did not have sufficient pedagogic training.
This is even more important when they teach students with varying entry levels. Many universities have to dedicate effort to ensure the students have the same level of expertise at the end of the course, but throughout the courses, this needs to be addressed all the time and requires specific pedagogic approaches to be able to provide a personalized teaching experience.
It has also been confirmed that the enterprises are vital, not only to ensure incorporation of real-workplace scenarios but also to increase the adaptability of students, to support student´s real-life competencies and to enhance the students' employability. Closer cooperation with the labour market and the enterprises thus has to be more active outside of project activities and should be imperative for the advancement of innovations, capacity building and creating a community of practice in HSE education.
The role of students may be enhanced and supported in more ways than simple feedback at the end of the course. The paradigm should shift for students to cooperate with the teacher more closely and to build up an environment of trust and collaboration as much as possible. One approach which proved itself was group interview via impartial and neutral facilitator with students and teacher of the course which provided great insights and helped to further develop the course.
Both students and teachers should be able to express themselves in an anonymized way as well. Some students are not comfortable or even scared to openly criticize the teacher. In the same manner, the teacher should be able to address some issues without antagonizing the students. Both parties must be protected against verbal attacks and being needlessly demotivated.
One of the major aspects of change has been the asynchronous aspect of education, where students are studying at home. During the first months in COVID restricted education, it has been shown that in online education the students spent an increased amount of time not only studying on their own but also trying to cooperate in teams and groups but without proper training and directives both on side of the teacher and their own.
So the emphasis in the future should be on students meta-competencies such as learning how to learn, self-evaluatory studying or peer-evaluatory learning. The teachers need to take over their role as well in preparing and educating students in this new environment.

Most of these issues and challenges are being incorporated in the follow-up OshDigit project which is derived from the lessons learned and from the necessity to adapt to COVID. There are some changes such as switching from HSE to OSH domain to be able to use more specific resources in digital learning, but the overall goal is to complement the RiskMan project. The integral part of new activities is an enhancement of the digital pedagogic competencies of OSH teachers and lecturers for them to be able to create teaching in a digital environment because the didactics of online, blended and face-to-face education are seldom interchangeable. Special attention will be on evaluation and adjustment of existing and creation of new e-resources suited for digital OSH education. Throughout the OshDigit project, there will be many opportunities for the exchange of opinions, experiences and good practices as well as a focus on self-evaluatory improvement of didactic and digital competencies.

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