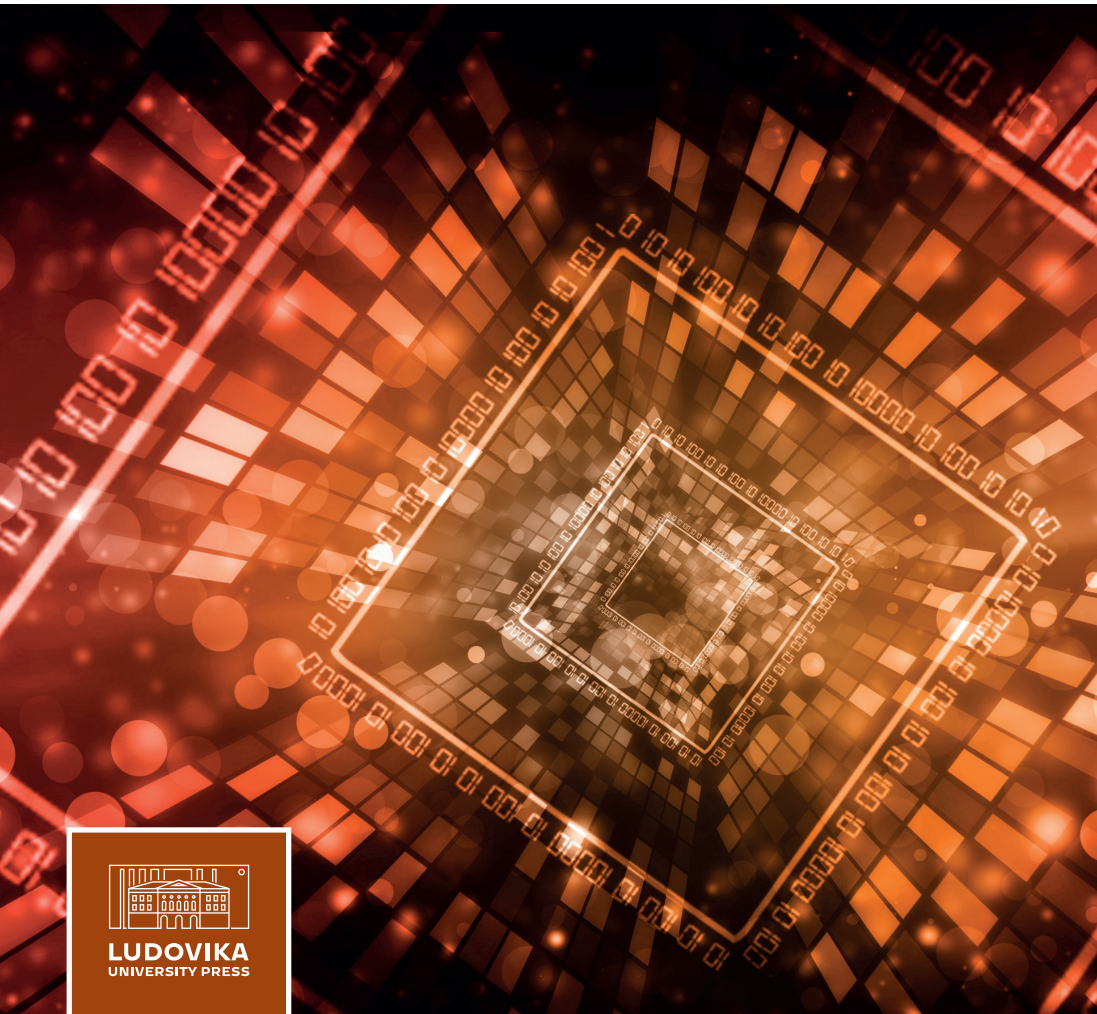
Handbook on Teaching Methodology for the Education, Training and Simulation of Hybrid Warfare

Edited by
Zoltán Jobbágy – Edina Zsigmond



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An Appendix to the Hybrid Warfare Reference Curriculum

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Contents

Introduction

It is commonplace to state that the forms of war are constantly evolving. In the contemporary conflict environment, hybrid actors and proxy groups wage war in an asymmetric, low-intensity and irregular manner by exploiting ambiguity, strategic surprise and deception to accomplish their objectives. This conflict environment is volatile, uncertain, complex and ambiguous, in short, VUCA. This environment requires that educational and research institutions disseminate knowledge to help students of diverse academic backgrounds to perform complex tasks and duties in an efficient and effective manner. Curriculum development within higher education is a performance improvement tool that helps both lecturers and students gain cutting-edge knowledge to perform up to a certain standard or obtain the expected level of performance. This is even more important as security challenges come in many disguises. The concerns European societies face, are of unknown magnitude and the need for proper understanding and adequate policy responses is paramount. Supporting improved awareness, strengthening resilience and building the required capacity are all part of this effort. The Russo–Ukrainian war precisely/perfectly underlines the need for such capacities and capabilities. Security challenges and threats, in whatever form they may come, have the potential to undermine the security of the European Union (EU) and the very values that underpin and inspire its societies. The EU must be committed to addressing these challenges with all available means. Citizens need to have a clear understanding of the risks and threats affecting the security, resilience and sustainability of their environment, including the smaller and larger communities to which they belong. The term hybrid warfare first appeared in 2005. The underlying concept subsequently evolved to cover a multitude of actors, strategies and actions. Overcoming a uniquely military-centred point of view is at the core of hybrid warfare as it takes advantage of the disunity within organisations of political entities and the absence of a hegemon in international relations. The *Hybrid Warfare Reference Curriculum* was created within the framework of a Cooperation Partnership project of the Erasmus+ Programme. Financed by the European Union, in 2021 four European and an Israeli higher education institutes and a U.K. think tank embarked on a journey to create cutting-edge education and training material on the hybrid warfare topic. A curriculum with relevance hard to underestimate – especially after the war started in 2022 in Ukraine – but missing from European universities' study programs. The present curriculum takes into account the diversity of actions forming part of hybrid warfare, uniting a variety of disciplines. Founding on

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the academic and geographic diversity of the project partnership, the *Education and Training on Hybrid Warfare Project* recognises the responsibility of higher education institutions in contributing to stable societies. The partners' aim is to provide a conceptual framework for a better understanding of current and most likely future conflicts to a variety of key national stakeholders, ranging from government to civil society and with a specific focus on Youth. This requires a comprehensive academic and professional curriculum aimed at enhancing situational and contextual awareness and in particular, the anticipated consequences of such conflicts. The project accords with the clear requirement of the security studies institutions to become more familiar with the complexities associated with hybrid warfare and to initiate a consolidated familiarisation with a refined appreciation of the disparate risks associated with hybrid warfare. In terms of foreign and defence policy postures and capabilities, it is essential for EU members to foster a culture of common appreciation, allowing for a wider understanding and dissemination of knowledge and to support the crafting of common responses to hybrid warfare. The failure to address issues ranging from definitions and lexicon to the mechanics of force or policy posture can be detrimental to EU members' ability to work collaboratively, especially in periods of high tension and crisis. The intention behind the development of the project was to provide common study material for civilian, police and military higher education institutions to address a significant number of issues associated with the policy and operations of most forms of hybrid warfare. Through the newly developed curriculum and teaching methodology students shall gain:

- an insight into the non-military aspects of hybrid warfare, ranging from information and cyberattacks on critical network infrastructure to the nexus of public health and national security in response to the malicious use of life sciences and artificial intelligence
- a more nuanced understanding of how some hybrid warfare acts intend to destabilise communities and society, from the instigation of alternative news narratives to inciting community violence and criminality
- a deeper understanding of the decision-making process generated by hybrid warfare across a myriad of sectors to benefit from risk analysis, crisis management case studies, and simulation exercises to reinforce the contextual and situational awareness
- a better understanding of how hybrid warfare impacts today's modern military forces, in terms of doctrine, force structure, armaments, operations, command and control and training

The developed hybrid warfare reference curriculum, its supporting methodology, and massive open online course will allow blended (physical and virtual) learning methods for accredited university classes, but also allow for mass online learning, thus reaching a much wider audience. The reference curriculum shall form the basis for either the partial or entire redesign and update of courses within the curriculum of the military, police and civilian students of higher education institutions. The reference curriculum as a document reflects the combined knowledge of a multinational team of academics and policy experts drawn from European and Israeli universities and think tanks. The reference curriculum comes as the result of close cooperation between the project partners to motivate others interested in the subject. The reference curriculum also serves as an initial document for individuals or organisations looking to develop a curriculum dedicated to combating hybrid challenges, or to amend their existing curricula accordingly. The content of the hybrid warfare reference curriculum is not intended to be adopted in lockstep, but rather to fit particular needs and aspirations. Its function is to increase intellectual interoperability and foster in-depth and specific academic knowledge and professionalism in an interdisciplinary manner. It can also support interested partners in enhancing their capacities to develop their national skills and improve suitable strategies to counter or wage this sort of warfare. The reference curriculum also serves as a fundamental document to address educational institution requirements and provide helpful guidelines for relevant courses on security and defence. The reference curriculum, among others, provides an overview of underlying ideologies, motivations and methods, as well as contemporary practices and projections of future potential. As such it contributes to European and Transatlantic cooperation in security-related issues through education by offering students, professors, researchers, policy experts and the interested public a new international and interdisciplinary platform of study, and also a foundation for cutting-edge, practice-oriented knowledge. The curriculum also serves as a basis for those who intend to implement tailored versions for their distance learning or residential courses. It contributes to a student-centric environment too, as it can help train students to better understand the complex challenges posed by hybrid warfare and to respond better to it. The reference curriculum promotes critical thinking and a thorough understanding of European core values and interests. This important pedagogical objective is fostered through participatory structures and transformative education. To reach the goals set above and to exploit the synergies created by the participating institutions, the reference curriculum may

be regarded as the basis of a modular system resulting in various single or joint degree courses at a later stage. The reference curriculum contributes to a series of online and blended modules with a focus on selected security and defence issues, involving a participative and extensive simulation exercise/wargame moderated by trained staff. All recipients of the curriculum, irrespective of their previous background and knowledge, shall benefit from a range of delivery methods including:

- a cutting-edge, transdisciplinary curriculum
- a combination of presentations, tutorials, case study analysis simulation exercises and tabletop exercises
- a massive open online course on hybrid warfare to reach a much wider audience

Thus, global issues, especially security ones, are increasingly becoming the subject of policy-level deliberations, both nationally and internationally. Transnational cooperation in science deals with these issues. Cooperation in the form of various partnerships is of special importance because they possess much of the expertise, data and resources that are needed to find effective solutions. The reference curriculum makes it clear that hybrid warfare stands for issues and options that deserve the attention of scientists and researchers as they seek to design, initiate and manage collaborative research programs and projects that include both scientific and development goals. Links between science policy and the mechanisms to address raised issues already exist in EU countries. Motivations and opportunities to support scientific collaboration in the form of partnerships to strengthen research capacity have assigned a higher priority to global issues, put more emphasis on collaborative research, and moved beyond traditional knowledge transfer. The reference curriculum simply reflects the fact that scientists and policymakers are/have been increasingly turning towards desirable and even crucial partners who can provide a wide range of expertise, resources and other benefits. Some are identifying ways to organise projects that encourage the full participation of researchers who are actively building and enhancing research capacity to create and utilise the new knowledge that is essential for their development to address local and regional manifestations of global-scale challenges of which hybrid warfare is but one. Recognising the importance of global security challenges and trends and seeking to maximise the benefits of cooperation by linking science policy with science capabilities, thus contemplating new cooperative ventures to improve existing efforts. Moreover, we are living in a time when different generations

may see the world dramatically differently. Therefore, the experience of the 20th century must reach out to the enthusiasm of the 21st century and make a strong bond. The reference curriculum can forge a bond in the mind and soul of the young generation, among whom university students play an important role as they will form the future cohort of intellectuals and decision-makers that will need to take care of various policy and military responses to hybrid threats in the near future. The reference curriculum offers a comprehensive and interdisciplinary approach in the broadest sense, since it encompasses definitions and descriptions, addresses the hard and soft aspects of hybrid warfare, and names disciplines and subjects to make hybrid warfare studies accessible for lecturers and students alike. The project stands for a change in the institutional portfolio of the authoring partner institutions since it produces new knowledge that they institutionalise and disseminate through various social practices over time. Thus, the reference curriculum brings something new and creative to the partners involved and to the wider EU community. The partnership powers high quality and fosters innovation by exploring and considering a new concept such as hybrid warfare, and by delivering new content and methods with much value to lecturers, researchers and students. It can be seen as a descriptive, reflective and explanatory study of hybrid warfare seen from many different angles. It is descriptive in the sense that it describes hybrid warfare as a complex phenomenon posing serious threats to the stability of any political unity. It is also reflective since by approaching hybrid warfare as an intrinsically complex and multi-layered phenomenon, consistency and coherence are provided by the use of the respective scientific literature and, very often, Clausewitz's epic volume *On War.* It is explanatory since inconsistencies are discovered, the authors identify and explain the contributory factors in detail. The reference curriculum aims at developing a coherent framework that offers a novel approach to hybrid warfare by detailing the underlying attribute from multiple points of view. Since the curriculum exceeds the framework of a semester class in volume, the team of authors agreed to divide the chapters into compulsory lectures (Volume I), elective seminars (Volume II) and elective lectures (Volume III), from which lecturers may choose the most relevant topics for their classes. The present handbook is an appendix to the three volumes and offers effective teaching methods and simulation tools to address hybrid warfare to various audiences. Without the appropriate design and use of methods and tools, it is impossible to spread quality information and create a firm foundation to any course offered to students. Teaching methods and simulation contained within this handbook are the toolbox to be used in the right way – for the right job. Teaching methods, if understood and used appropriately

can make any interaction between the lecturer and the student a lot easier. Thus, the handbook attempts on the one hand to explain and demystify the world of teaching methods and simulation means, whilst on the other it seeks to provide a starting point for their use. In this, the editors are not suggesting that using teaching methods and simulation tools means things become easy, but merely that lectures and seminars on hybrid warfare can be appreciated by lecturers and students alike. The editors hope that the readers can enjoy this handbook, which reflects a wider aim to develop and improve the performance of the regeneration that will most likely have to do with hybrid warfare. This handbook aims to meaningfully address some of the persistent issues faced by civilians, and military and police personnel, and to prepare them to act in adequate manner when reacting to hybrid threat situations. The teaching methods and simulation tools contained in this handbook will allow blended i.e. physical and virtual learning for accredited university classes, but also provide a sound foundation for mass online learning, thus reaching a much wider audience. The handbook also helps tackle skill gaps and mismatches through the content of the three modules of the reference curriculum, and sets the framework for blended simulation/wargaming exercises. The methods and tools contained in this handbook are innovative and pioneering as they stand for a handful of innovative pedagogies applicable to study hybrid warfare. Thus, the handbook can be seen on the one hand as an extensive methodology manual for professors or trainers who deliver the reference curriculum and wish to achieve maximum impact by applying innovative, interactive, transdisciplinary teaching methods, including blended elements. On the other hand, it is an extensive simulation manual for professors or trainers who wish to set up a simulation exercise complementing the hybrid warfare elective course. Practical recommendations on gender perspectives and military effectiveness complement the teaching methods and simulation tools of this handbook, referring to the importance of the gender dimension. The Hybrid Warfare Project Team from the Ludovika University of Public Service in Budapest, Hungary; the "Nicolae Bălcescu" Land Forces Academy in Sibiu, Romania; the Armed Forces Academy of General Milan Rastislav Štefánik in Liptovský Mikuláš, Slovakia; the University of Turin, Italy; the Bar-Ilan University in Ramat Gan, Israel and the Centre for the Study of New Security Challenges in Edinburgh, U.K. wishes interesting and useful readings for all students, lecturers and independent learners.

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Digital Education: Theoretical Frameworks and Best Practices for Teaching and Learning in the Security and Defence Area

In today's fast-paced world, education is evolving at a rapid rate, driven by advancements in technology. Digital tools have become an integral part of modern education, transforming teaching methodologies and empowering educators to create engaging and interactive learning experiences for their students. It is very important to guide teachers in the transition to innovative teaching methodologies that utilise digital tools effectively. With the adoption of digital tools and innovative methodologies, educators can enhance student engagement, promote critical thinking and foster creativity. From online resources to virtual classrooms, technology offers a lot of opportunities to enhance teaching approaches that can engage, inspire and empower students, promote collaboration and encourage critical thinking.

Introduction

There are several strategies and best practices that have been studied and that can be used to incorporate effective technology into teaching practice. Both educators and students can benefit from technological innovation, transforming the way students and teachers learn, teach and communicate: in fact, educators can reach students in new and innovative ways. Technologies can provide access to different kinds of resources, facilitate collaboration and promote active student participation. Technologies can provide students with a personalised learning experience, tailored to their unique needs and learning styles. Furthermore, educators collect a wealth of data and analytics can be used to assess student

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progress, identify areas for improvement, and adapt instruction to meet individual learning styles and needs. By utilising these data-driven insights, educators can create a more personalised learning experience, promoting student engagement and achievement. Moreover, digital tools can offer real-time feedback, track student progress and support data-driven decision-making, not just for teachers and students, but also for policymakers and administrators. Understanding these benefits is crucial for teachers to embrace the potential of digital tools fully. With the abundance of digital tools available, it is essential to avoid overwhelming teachers and students; the important matter is quality rather than quantity. In the next sessions, different perspectives about the integration of digital technologies and innovative methodologies will be discussed, providing tips for selecting and implementing educational technology tools, and offering insights on how technology can be used to enhance student engagement, improve learning outcomes and promote collaboration.

Models and frameworks for modern education

Several frameworks provide guidelines to educators to integrate digital tools and innovative methodologies into their teaching practices. The analysis of educational methodologies also concerns the role of technologies in planning the learning activities. One of the models that describe the pervasiveness of technologies in education is the SAMR model,[3] which stands for Substitution, Augmentation, Modification and Redefinition. It is a model adopted to classify educational materials provided according to the technologies involved. This model includes four different approaches to new technologies. It is hierarchical, from low to high integration of technology, with every step representing an improvement in learning outcomes and students' engagement:

– Substitution refers to using technology to replace a face-to-face teaching method. One of the easiest examples of Substitution is simply substituting face-to-face lectures with online live meetings where students can interact. This approach does not cause any actual change in the educational offer, and it does not involve any improvement in the teaching methodology: the traditional setting is simply shifted from the physical class to the online platform together with the synchronous explanation of the teacher. Beyond

[3] Puentedura 2013.

the advantages for those students who cannot be physically present during classes, the overlap between online teaching and synchronous activities also implies some recurrent disadvantages, such as the unavailability of a strong connection or the impossibility of using an appropriate device during classes for some of the students.

- Augmentation refers to using technology to enhance a face-to-face teaching method. In this case, students may be provided with the resources, with uploaded recorded video lectures specifically designed for asynchronous fruition and other activities that may promote effective e-learning. These didactic materials allow the students to autonomously access resources with the further advantage of the teacher's oral explanation, which promotes more effective comprehension and mastery. Resources and activities are planned to improve students' fruition through the possibility of self-management of materials and time and individualisation of the learning process. Another example is given by a teacher opening a personal channel on various social accounts, which is now a very common practice: teaching in this way is almost a substitution, but some features of the technology provided by the streaming service may enhance the learner's capabilities. Other relevant examples of online learning as Augmentation are the use of forums for questions and doubts about the disciplines to which students themselves were able to answer, and the use of Automatic Assessment Systems for the formative evaluation, provided as online drills and followed by personalised feedback. This model of online learning brings about actual and relevant improvements to the learning processes, the most significant being the increase of students' engagement.[4]
- Modification refers to using technology to redesign a teaching method: the activities are redesigned to consider the potentiality of technologies. An example of Modification is the adoption of remote online exams and the necessity of new forms of assessment: policymakers have to provide professors and stakeholders with guidelines on the best evaluation systems. In this case, it is not just a matter of technology adoption: teachers have to redesign examination procedures in order to avoid cheating or other issues, teachers may need to modify exams previously structured in open questions or multiple-choice questions as, for example, open book exams,

[4] Barana et al. 2020.

focused on papers or works to be submitted. The advantage of open book exams, which allow the students to freely access educational materials and manage the execution time, consists in the possibility of avoiding the difficulties presented by simultaneous tests, such as cheating or technical issues caused by the synchronous use of online tools. Moreover, the use of specific tools that allow professors to add comments and assess students' submissions must be promoted. Since the assessment phase fully involves the didactic planning of a course, this is a relevant example of technology acting not only as a direct substitute for functional improvements, but also as an actual "modification" of traditional methodologies. Professors were invited to also use formative assessment and to use the examples of final assessments available on the platform in order to help students better prepare for them,[5] more details on assessment will be shown afterwards.

– Redefinition refers to using technology to create a new teaching method that was not possible before. This is the most pervasive use of technology. The redefinition must be carefully designed in order to achieve learning goals, the starting point of education. For example, teachers can design and generate interactive experiences for students, or make them elaborate large quantities of data, something that would take an enormous amount of time without technology, or make students submit a project to disseminate and communicate what they learned through social media. However, a lot more can be done. This step of the framework is the most advanced and projected into education in the next few years.

The technology itself cannot guarantee effective teaching: in a study comparing the function of teachers in face-to-face and the online teaching mode,[6] the report finds no important differences, and they continue by saying that "if these differences do exist, they are likely to be due to the teacher's involvement and the institution's commitment in the programming of the learning process". This happens because online courses are used only as an alternative or a replacement for face-to-face ones, but they should also be an addition, an integration. Thinking in terms of transition is useful to explain the journey of university professors, but in the end face-to-face teaching and online teaching influence and change each other, none of the two is better than the other. Beyond the possible applications

5 Barana et al. 2020.

6 Díaz–Entonado 2009: 342.

of technologies in education, it is very important to make a distinction about the context where learning happens. The literature shows that the transition between face-to-face to blended[7] (a mix of face-to-face and online teaching) and online teaching is quite challenging, since teachers' roles change.[8] Both Redmond[9] and McQuiggan[10] notice that many experienced teachers find themselves as novices when first approaching online teaching, and this may result in resistance towards online teaching. In addition, the transition to online teaching and learning from a traditional face-to-face approach challenges the expectations and roles of both instructors and learners.[11] Later, Berge, Feiertag and Berge[12] and Alvarez et al.[13] proposed a model for the instructor's role based on four categories: pedagogical, social, managerial and technical. Thus, teachers do not only have to learn new approaches, new methods and new technology, but they also have to take on new roles. Redefining professional identity and teaching practices takes time and training, otherwise many instructors run the risk of replicating existing course design and pedagogical practices when they move from face-to-face teaching to blended or online teaching.[14] In Ammenwerth,[15] the author points out that these traditional approaches may not be adequate for online teaching and that if we evaluate online teaching following the Technology, Pedagogy and Content Knowledge (TPACK) model, university teachers appear to have high expertise in content knowledge and a weaker one in technology and pedagogy knowledge.[16] Technological knowledge refers to the knowledge of different technologies that can be used in education. Pedagogical knowledge refers to different teaching strategies. Content knowledge refers to the knowledge of the subject matter that is being taught. The TPACK framework states that effective technology integration in teaching requires teachers to have a deep understanding of the interaction and integration between technology, pedagogy and content knowledge. These results may suggest that university professors lack expertise in pedagogy. In addition, the

7 Ossiannilsson 2017.
8 Coppola et al. 2002.
9 Redmond 2011.
10 McQuiggan 2007.
11 Meloncon 2007; Redmond 2011.
12 Berge 1995; Feiertag–Berge 2008.
13 Alvarez et al. 2009.
14 Bonk–Dennen 1999.
15 Ammenwerth 2017.
16 Mishra–Koehler 2006; Koehler–Mishra 2009.

recent emergence of EMI (English Medium Instruction) in universities all around the world has posed a number of linguistic and pedagogical challenges for university professors who teach their courses in English, mainly for internationalisation purposes. Many studies report that in EMI contexts around the world, there is a lack of well-defined and structured EMI teacher training and development opportunities[17] to help with both language-related challenges, such as the lack of proficiency, and pedagogy-related ones, such as the lack of awareness when it comes to understanding students' learning styles and preferences.[18] However, universities are implementing transnational policies for quality assurance, which frequently include the establishment of language assessment methods and teacher training programs.[19] Another major challenge identified by Yang and Cornelious[20] for instructors who are used to a teacher-directed face-to-face environment to an online one is to redesign learning with a constructivist approach. Especially in universities, where student numbers in a classroom can reach 300 participants, learner-centred, inclusive and interactive approaches are very difficult to put into practice. This shift in the teacher's role has already changed the way secondary school teachers teach,[21] but university professors are still struggling with the adoption of a new approach as "designers and facilitators of learning"[22] or as coaches in their students' learning process.[23] Another very common concern among university professors is that teaching online may affect their image or prestige.[24] Nevertheless, there is evidence that academics may be ready to become reflective practitioners in the pedagogy of the subject they teach,[25] and that learning to teach online may fuel further self-reflection and evaluation of current teaching practices;[26] some of these worries and aspects also apply to college teachers.[27] In addition, researchers have found that teaching online changes the way teachers think and approach teaching, course design and

17 Costa 2015; Macaro et al. 2018.
18 Alhassan 2021.
19 Christison et al. 2022; Lasagabaster 2022; Macaro 2020.
20 Yang–Cornelious 2005.
21 European Commission 2019.
22 Hlynka–Jacobsen 2009.
23 Ammenwerth 2017; Alvarez et al. 2009.
24 Wingo et al. 2017.
25 Laurillard 2002.
26 McQuiggan 2007.
27 Dietrich 2015.

their relationships with students.[28] An interesting model to smooth the transition between traditional and online teaching is the "training the trainers" one[29] promoted by the field of instructional design based on constructivist principles and aimed at creating a stimulating and interactive learning environment. The goal of instructional design is to teach teachers how to create the resources they need and how to use the technology at their disposal to accomplish their educational objectives.[30] Speaking less of technology and more of the educational activities as a whole, a helpful framework is the ADDIE model which stands for Analysis, Design, Development, Implementation and Evaluation.[31] It is a widely recognised instructional design framework that guides the development of effective learning experiences. This model provides a systematic approach to designing, developing and implementing instruction, ensuring that learning objectives are achieved and learners' needs are met. Let us explore each phase of the ADDIE model in detail.

1. *Analysis.* During this phase, instructional designers gather information about the learning needs, target audience and desired learning outcomes. This involves conducting a thorough analysis of the learning context, identifying the knowledge and skills that learners need to acquire, and understanding any constraints or limitations. The goal is to determine the gap between the current and desired states of learning.
2. *Design.* Instructional designers use the information gathered in the *Analysis* phase to develop a blueprint for the instructional solution. This includes defining clear learning objectives, selecting appropriate instructional strategies, and designing the structure and sequence of the learning materials. Design decisions are guided by educational theories, learning principles and best practices in instructional design, considering the use of multimedia, technology and interactive elements to enhance the learning experience.
3. *Development.* Once the instructional design plan is in place, it is time to create the actual learning materials and resources. This includes developing content, designing assessments and creating multimedia elements such as videos, interactive simulations, or online activities. Instructional designers work closely with subject matter experts and other stakeholders

[28] Major 2010.
[29] Biggs–Tang 2011.
[30] Marchisio et al. 2019b.
[31] Dick et al. 2009; Morrison et al. 2013; Smith–Ragan 2005.

to ensure the accuracy, relevance and quality of the learning materials. Iterative review and feedback processes are often employed to refine and improve the instructional materials.

4. *Implementation.* The designed instruction is delivered to the learners, in whatever modality: face-to-face, online, synchronously, asynchronously, blended (mixing face-to-face and online learning and adopting suitable methodologies) or hybrid (mixing face-to-face with remote learners and adopting suitable methodologies). Instructional designers collaborate with teachers, trainers, or facilitators to ensure smooth delivery of the instruction. They may also provide training or support to instructors, if needed, to ensure effective implementation of the instructional materials and activities.
5. *Evaluation.* This phase is crucial for assessing the effectiveness of the instruction and making data-driven improvements. Evaluation methods may include assessing learner performance by gathering feedback from learners and instructors. Multiple levels of evaluation are typically conducted, including formative evaluations, in which students learn while performing assessments providing teachers with real-time data about students' understanding, and summative evaluations, a standardised type of assessment in which the teacher measures the student's performance with grades. These types of assessment will be analysed later. The use of data in education for evaluation is also known as Learning Analytics. They refer to the process of collecting, analysing and interpreting data generated during the learning process to gain valuable insights into learners' behaviours, progress and overall performance. The findings from the evaluation phase inform revisions and refinements to the instructional design, ensuring continuous improvement of the learning experience. By leveraging data analytics techniques, educators and institutions can identify patterns and trends, understand how students engage with the content, identify areas that need improvement, reflect on the effectiveness of different tools and instructional strategies, and seek feedback from students and colleagues to continuously improve teaching practices, use data-driven insights to make informed decisions about the integration of digital tools. The aim is to harness the vast amounts of data generated by digital learning tools, such as learning management systems, online assessments and interactive learning platforms. Learning analytics enables

> the creation of personalised learning experiences, tailoring instructional strategies to meet individual needs, and offering timely interventions for struggling students. Furthermore, this data-driven approach empowers educators to make informed decisions regarding curriculum design, instructional methodologies and resource allocation, ultimately enhancing the overall learning outcomes and fostering a more effective and adaptive educational ecosystem. As learning analytics continues to advance, it holds great promise in transforming education by optimising the learning process and promoting continuous improvement in teaching and learning methodologies.

Thus, there are several models that help educators in teaching now and in the prospective years, also when level transitions such as from secondary school to university are involved.[32] However, it is not enough to know those frameworks, since the practice implies the use of digital tools and the need for competencies, which is the topic of the next section.

Digital competencies of educators

Teachers are primarily subject experts and they often receive little pedagogical and technical training, as Ammenwerth[33] notices. Professional development programs are essential for promoting high-quality instruction, encouraging a culture of continuous improvement, assisting faculty career development, catering to the requirements of different student populations and advancing institutional goals.[34] Depending on the institution and its aims, this could take many different forms, but the objective is always to give instructors the assistance they require to maintain their teaching proficiency and keep up with the most recent developments in higher education.[35] There are several models for the digital competencies of teachers and students. These models provide a holistic approach to understanding the digital competencies to integrate technology

[32] Bruschi et al. 2018.
[33] Ammenwerth 2017.
[34] Robinson–Hope 2013.
[35] Fernandes et al. 2023.

effectively in teaching and learning. Digital literacies are well known in the scientific community: they refer to the skills, knowledge and dispositions that enable individuals to effectively use digital technologies for communication, collaboration and learning.[36] Digital literacies encompass a range of competencies, including information literacy, media literacy, and digital citizenship. These competencies are essential for teachers and students who are working in digital environments. A known criticality is that the stakeholders tend to overestimate their digital abilities: this leads them to believe that the knowledge they possess is enough for their purposes, and that they can always rely on others who are more skilled with tools if they need help beyond their capabilities. Both students[37] and teachers[38] are inclined to this misbelief; as a consequence, there is a reduced focus on the significance of acquiring sufficient digital competencies. There are also institutional frameworks that must be considered when dealing with digital competencies: firstly, developed by the European Commission, there is the DigComp,[39] a framework that is useful for all citizens to provide a common understanding of what a digital competence is. It classifies digital competencies into five areas: information and data literacy, communication and collaboration, digital content creation, safety and problem-solving.[40] Information and data literacy refers to the ability to find, evaluate, manage and use information collected from web searches effectively. Communication and collaboration refer to the ability to interact, communicate, share and collaborate effectively with other people using digital tools. Digital content creation refers to the ability to develop and re-elaborate digital content using different tools with a close eye on copyright issues. Safety refers to the ability to use digital tools safely and responsibly, especially when dealing with personal and sensitive data: protection must act on two levels, the one of devices (hardware) and the one of cyber threats (software). Problem-solving refers to the ability to use digital tools in different ways to make life easier: being able to solve technical problems, and identifying needs and gaps. The framework is refined when dealing with education in the Digital Competence Framework for Educators, the DigCompEdu framework.[41]

36 Hague–Payton 2010.
37 Buffardi–Taddeo 2017.
38 Tomczyk 2021.
39 Vuorikari et al. 2022
40 Ferrari 2013.
41 Punie–Redecker 2017.

It provides a comprehensive set of competencies that teachers need to possess in order to effectively integrate digital technologies into their teaching practice. The framework identifies 22 competencies organised into six categories such as:

1. Professional Engagement
2. Digital Resources
3. Teaching and Learning
4. Assessment
5. Empowering Learners
6. Facilitating Learners' Digital Competence

More on the institutional point of view, the European Commission also developed the Digital Education Action Plan (DEAP)[42] to provide guidelines for European educational systems for a common vision of high-quality, inclusive and accessible digital education in Europe.[43] The DEAP proposes two main priorities; priority 1 works on fostering the development of a high-performing digital education ecosystem. Priority 2 works on enhancing digital skills and competences for the digital transformation. The priorities are sub-divided into actions that target specific objectives that need to be achieved:

- Remember that integrating digital tools may come with technical challenges.
- Ensure reliable access to the internet and appropriate hardware devices.
- Familiarise with the tools and troubleshoot common technical issues.
- Collaborate with the school's IT department or technology coordinator to seek assistance when needed.
- Provide students with guidelines and resources to overcome technical difficulties they may encounter.
- Collaborate with colleagues to share best practices, ideas and resources.
- Reflect on teaching practices and seek feedback from peers to improve instructional strategies.

In order to do this, teachers must stay updated with the latest trends, attend workshops, conferences and webinars, and actively participate in online communities of educators.

[42] European Commission 2020.
[43] European Commission 2020.

Setting learning outcomes

Before integrating digital tools into teaching, it is important to define clear learning outcomes. Teachers need to consider the desired outcomes (skills, knowledge, responsibility, autonomy) for students to acquire, then teachers may determine how digital tools can enhance those outcomes and ensure alignment with curriculum standards. By setting clear goals, teachers can effectively select appropriate tools and design activities that align with the teaching methodologies. In order to select learning outcomes effectively, the most important work that one must consider is Bloom's Taxonomy,[44] which provides a hierarchical framework for classifying learning objectives based on cognitive levels, ranging from remembering and understanding to applying, analysing, evaluating and creating. These cognitive levels help educators design learning experiences that promote critical thinking and deeper understanding.

- At the lowest level of the taxonomy – remembering – learning objectives involve the recall of factual information. For example, a learning objective might be for students to recall the main events of a historical event or define key scientific terms. This level focuses on the foundational knowledge necessary for higher-order thinking.
- Moving up the taxonomy, understanding involves comprehending and explaining concepts. Learning objectives at this level may require students to summarise a text, interpret data, or explain cause-and-effect relationships. Understanding encourages students to make connections and deepen their comprehension.
- Applying refers to the use of knowledge and skills in new situations. Learning objectives at this level require students to apply their understanding to solve problems, complete tasks, or make predictions. For instance, a learning objective might require students to use mathematical concepts to solve real-world problems or apply scientific principles to design an experiment.
- Analysing involves breaking down information into its component parts and examining the relationships between them. Learning objectives at this level prompt students to analyse data, identify patterns and draw conclusions. They may involve tasks such as comparing and contrasting different perspectives or evaluating the strengths and weaknesses of an argument.

[44] Bloom 1956.

- Evaluating requires students to make judgments based on criteria and evidence. Learning objectives at this level involve assessing the validity of arguments, justifying opinions, or evaluating the quality of a product or performance. Students engage in critical thinking and decision-making processes.
- Finally, creating represents the highest level of Bloom's Taxonomy. At this level, learning objectives involve the synthesis of knowledge and skills to produce original work. Students may be tasked with designing, constructing, or inventing something new. These objectives foster creativity, innovation and the application of learning in novel ways.

By aligning learning objectives with cognitive levels, teachers can design learning experiences that promote higher-order thinking and deeper understanding. The use of Bloom's Taxonomy encourages educators to move beyond rote memorisation and foster critical thinking, problem-solving and creative skills in their students. Furthermore, it provides a framework for assessing student progress and achievement, as different levels of the taxonomy require different types of evidence and demonstrations of learning. The literature also provides more specific guidelines, regarding for example the number of learning outcomes. Although it certainly depends on the size of a given module, it is generally agreed that instead of having an abundance of minor learning outcomes, it is advisable to have a few significant ones.[45] In addition to the desirable qualities of being observable, measurable and assessable, learning outcomes must also be clearly and unambiguously stated. Bloom's taxonomy provides a list of "measurable verbs" that may be used for writing learning outcomes, with an emphasis on active, concrete verbs. Fry et al. and Gosling and Moon[46] among others, give further practical advice insisting on the importance of clarity, simplicity and straightforwardness in the vocabulary used. The key role of Bloom's taxonomy is further stressed in the revision of Anderson et al., in that it helps teachers translate standards into a common language for comparison with what they personally hope to achieve.[47] When it comes to learning outcomes, one of the biggest challenges for teachers is to make sure that teaching strategies, assessment methods, assessment criteria and learning outcomes are consistent and

[45] Kennedy et al. 2007.
[46] Fry et al. 2000; Gosling–Moon 2001.
[47] Anderson et al. 2001.

aligned with one another in order to increase the transparency and significance of students' overall educational experience.[48] Ramsden further points out that students' clear understanding and expectations of evaluation techniques and criteria are connected with a higher satisfaction and performance.[49]

Designing learning experiences

Setting the Learning outcome is the first step before the choice of the most suitable technology. The market is flooded with a wide variety of digital tools designed for education. The most suitable ones are Digital Learning Environments (DLEs). The DLE is defined as a virtual framework in which teaching and learning occur together with the development of competencies. Its human component, consisting of one or more learning communities, is focused on the interactions between teachers and students and among students themselves, but also other interactions with other figures in education (tutors, instructors, facilitators, administrators, policymakers) play an important role. Its technological component includes a Learning Management System along with other integrated tools, based on the educational need. These tools allow the adoption of specific methodologies, such as problem-solving or formative practices. To choose the right tools, first the learning outcomes must be considered. Then, instructors should also consider student needs and the specific subject area. The evaluation of the most appropriate tools should be based on their usability, functionality, compatibility, data privacy and security features. Consider seeking recommendations from colleagues, attending professional development sessions, and exploring online communities to discover effective tools that have been tried and tested. When selecting educational technology tools, it is important to consider the students' needs and learning styles, as well as the specific learning outcomes that need to be achieved. There are a wide variety of educational technology tools available, ranging from online learning platforms to virtual reality applications, each offering unique benefits and drawbacks. Content aggregators and repositories are also an important source of materials and ideas. Following Dringó-Horváth et al.[50] they may be grouped as follows:

[48] Kennedy et al. 2007.
[49] Ramsden 2003.
[50] Dringó-Horváth et al. 2021.

- educational portals
- digital libraries and archives
- image, audio and video sharing services
- presentation services

Especially when consisting of OERs (Open Educational Resources) with Creative Commons licences, these resources can be used, reused, modified and built on according to one's needs, allowing teachers to save time without having to prepare materials from scratch. To complement this, the selection and the production of materials can be performed with an interdisciplinary perspective where appropriate, through the use of versatile modules. The use of OERs is pivotal in devising Open Educational Practices (OEPs), that blend using those resources with adopting innovative pedagogical models, and engaging both educators and learners in learning settings either formal or informal.[51] Indeed, the implementation of "practices which support the (re)use and production of OERs through institutional policies, promote innovative pedagogical models, and respect and empower learners as co-producers on their lifelong learning path", as one of the most used definitions of OEPs spells out,[52] allows for giving a methodological basis to the use of OERs. This goes beyond the open nature, which is necessary, but not sufficient since it is also important to facilitate changes in educational approaches, institutional policies and pedagogies. Namely, the production, management and re(use) of OERs have to be accompanied by:[53]

- The development and the application of open pedagogies in teaching practice, to support students and educators and make valuable contributions to the pool of public knowledge resources.
- Open and peer-to-peer learning, with open accreditation of students.
- Open scholarship: in researching, in disseminating data, in publishing *open access.*
- Open sharing: outcomes, teaching ideas, examples of teaching practice.
- The use of open technologies and tools, beyond educational resources.

[51] Marchisio et al. 2020.
[52] Ehlers 2011.
[53] Beetham et al. 2012.

It follows that OEPs can influence the design of learning experiences under several points of view, which can be summarised as follows:[54]

- Cultural: knowledge and curricula can be composed with more versatility, if open resources are available and open practices are implemented.
- Legal: the open licences, such as Creative Commons, generally allow more (re)usability with respect to the rigid copyrighted materials, albeit some limitations can still exist.
- Pedagogical: students can be engaged and assessed in new ways.
- Technical and technological: open formats can permit better interoperability and connectivity, since they are usually designed to be multiplatform, without artificial limitations put in place for commercial reasons. This could be also an advantage under the financial perspective, preventing institutions from acquiring expensive hardware or software for reaching goals in all respects attainable also at a lower cost.

A potential drawback to the use of open instruments is the possibility of having less support: sometimes, if problems arise, it is easier to resort to a business customer service than to try solving them in a community made by users. Practically, a proper compromise has to be made. This brings us back again to the initial question: how to choose the proper tools for education? To select the best educational technology tools for the students, consider the following factors:

- Learning Outcomes: What are the specific learning outcomes to be achieved? Do critical thinking, collaboration, or creativity need to be promoted?
- Student Needs: What are the specific needs of students? Are they struggling with a particular concept or subject area? Are they visual learners, auditory learners, or kinaesthetic learners? Does it allow for personalisation?
- Accessibility: Is the technology accessible to all students, regardless of their background or ability level? Are there any potential barriers to access that need to be addressed?
- Cost: What is the cost of the technology, and does it fit within the budget? Are there any ongoing costs, such as licencing fees or maintenance costs, that need to be considered?

[54] Hodgkinson-Williams 2014.

- Ease of Use: Is the technology easy to use and implement? Will it require extensive training or technical support?
- Teacher Needs: Does it allow for customisation? Is the technology reliable, relevant and consistent with the desired learning outcomes?

Foshay et al. 2010[55] divide the different kinds of instructional software in three groups, clarifying that a given technology may be used in one way, making the purpose and not the design of the software itself a priority:

- Supplementary: software that supplements instruction already provided in other modalities by adding little to no new content. Electronic substitutes for textbooks, lectures, workbooks, references, drill and practice sessions are a few examples.
- Complementary: software that expands the curriculum with additional material in ways for which often there are no non-electronic alternatives. Some examples are simulations, problem-solving and project design tools, as well as a number of enrichment applications.
- Software that serves as the primary source of initial instruction, as a substitute for non-electronic modalities of instruction, often used in distance education.

By carefully considering these factors, educators can select educational technology tools that are tailored to their students' needs and aligned with their specific learning outcomes. Digital tools should be integrated seamlessly into the curriculum to create engaging learning experiences. When people are new to the use of pervasive technology in education, there are some recommendations and practices that could help in incorporating technology into teaching. At first, educators should start small: incorporating technology into the teaching practice can be overwhelming; it is better to select a few key tools and experiment with how they can be integrated into lessons. Secondly, the integration of technology must be seamless: educators must avoid using technology for the sake of using technology and instead focus on how it can enhance student learning outcomes. Third, technology can be helpful if it fosters collaboration. Technology offers a wealth of opportunities for collaboration and group work. Encourage students to work together, utilising online tools such as virtual whiteboards and collaboration platforms. Fourthly, technology can give us a lot of information that may not

[55] Foshay et al. 2010.

be relevant or incorrect: educators then should emphasise critical thinking, encouraging students to analyse, evaluate and synthesise information, engage with online resources, and evaluate the credibility of information. Digital tools provide opportunities for active student engagement in the learning process. Encourage students to take ownership of their learning by using tools that allow them to explore, research and discover information independently. Incorporate gamification elements to make learning more enjoyable and motivate students to actively participate. Provide immediate feedback through formative assessment tools to guide student progress. Last but not least, it is very important to remember that, since technology in education acts as a means and not as a scope, the order of the operations to be performed is first planning careful instructional design and then using the technology needed, not vice versa.[56] It is clear that technical limitations and merits constitute a factor which has to be necessarily taken into account, but learning experiences have not to be constructed around them, that is designing them by taking as absolute priority to exploit the environment in the best way possible under the technological point of view. Often, it is better to make use of technology up to a certain extent, while keeping solid methodological bases motivating the structure of what educationally produced.

Integrating digital tools into assessment

Assessment plays a crucial role in measuring student learning and progress. According to Astin,[57] from the viewpoints of both teachers and students, assessment defines the whole educational process and provides information that measures its objectives and content, the process of learning and instruction, and the achievements of the learner, while also contributing to a more efficient organisation of teaching and learning. In Dringó-Horváth et al.,[58] the authors call for a revaluation of pedagogical assessment, which in turn implies the development of new strategies with specific objectives, stressing that the selection of digital tools should be dictated by and subordinated to those goals and not vice versa. Digital tools offer innovative ways to assess student understanding and provide valuable insights into their strengths and areas for improvement.

[56] Marchisio et al. 2022.
[57] Astin–Antonio 2012.
[58] Dringó-Horváth et al. 2021.

Utilise online quizzes, interactive presentations and multimedia projects to assess student knowledge. Embrace tools that provide automated grading and analytics to streamline the assessment process and inform instructional decisions. Digital tools can be particularly beneficial for students with diverse learning needs. Provide options for accessibility, such as text-to-speech or closed captioning features. Offer differentiated instruction by selecting tools that allow for individualised pacing and adaptive learning experiences. Ensure that digital tools are inclusive and accessible to all students, regardless of their abilities. Technology offers a wealth of opportunities to provide personalised learning. Consider incorporating interactive multimedia elements such as videos, simulations and virtual reality experiences to enhance student understanding. Design activities that encourage student collaboration, critical thinking and problem-solving. Provide opportunities for students to create, share and present their work using digital tools. One strategy to consider the diverse learning needs is Formative Assessment and feedback. For the construct of Formative Assessment, Black and Wiliam's definition is one of the most recognised in literature.[59] They state that "practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited". Critical to this definition of Formative Assessment is the collection of evidence, and the interpretation and use of the information gathered to act on learning. The mere collection of students' answers, without altering and tailoring the learning path according to the collected data, is not to be considered formative.[60] Among the strategies of Formative Assessment, the provision of feedback is undoubtedly the most distinctive one and the object of in-depth studies. Results on feedback efficacy on learning are controversial.[61] For instance, from an outstanding review of feedback[62] it emerges that in more than one-third of the 607 analysed cases, feedback interventions reduced performance. This means that great attention should be paid to feedback design. Hattie and Timperley[63] provided a model for constructing effective feedback. They define

[59] Black–Wiliam 2009.
[60] Wiliam 2006.
[61] Azevedo–Bernard 1995.
[62] Kluger–DeNisi 1996.
[63] Hattie–Timperley 2007.

feedback as "information provided by an agent, such as a teacher, a peer, or a book, regarding aspects of one's performance or understanding".[64] According to their definition, feedback is a form of communication that aims to bridge the gap between a learner's current understanding or performance and the desired goal. It serves as a mechanism to provide learners with specific information about their strengths and weaknesses, guide them toward improvement, and enhance their future learning. Hattie and Timperley emphasise that effective feedback should be timely, specific and actionable, providing learners with clear guidance on how to close the gap between their current and desired performance. Effective feedback should indicate what the learning goals are; what progress is being made toward the goal; and what activities need to be undertaken to make better progress. Moreover, feedback can work at four levels: at the task level, giving information about task correctness; at the process level, adding details about the main steps needed to accomplish the task; at the self-regulation level, activating metacognitive processes; and at the self level, adding personal evaluations about the learner. While the literature shows that the self level is not effective, or even dangerous,[65] it seems that the only task level feedback alone is not enough: many studies show that elaborated feedback is more useful than the corrective one to improve learning.[66] The great part of elaborated feedback models that the literature proposes is static: students have to read them carefully and compare them with their results. Some studies also show that, more often than expected, students do not read them at all, especially if they perceive the task as too complicated or if they do not receive the feedback timely.[67] It is clear that if the learners do not process feedback, the latter lose all their potential.[68] Modern digital tools for assessment allow for formative assessment and the provision of feedback to be put efficiently in practice. For example, it is possible to provide "adaptive" questions, that are multipart questions in which the path proposed depends on the student's answers, acting as immediate feedback.[69] If the student correctly answers a question in the first instance, then their specific knowledge is ascertained, and the question ends with the first part alone, prompting the student

64 Hattie–Timperley 2007: 81.
65 Kluger–DeNisi 1996.
66 Shute 2008; Timmers–Veldkamp 2011.
67 Timmers–Veldkamp 2011.
68 Sadler 1989.
69 Galluzzi et al. 2021.

to another question. On the contrary, if the student wrongly answers the question in its initial stage, then subsequent parts of it are successively made available, allowing them to reflect on why they did not provide the right answer through a tailored path, which can end with asking again what was asked at the beginning of the question. This fits with the methodology of learning through errors,[70] which predates by decades the advent of the information revolution, highlighting once more how technology can help the implementation of already consolidated methodologies. Another capability of some of the so-called "Automated Assessment Systems" (AAS) is to interface with a computational engine, allowing to compare different forms of the same expression (e.g. a mathematical formula that can be written in several ways) in order to consider all of them as right while assessing. This is useful for scientific subjects, but not only: thanks to advanced capabilities, it is possible to devise tasks also for disciplines belonging to other areas such as Humanities and Linguistics,[71] thus widening the usability spectrum of the tool. It is also possible to construct questions containing randomly generated elements: when a question appears to the student, parameters are generated, and they change if that question is reattempted. This allows students to attempt a question several times, as the various attempts were different questions, thus essentially incrementing the amount of formative materials available to students with a lower effort than traditionally required.

Conclusion

The integration of digital tools into innovative teaching methodologies has the potential to revolutionise education. By embracing these tools, teachers can create engaging learning experiences, promote active student engagement, and facilitate personalised and meaningful instruction. However, it is important to approach this transition thoughtfully and deliberately. By setting clear learning objectives, selecting the right tools, and continuously reflecting on and improving instructional practices, teachers can harness the full potential of digital tools and enhance student learning outcomes. Teaching from a desk and teaching from a computer desktop are two very different ways of teaching: the first is a long-standing tradition, one that professors are familiar with and have

[70] Scriven 1967.

[71] Marello et al. 2019.

mastered throughout years of experience, while the second was born around thirty years ago; the first is a solitary act that typically only involves the teacher's expertise as far as the content, the delivery and the assessment are concerned, while the second is usually a team effort, which requires the collaboration of tutors, technical and managerial staff, and instructional designers. They share a similarity, though: in recent years, the pedagogical assumptions of traditional teaching have been questioned, while moving towards a more learning and learner-centred, constructivist model. This model is one of the foundations of online teaching, where the teacher becomes, more than ever, a facilitator of learning, who therefore must redefine their role. These principles are still very hard to put into practice at the university level in a classroom context, but through the design of online courses, professors are becoming aware of the necessity to "teach the way students learn".[72] However, designing online courses is a time-consuming, challenging process demanding that professors become once again learners too. Not only do they have to redefine their role and rethink their materials, they also have to familiarise with new technology and plan how to use it according to their courses' learning objectives, adapt evaluation to the automatic assessment model, and juggle academic commitments and the preparation of videos, animations, quizzes and other online interactive activities. Work organisation and time management become a priority in teachers' struggle not to be overwhelmed, so it becomes paramount that they are not left alone and are offered the support they need. At the same time, also students have to be taught how to overcome their digital literacy and technical issues, but above all how to become more autonomous and disciplined in order not to lose motivation even in contexts where in-person interaction is diminished or lacking. In addition, to make the transition smoother, teachers need to be constantly supported and universities must be equipped accordingly. Universities need people who are expert in designing online courses together with the teachers, who can find the most suitable solutions, who can show them models and innovative strategies. Providing constant and relevant feedback, together with the employment of multi-modality, gamification tools, setting clear expectations and maintaining an online presence has proved to increase student engagement and motivation and reduce dropout rates. The blended modality (joining face-to-face and online learning) can help the transition, too: by progressively reducing face-to-face teaching and offering stimulating online learning experiences, students are given time to

[72] Kolowich 2013.

become more independent and get accustomed to using the required technology. Despite all these difficulties, after the training most teachers express satisfaction for the work done, give encouraging feedback on the training received, and say they would repeat the experience. At the same time, preparing a blended, hybrid, or online course seems to prompt reflection on traditional teaching, and once the course is completed the integrated use of the classroom course and the online one provides undeniable benefits.

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Best Practices

The following paragraphs include a series of practical tips that could help teachers to put into practice the theoretical frameworks presented in the previous sections. They are aimed at improving interaction and engagement in a Digital Learning Environment (DLE). These suggestions can help improve classroom-based, online, blended and hybrid education. The practical indications are conceived for a Moodle-based Learning Management System. Moodle has been chosen since it is free, open source and highly used in European higher education institutions. However, similar functionalities are also available in other Learning Management Systems. For detailed information on the various settings of a Moodle course and of the various resources and activities available, it is possible to consult the Moodle Documentation page,[3] the Moodle Academy web page[4] and other useful resources available on the web.

Basics of Docimology

From the Greek words meaning "evaluate, estimate" and "logos, thought, speech", the term "docimology" stands for the science which studies issues related to the measurement and assessment in education. Assessment can be performed at different times of the learning path:

- At the beginning, with a diagnostic function, to investigate students' starting point and identify gaps in their knowledge that could lead to learning difficulties. In Moodle, it could be carried out through an online quiz focused on prerequisite and initial knowledge.
- During the path, with a proactive function: it is the case of formative assessment, conceived to foster and support learning. It dynamically

1 University of Turin.
2 IT Army Education and Training Command and School of Applied Military Studies.
3 See https://docs.moodle.org/402/en/Main_page.
4 See https://moodle.academy/.

DOI: https://doi.org/10.36250/01238_03

provides teachers with data on students' understanding, useful for orienting and modifying the teaching action. In Moodle, it can be carried out through a variety of tools, such as online quizzes, surveys, assignments, workshops, lessons and many other kinds of activities. They can also be combined in order to achieve different goals.

– At the end, to check if students achieved the learning goals. It is the case of summative assessment. It could also have a certification function. In Moodle, it can be performed through an assignment asking the submission of a complex work (e.g. an essay or a problem-solving activity), or an automatically assessed quiz or test.

When grading students' activity, the choice of a suitable grading system is relevant. Grades can be numbers in a fixed range or a grading scale in words. It is necessary to decide and share with students the criteria through which their performance will be graded. In Moodle, all the grades are collected in the course gradebook, accessible through the "Grade" option in the navigation block. There, students can see their grades, and teachers have an overview of students' grades in all the activities. Moreover, teachers can edit the gradebook settings, set a method to compute the course total grade, evaluate group activities and choose the elements to be displayed. In the course gradebook, teachers can also define grading scales to be used for the various activities. To assess an activity through a scale, it is necessary to set "Scale" as the grade type in the grade section of the activity settings page. It will be possible to choose among the scales defined in the gradebook. In automatically assessed tests, a given number of points is assigned to each item, and the final score is the sum of the points earned. In Moodle Quiz, it is possible to edit the maximum number of points for the questions after inserting them into the quiz. For more complex tasks, assessment can be performed through rubrics. Rubrics are tables that include a set of indicators and, for each indicator, a proficiency level. Clear and objective descriptors should be provided for the various levels of each indicator. In a Moodle Assignment activity, it is possible to set a rubric for assessing the students' submissions. In the general settings of the activity, the "Grading method" should be set "Rubric". After saving the activity details, it is possible to create a rubric by adding indicators and levels as shown in Figure 1. The grader, when examining the students' submissions, will have to indicate for each indicator the level achieved, as shown in Figure 2. It is also possible to add specific feedback for each indicator. The total points will be computed automatically.

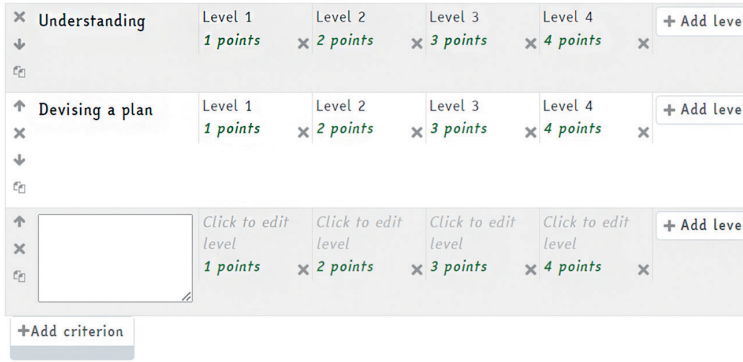

Figure 1: Setting an assessment rubric in a Moodle Assignment
Source: Compiled by the authors

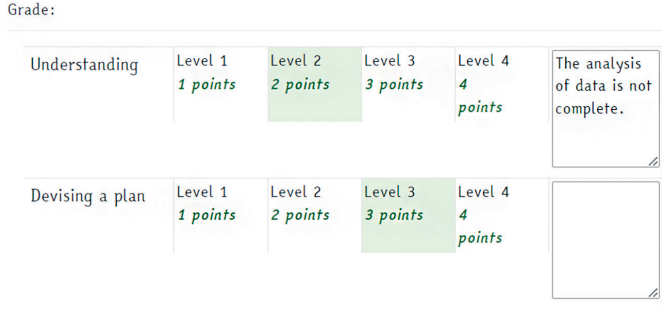

Figure 2: Assessing students' submissions through a rubric
Source: Compiled by the authors

Alternatively, it is also possible to use a marking guide, setting "Marking guide" as a grading method. Analogously to rubrics, it is possible to create a marking guide adding criteria with descriptors for students and for graders and a maximum grade for each criterion. Figure 3 shows how to set a marking guide with Moodle. In this case, during the assessment phase graders will have to select a number of points for each criterion and also give specific feedback. A marking guide may be preferable to a rubric when the score range that can be attributed to each criterion is wide.

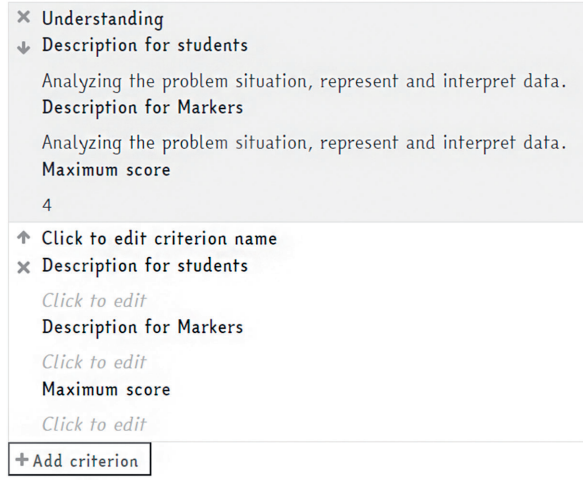

Figure 3: Setting a marking guide with Moodle
Source: Compiled by the authors

Whatever the grading system is, teachers should be transparent with their students and make them aware of the expected achievements. Useful tips on how to do this will be presented in the subsequent sections.

Description of learning outcomes: Knowledge, skills, responsibility and autonomy

Learning outcomes state what the learner will get at the end of the learning process. They refer to students' knowledge, skills, responsibility and autonomy. Writing the learning outcomes effectively facilitates the identification of the purpose of each learning activity and the alignment of the whole learning process, from learning to assessment. Learning outcomes can be written at course level, at module level, or even for every single activity. However, the general learning outcomes must be identified in the various activities that compose the course. Learning outcomes should satisfy these general features, the acronym *SMART* is useful for remembering these characteristics:

- Specific: clear and distinct from others. Learning outcomes should be well defined, they should not be vague.
- Measurable: identifying observable student actions, to let teachers and students know the level of their proficiency at each stage.
- Attainable: suitably challenging for students in the course. Learning outcomes should be realistic and achievable, adapted to the level of the target learners.
- Related: connected to other objectives and students' interests. Learning outcomes should be actionable, making learners able to use them afterwards for their future learning.
- Time-bound: likely to be achieved and able to keep students on task within the given time frame.

Moreover, as a general feature that is essential in every text, learning outcomes should be written in simple language in order to be understandable by the target learners. A general way to describe the learning outcomes contains three elements:

- Condition: what is required to reach the learning outcome, e.g. after completion of the whole course, or after attending the module, at the end of the learning activity.
- Action: active verbs that express knowledge skills or autonomy of the learners, for a list of useful verbs, one can refer to Bloom's taxonomy of learning objectives and its subsequent refinements.
- Eventual Criterion or Context: further specifications to show the learners the means by which the learning outcomes will be achieved (e.g. through an oral interview, by analysing samples, by writing a report), in which context is or will be applied (e.g. in the management of a complex system, to be applied in future experiments).

An example of learning outcome may be: "After the completion of the course, students will be able to interpret the results of a numerical simulation of a natural phenomenon in its different representations (graphical, numerical, symbolic)." Throughout the whole learning program, the teacher should always recall the learning outcomes for the design and delivery of a learning activity, in order to select the most suitable learning approach and digital tool: the DLE can provide teachers with a wide range of opportunities to make students, for example,

interact (lessons, quizzes, formative assessment), collaborate (forums, group projects submissions), peer-evaluate (workshop activity in Moodle) or any other active verb that can promote the achievement of learning outcomes. Moreover, one of the pillars of formative assessment is sharing learning outcomes and criteria for success with students. Being aware of what is expected from them and how their work will be assessed is crucial to focus on the activity, enhance motivation and foster self-regulation.

Customisation of the digital learning Moodle-based environment

In order to make the DLE more engaging and attractive for the students, it is advisable to customise the Moodle course on which the DLE is based as much as possible. When a course is created in Moodle, it is empty and has the default settings. Before filling it with materials and activities, it is advisable to make the general aspect of the course clear, so that students are able to orient themselves, feel supported and not confused. This allows students to start the activities with a positive attitude, which will benefit the final results. The course structure for teacher editing is organised as follows:

- *Administration block* – the "Administration" panel allows changes to be made to the structure and general settings of the course, such as managing users and assessments. By opening the "Edit settings" menu and expanding the first item "General", it is possible to set the title of the course, the visibility of the course (for example, it is possible to keep the course hidden from students and make it visible when it is finally ready). By expanding the "Description" part, an introduction to the course can be inserted, which will be displayed in the list of courses next to the title. It is advisable to write a short text summarising the objectives of the course. It is also possible to upload an image, which will be displayed as an icon under the title of the course (in the list of all courses on the platform). The description can also be included in the main page of the course, in the description block. The "Course format" section allows the teacher to choose the format of the course, i.e. the structure of the page and the sections in which the materials will be placed. For example, the course can be organised by topics, with a section for each topic of the course, or by week so that the course is divided into weeks and the

start of the first week is determined by the start date of the course. For school or university courses, the subject format is usually chosen or the weekly format; for example, for a semester course of 12 weeks, it may be appropriate to choose the weekly format. If the duration of the course is not too long, it can be organised by topic. Teachers can also choose to display the section on the same course page or on a different page. The second allows to have a specific section link. This setting is useful if teachers want to have links between sections, or perhaps to personalise some feedback and link it to specific sections. These course formats are available by default. However, many others can be found in the Moodle plugin repository; check out and try other course formats to find the one that works best for the students. In the administration panel teachers can also access filters. Some filters personalise the user profile fields within the materials or displayed in blocks. The multilanguage filter enables resources to be created in multiple languages. When turned on, teachers can insert a text block in different languages inside a span HTML tag (text in the selected language, where “xx” are two letter representing the language, “en” for English, “it” for Italian and so on). Then it selects and outputs the text in the user’s language (as set in their browser or in their preferences).

- *Navigation panel* – the “Navigation” panel contains links to the other courses in which the user is enrolled. It provides easy access to many of the platform’s tools (i.e. participants or sections of the course). It also contains the link to the list of participants or to the competencies, badge and gradebook. In the latest version of Moodle, and based on the chosen theme, the navigation panel will show all the sections, all the resources and activities within them, and their completion status.
- *Body of the course* – the “Body” of the course is the central part, containing all the resources and activities, and it is divided into sections. It may contain for example a discussion forum where students can interact and discuss resources such as text, video, audio and activities to put the acquired knowledge into practice and to consolidate skills. The sections can be customised by the teacher, not only by adding activities and resources, but also by inserting an image for each section to make it more attractive to the students. Sometimes it is useful to include an image in the section that shows the key words of the topic of the section, so that

students can easily find materials within the course. Any element included in the body of the course must be consistent with its learning outcomes. It is useful to include an "Announcements" forum where the teacher can easily post communications and messages for the students. It is possible to hide topics that have not yet been covered, or material that will only be available after a certain time or that is not yet final.

- *Later blocks* – the left and right columns of the course contain boxes called "Blocks", which allow the teacher to customise the layout and feel of the page. In edit mode, teachers can add or remove blocks and change their position. Some examples of blocks are the calendar, the recent announcements or the online user's block. As a teacher of the course, it is possible to decide which blocks students can see. The main side blocks are the standard administration and navigation panels.

Interactive learning: Synchronous or asynchronous resources and activities

Interactive learning materials are resources designed to teach a specific learning outcome and make students respond to different stimuli. They are composed of any combination of text, images, audio, video and are usually delivered via a DLE. There are several reasons to consider the use of interactive materials for students, among several others it is important to mention that interactive materials:

- allow learners to study autonomously
- are scalable (can be delivered to a large number of learners) and are flexible
- train students for lectures or lab work
- support distance learning
- enable students to practice the skills learnt in classes

Within a Moodle course there are several activities or resources to support learning. In edit mode, a teacher can add activities or resources using the "Add an activity or resource" button (Figure 4).

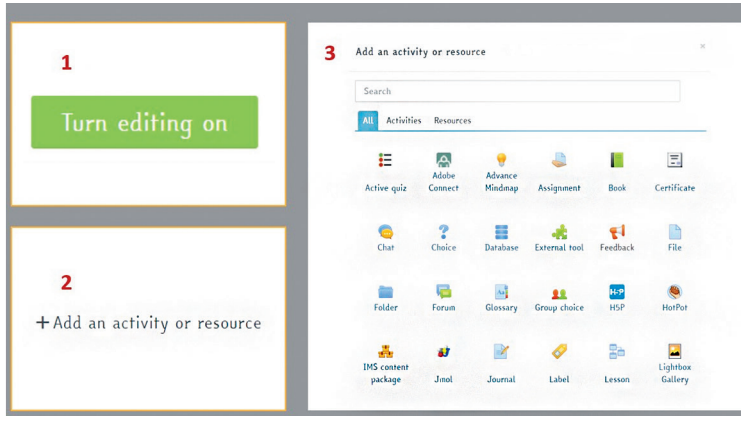

Figure 4: Steps to add an activity or a resource
Source: Compiled by the authors

A resource is something that a teacher can use to support learning by providing students with different kinds of materials. Moodle supports a range of resource types that teachers can add to their courses:

- video
- embedded file that can be viewed within the course
- link to external sites
- folder for collecting materials
- podcast

An activity is a generic name for a group of features in a Moodle course. Typically, an activity is something in which students interact with other students and/or the teacher, or collect feedback from the course. Moodle contains different kinds of activities that teachers can add to their courses, for example for synchronous activities:

- Integrated web conference tools, where the online meeting is directly accessed from the platform and students do not need to download any other applications.
- Chats for online discussions.

And for asynchronous activities:

- quizzes and tests with automatic feedback
- interactive resources (e.g. H5P,[5] rich HTML5 content)
- assignments and group submissions
- questionnaires and surveys
- forums for discussions between teacher and students or between peers; for example, a forum for doubts and questions can be included in the Moodle course so that students can discuss and compare and contrast a particular topic
- workshops for peer evaluation
- wikis for the collaborative creation of a net of documents
- databases and glossaries for a shareable collaborative collection of resources
- lessons for the customised and enhanced exploration of several pages

It is important for teachers to take into account the timing of the activity and whether the activity is intended to be synchronous or asynchronous. Most of the asynchronous activities can also be delivered during classes or meetings (which means during synchronous learning). It is also important to alternate synchronous and asynchronous tasks, in order to accommodate different learning needs, to take into account eventual connection problems, to let students choose the timing of their online learning, since it is tiring to spend many hours in front of a computer. Moodle activities may include evaluating, the previous sections may be useful in learning more about this.

Civilian and military collaborative learning

Learning in the security and defence field is not an isolated or exclusively individual process: it takes place in a multi-integrated and social dimension, where there are many forms of interaction and collaboration, among different kinds of actors (militaries, civilians) and in international contexts. This section focuses on organising collaborative learning activities with the involvement of civilian and military students at the same time. Every actor in the environment is considered a resource and an opportunity. The learning process, starting

[5] See https://h5p.org/.

from its individuality, is cleared through a process of reciprocity, surrounded by the possibility of a mutual exchange of knowledge, skills and competencies. Collaborative learning activities have a twofold effect:

- the development of teamwork skills
- the development of cooperation skills for future interactions between militaries and civilians

Both teamwork and cooperation skills form the basis to acquire and consolidate leadership, problem-solving and critical thinking skills. All these transversal skills are very useful for the career of an officer or civilian who wants to operate in the field of security and defence. Surely, in a long time, the basic training of civil–military cooperation with the creation of real collaborative learning laboratories could be the right investment for international institutions to make for the joint framework of the fight against hybrid threats. The processes for developing these skills are set out in a series of examples of collaborative learning activities that are described in the following paragraphs.

Group activities

Group work helps students to develop the following soft skills:

- communication: being able to communicate effectively
- critical thinking: a thought that is constructed by observing a phenomenon from various points of view trying to understand the reason
- decision-making skills: trying to consolidate the sense of choice and responsibility
- mediation and conflict resolution: in a group there is always a moment of controversy
- emotional and empathic intelligence

According to the Random Collaborative Learning model, groups should not be too numerous and large groups should be divided into subgroups. In each subgroup, a leader should be identified, which does not mean the person who shares and divides the tasks to guide the team, but one that possesses a charisma and social skills capable of guiding the other members. The leader can be chosen directly by the group's members, by the professor or following a task rotation among members. Groups should be heterogeneous: males and females, civilians

and military, different nationalities, soldiers of different specialties. During the practical activities, groups can change or not change their composition. This enables a better exchange of ideas, a better division of tasks, greater participation of all members, a co-built learning process, and students' awareness of their own strengths and weaknesses. It is very important to provide, at the end of the group activities, feedback from the group leader or from several participants in the group. It is important that the teacher provides feedback on group activities, too.

Team games

Team games allow for the introduction of gamification elements on the one hand and the creation of challenging situations on the other. These activities can be introduced to test students' acquisition of knowledge and skills. Having a team implies that students work to achieve "common goals". This situation creates a strong relationship between the participants sharing the team game experience. The presence of other individuals gives rise to a continuous debate among the members of the group on possible doubts, perplexities, uncertainties. The team can also be seen as an antidote to insecurities and low self-esteem. Through the team game and its challenges, students also develop intrinsic motivations for achieving the result. Moreover, a team game also means having rules, an excellent tool for the acquisition of a sense of duty and responsibility by students, especially in security and defence education.

Simulations and role-playing

The simulation of real situations entrusts different tasks to participating military and civilian students to allow them to better understand the dynamics studied in theory and put into practice what they learned during the lessons. Simulations can include the use of specific computer tools or virtual platforms that allow decisions in real time and interactions among participants. In addition to simulations, role-playing means acting the role of a character or person when partners take other roles. Role-playing can be based on simulations related to a real situation and structured in such a way as to be emotionally engaging. This activity provides multiple stimuli for learning through imitation, action, observation of the behaviour of others and the comments received on one's own.

Analysis of case studies

A case study is a detailed description of a specific subject or phenomenon. Case studies are used in security and defence education to face what has been studied at a theoretical level and understand its concrete applications. The analysis of a case study can be conducted by several military and civilian students with different backgrounds, individually or in groups, to grasp different perspectives and confront each other.

Debates

Before addressing a specific topic or after the topic has been addressed, it is useful to open discussion sessions that can allow military and civilian students to express, argue and defend their ideas. The approach to different styles of thinking, such as the civilian and military one together with the teachers' perspective, is an excellent fertile ground for understanding various points of view and approaches that in a homogeneous group of students would not have the same blooming. In this way, communication skills are developed, and civilian–military interactions are promoted. Transversally, students develop critical thinking and ask questions for a deeper knowledge and understanding of the topic.

Peer evaluation activities

Each actor within the learning environment is a resource and an opportunity. In the evaluation process in a collaborative learning environment, not only the teacher has an important role, but also the other students can assess. Peer evaluation activities especially between civilians and militaries acquires an added value: it means giving feedback on each other's work, or another group's work. It builds students' confidence in understanding and applying selected criteria. These activities are usually formative to reduce the focus on grading and scores. More detail on peer evaluation can be found in the Section *Assessment, peer assessment and self-assessment.* To increase the effectiveness of the activities, some points must be followed and kept in mind.

- Activities can be carried out face-to-face or remotely within a digital learning environment. This allows the teacher to develop the students' digital skills, and create areas for debate and exchange of opinions.
- Activities must be well designed by the teacher in terms of objectives to achieve, duration and tasks of the students.
- For constant updating and quality control, supervision of the teacher is essential to give individual or collective feedback with the aim of stimulating, helping, clarifying, correcting and gratifying.

Making short videos

Creating a video for multimedia learning is a great way to engage learners and enhance their educational experience. However, it can also be a challenge to create a video that is effective and engaging. In this section, some of the key points to consider when producing a video learning resource will be discussed and some suggestions on how to do so will be offered.

1. The first point is the purpose and focus of the video. It is important to have a clear purpose and focus on specific learning outcomes. This helps to ensure that the content is relevant and targeted to the intended audience, making it more effective in achieving the desired learning outcomes. This is a key point that will influence all other aspects of the video production, including the content, visuals and length of the video. It is important to include a short introduction in the first minute of the video, explaining its purpose and topic. This will help set the context for the content and provide a clear overview of what will be covered in the video. A similar description can be included in the video description or in the title. If the video is part of a Moodle resource, teachers can also add a description in the description field and display it on the course page.
2. The second point is length. When making a video, it should be remembered that attention span tends to decrease after 6 minutes, so keeping the video short will help to keep learners engaged. Research suggests that training videos should ideally be less than 10–12 minutes long and definitely not more than 15 minutes. In an online context, it is better to have 5 short videos than one long video. This also reduces the size of the files and avoids problems regarding the upload within the Learning Management System.

3. To keep the length of the video in check, planning is fundamental. It is important to plan the video in advance using storyboards and scripts to define the content and the images. This will help ensure that the video is well structured and flows smoothly, making it easier for learners to follow and understand the content. It also allows for any necessary revisions or edits to be made before filming begins. There are programs that can estimate the length of the video based on the script. Otherwise, it is generally estimated that 1 minute ≈ 150 words. There are also AI tools that can provide a basic script that can be extended. When writing the script, one must consider the language. Simple and clear language makes the content more accessible and understandable to learners. Technical terms or idioms that might be unfamiliar to the public should be avoided. If specialised terms are used, they should be clearly defined and examples or explanations may be added to clarify their meaning. When designing the language of the video, it is also important to consider the language level of the audience. Scripts also make it easy to translate the video into other languages, if necessary, or to add subtitles and provide a transcript.
4. The fourth point is the use of visuals. Visuals can be pictures, diagrams, animations, and other visual aids to illustrate concepts and ideas. Visuals can be used to enhance the content and make it more engaging for learners. Signalling techniques, such as highlighting or underlining, can be used to draw attention to important ideas or concepts.
5. The fifth point is the use of audio. Good audio quality is essential to ensure that the narration is clear and easy to understand. Poor audio quality can be distracting and detrimental to the learning experience. Audio editing software can be used to improve sound quality.
6. The sixth point is to use active learning. Videos can be placed in an active learning context by incorporating questions and interactive elements into the video. This encourages learners to actively engage with the content itself rather than passively watch the video. The H5P[6] Moodle plugin easily creates interactive videos. Videos can also be adaptive and provide feedback to students based on their responses to questions or interaction with interactive elements.

[6] See https://h5p.org/.

7. The seventh point is the use of accessibility. Videos should be accessible to all learners by including captions or transcripts. This will ensure that students with hearing loss or other accessibility needs can fully engage with the content.
8. The eighth point is reusability. Videos can be reused over time in different contexts. This can help maximise the return on investment in video production and ensure that the content remains relevant and useful for future learners. In order to achieve reusability, it is essential that the video is short in length and has a specific and clear purpose.
9. The ninth point is production quality. It is not necessary to have fancy equipment or software, but it may be worth considering using free or low-cost tools to enhance the educational effectiveness of videos. Simple production styles can be just as effective as high-budget studio productions, as long as the content is clear and engaging.
10. The tenth point is evaluation. To evaluate the effectiveness of a video, students can give feedback through questionnaires. In addition, student performance can be monitored by designing tasks related to the video content.

After designing the video, another important aspect is choosing the best tool to make it. For example, to make a video to explain a concept while having a presentation, it is possible to use the recording tool provided by PowerPoint.[7] The voice and the image (such as the webcam) are recorded, while the slides vary. While recording, presenter mode can be used to read the notes of each slide and to use other tools to enhance the presentation (such as a laser pointer or highlighter). At the end of the recording, the audio is inserted into each slide. Alternatively, it is possible to manually add audio to each slide. Then the presentation can be exported in video format, choosing the output quality. A similar effect can be achieved by recording video into a web conferencing system, like Zoom,[8] Teams[9] or Webex.[10] Most web conferencing systems also allow to automatically add subtitles based on the voice recording. Using software

[7] See https://www.office.com/.
[8] See https://zoom.us/.
[9] See https://www.microsoft.com/microsoft-teams/.
[10] See https://www.webex.com/.

such as PowerPoint (although the free software ActivePresenter[11] can also be used in the same way) allows teachers to have a source file that is easily modifiable compared to recording in a web conferencing system. Instead, to create a video that shows how to do something, it is possible to use some screen recording software. This type of software records everything that happens on the computer screen, including mouse movements and speech. For example, all new computers running Windows have a feature called the GameBar (Windows key + G) to do this. Alternatively, other software such as Camtasia,[12] ActivePresenter,[13] OBS Studio,[14] etc. can be used. The advantage of using this type of software is that the registration takes place in one go without having to modify it later. The downside is that the video cannot be edited later, for example to correct a mistake.

Assessment, peer assessment and self-assessment

When referring to "assessment", it is usually thought of a teacher evaluating the students. However, this is only a part of that practice, since students can also take advantage of being evaluated by other stakeholders. In fact, assessment can be performed by three different agents:

- External agents, such as the teacher or the computer. It is the case of assignments manually graded by instructors or online quizzes automatically graded by the computer, according to rules set by the teacher. These kinds of activities can be used for diagnostic, summative and formative assessment.
- Students themselves through self-assessment activities, that are usually included in formative assessment.
- Peer students, through peer-assessment activities, are generally used for formative assessment as well.

In this section, the reader will find suggestions for setting assessment activities of external assessment, self-assessment and peer assessment for summative and formative purposes.

[11] See https://atomisystems.com/activepresenter/.
[12] See https://www.techsmith.com/video-editor.html.
[13] See https://atomisystems.com/activepresenter/.
[14] See https://obsproject.com/.

Using online quizzes for summative assessment

Online quizzes are commonly used to check if students have achieved the learning outcomes at the end of a path. To adapt online quizzes to summative assessment, it is important to pay particular attention to the following hints. A particular reference must be done on the Moodle Quiz activity; however, it is possible to define similar settings also using different automatic assessment systems.

- Each item should be related to one and only one learning outcome.
- Each item should address only one question (avoid multiple requests in the same item).
- Items should be independent of each other: avoid creating items that rely on previous answers.
- It can be useful to limit the availability to the test through time constraints. They should be set in the "Timing" section of the activity details page.
- If the test needs to be completed in a fixed time, the time limit (in minutes) can be set in the "Timing" section of the activity details page. It is also possible to set different time limits for specific students or groups of students. This can be done through the Group or User override sections in quiz administration.
- To avoid cheating, it could be useful to make only one attempt available. In Moodle Quiz, the number of attempts can be set in the "Grade" section of the quiz administration. Through the Group or User override section it is also possible to specify different settings for single students or groups.
- To avoid cheating, it is useful to randomise the question order and elements of questions, such as the multiple-choice options, or questions themselves. To randomise the question order, the "Shuffle" option in the "Edit quiz" page should be flagged. To randomise question parts, such as the options of multiple-choice questions, the "Shuffle within questions" option in the quiz administration must be enabled, and the "Shuffle the choices" option in the question setting must be enabled. To add random questions from a set, the questions should be previously created in a category of the course question bank; in the "Edit quiz" page, click on "Add" and then choose "Random question". When using randomisation, it should be considered that a different order may affect student response or the perceived difficulty of the test.

- Also, numeric elements within questions can be randomised, provided that the difficulty of the question is preserved. In the Quiz activity, there are specific question types that allow this kind of randomisation, such as: calculated, calculated simple and calculated multichoice. Other tools also allow the randomisation of different parameters such as words, increasing the possibility of generating different versions starting from a single question.
- In multiple choice questions, try to avoid:
  - options that are too obviously wrong
  - including one option formally different from the others (for example, in length and elaboration of sentences)
  - high syntactic complexity
  - using terms such as "always" or "never", which makes the question obviously false
- Embed tasks in relevant contexts and real-world situations, in order to develop competencies.

Using online quizzes for formative assessment

Online quizzes can also be used to support and monitor learning during the path. The following list includes suggestions for making automatically assessed tests formative and offering students valuable feedback.

- Allow repeated attempts in assignments and questions, so that students can repeat the activities and monitor their progress.
- Use time limits only when it is relevant.
- When possible, randomise the various elements of the test: question order, options in multiple choices, numeric parameters (and other parameters such as words, if available), the choice of questions from a set. This helps to have different versions of the tests for each student and, for each student, different versions of the test at each attempt.
- Ask students to collaborate, in a synchronous or asynchronous way, to solve tasks. Using Moodle it is possible through collaborative activities such as forums, chats and web conference tools. It is particularly effective when they have random values in their questions, so that they have to compare processes and not results.

- Use open-ended questions whenever possible: completely open ones such as essays have the disadvantage of being generally not automatically evaluable, but alternatives such as asking for numbers or words without giving items from which to choose are often a good balance between evaluability and effectiveness. If there is no alternative to the use of multiple-choice questions, follow the relative suggestions provided in the paragraph above.
- Offer immediate feedback; if possible, let students check the correctness of their answer and the feedback during the quiz itself, not only at the end. The options to control when students can check their answers are in the "Review options" section in the quiz settings page.
- Embed tasks in relevant contexts and real-world situations, in order to develop competencies and to keep students' interest high: students are more eager to solve their tasks if they refer to something they perceive as familiar or related to their field of study, especially if practical applications are involved.
- Try to include feedback that is directed towards the students' activity, that gives details on the underlying processes, learning strategies, reflection on results and solving approaches. It is possible to add feedback to each question, and also to differentiate feedback based on the given answer.

Managing peer assessment

Since the peer feedback is usually effective for learning, it is possible to use the Moodle "Workshop" activity to create a peer assessment activity. The workshop is constituted by 4 phases:

1. Design phase: the teacher prepares the workshop by filling the activity settings page. Here it is possible to include time constraints for submission and for assessment, give instructions for the submission and for the peer assessment, and prepare an assessment form for the peer evaluation.
2. Submission phase: students submit their work.
3. Assessment phase: students assess their peers' submissions.
4. Conclusion phase: the teacher revises the submission grades and chooses a method to compute grades for peer assessment, which are automatically computed through algorithms.

The distribution of the submissions to the participants can be done both manually and automatically. It can be useful to assign a weight to the grades for peer assessment, thus students carry out this activity with attention. For this activity, it is essential to share grading criteria, better if in the form of an assessment rubric, with students, since the submission phase. The grading criteria can be implemented in the assessment form that students have to grade their peers' submissions.

Creating self-assessment activities

Including a subjective perspective in assessment helps students gain confidence with learning goals and assessment criteria, and develop metacognitive skills. Self-assessment is a complex competence and requires training to be mastered. In online courses, self-assessment questionnaires can be included after submissions that will be evaluated by teachers or tutors. Self-assessment activities should not be confused with automatic assessment activities: the latter (e.g. online quizzes) return feedback that can be useful to help students self-assess their learning level, but the assessment action is performed by the computer, not by students. "Self-assessment questionnaire" refers to a survey with reflective questions which guide students to self-assess their work. Using Moodle, it can be created through a "Questionnaire" or "Feedback" activity, using Likert scale questions, in which the items are formulated on the basis of the assessment criteria used for the assignment, previously shared with the participants. For example, if the submission is assessed through a rubric consisting of 4 indicators, the self-assessment questionnaire could include 4 items, each of which is formulated based on the 4 indicators, asking at which level students think they have achieved them.

Software suggestions for didactical use

Choosing the right software for digital education is quite important: both teachers and students have to feel comfortable with the technological tools, while at the same time all the stakeholders have to assure that the applicatives chosen are effective for teaching and learning. Technology should not complicate the didactic

experience for both sides of the desk, otherwise they could be discouraged from using it proficiently. Furthermore, the use of free software, while available and feasible under the support point of view, allows the users not to burden the coffers of their institution, making it simpler to implement inside an educational context. Some suggestions could be:

- *Web conference systems.* They allow for synchronous (live) interaction at a distance, which can be used for activities such as online sessions (also in a hybrid teaching framework) or consultancy calls. Two examples of such programs are BigBlueButton[15] and Zoom[16] (the latter free in a version with some limitations).
- *Screen recording.* Various applications allow to record the user's monitor (screencast) and its audio if needed, both for synchronous (live streaming) and asynchronous purposes, that can be used alternatively to or in combination with a web conference system. It could be useful recording for instance presentations making use of a slideshow, or expositions generated with personal software not easy to make available to students (e.g. because it is commercial and expensive). Two examples of such applicatives which are free are OBS Studio (Open Broadcaster Software)[17] and VLC media player (VideoLAN Client).[18]
- *Web content collaboration frameworks.* In the past, creating materials for being published on the Internet used to require dealing with the difficulty of having specific technical knowledge, such as being able to handle markup and programming languages requiring a dedicated training. Fortunately, over the years new solutions allowing the creation of resources for the Web, simpler from the technical point of view, have been developed, widening the potential to create without needing those skills. These solutions present themselves under the form of frameworks; an example of such a free framework is H5P.[19] It consists of a web-based content editor, able to add and replace multimedia and textual content in visual live editing, a website for sharing content types, plugins for management systems such as Moodle, and a file format of its own for bundling

15 See https://bigbluebutton.org/.
16 See https://zoom.us/.
17 See https://obsproject.com/.
18 See https://www.videolan.org/vlc/.
19 See https://h5p.org.

together these resources. It allows creating contents such as interactive videos, presentations, games and quizzes, which can be of great help in keeping the interest and the attention of students high.

– *Statistics.* This subject is actually multidisciplinary, since on the one hand it possesses hard scientific premises in terms of mathematical foundations, while on the other hand its applications encompass widespread areas such as social sciences, demographics and military. This implies that its use is important in the security and defence contexts, since the outcomes of statistical evaluations can give relevant bases to some decision-making processes. An example of a free applicative distinctly devoted to work with statistics is R.[20] It allows users to perform statistical computing at different levels, starting from simple computations of quantities such as indices, and arriving to use it as a true programming language with all the versatility of the case. Alternatively, if advanced features are not required and Microsoft Excel[21] is not available, OpenOffice[22] LibreOffice Calc can also be suitable for the needs, being up to a notable extent compatible with the well-known commercial spreadsheet application.

Tools to monitor and self-monitor progresses

All teachers working in DLEs can independently access and consult data and statistics about their students to understand and improve their teaching through Learning Analytics (LA). As an example, in Moodle platforms there are some analytics which are native tools and plugins that can enhance the capabilities of the Learning Management System. The reports in Moodle allow the teacher to consult:

– Logs and Live logs: all the interactions that are carried out by the user (accesses, deliveries, navigation, etc.). The live logs are those made simultaneously while the teacher is consulting.
– Activity report: it shows the number of accesses to individual activities and the number of people who have accessed them. It also includes the day and time of the learner's last access.

[20] See https://www.r-project.org/.
[21] See https://www.office.com/.
[22] See https://www.openoffice.org/.

- Course participation: like the previous one, it allows teachers to check participation in the activities, but the data is not aggregated, so it is possible to consult access by individual students (or groups of students).
- Activity completion: if completion progress is enabled, it shows a table for each student in which teachers can see students' completed activities. Teachers can also see a similar report via the Completion progress or Progress bar, two blocks that can be integrated into the course interface.
- Statistics: this feature shows graphs with the number of views or posts by students in a certain period of time.
- Gradebook: it allows teachers to view the student's final grade for each assignment.
- Student's personal overview: where the student's name appears, it is possible to select it to go and see their personal profile related to the course.

Beyond these basic analytic tools, there are several others that can be added to an Integrated DLE. In some cases, it is possible to write down one's own code or download the databases of educational data and perform other kinds of analysis, for those interested in performing customised analytics.

Open education resources: How to use the existing ones and to make available those produced under the right licences

Since previously Open Educational Resources (OERs) were cited, in this section, a more detailed explanation of how to use them will be delivered. When searching OERs, it is important to know which rights are granted to the final user. International laws on copyright generally recognise the rights of intellectual property to the authors, even if they lack to express their wills. When not specified, it is usually implied that the authors want to keep all their rights as reserved, which is not an appropriate choice if the resources are meant to be made open. Therefore, an international nonprofit organisation generated the Creative Commons (CC) licences,[23] a family of licences that grant the users various rights to author, share, edit and distribute materials. The licences are generated by four attributes:

[23] See https://creativecommons.org/.

- BY means that the resource needs attribution to the author, whenever reusing CC licensed works, one can use the TASL acronym, to remember the inclusion of Title, Author, Source and Licence.
- NC means that the resource cannot be used for commercial purposes.
- ND means that the resources can be used in unadapted form only, no derivatives or adaptations of the work are permitted.
- SA stands for Share Alike, adaptations must be shared under the same terms; for example, when originally commercial use is permitted, it is prohibited to forbid commercial use of the new or modified materials.

The combination of the four attributes generates licences as follows:

- CC0: the material lies in the so-called *public domain,* meaning that the authors give up their copyright. A resource licensed as CC0 can be redistributed and modified without any restriction, also for commercial purposes. This is the laxest licence.
- CC BY: the material can be redistributed and modified, also for commercial purposes, but it is mandatory to give credit to the authors, specify that this licence holds, and retain an indication of previous modifications to the work.
- CC BY-SA: the material can be redistributed and modified, also for commercial purposes, but it is mandatory to give credit to the authors, specifying that this licence holds, and stating explicitly any modifications with respect to the original. Furthermore, in case of modifications, the new or modified materials are required to be licensed in the same way (CC BY-SA).
- CC BY-ND: the material can be redistributed, also for commercial purposes, but it is mandatory to give credit to the authors and specify that this licence holds. However, the material cannot be modified.
- CC BY-NC: the material can be redistributed and modified, but it is mandatory to give credit to the authors, specify that this licence holds, and retain an indication of previous modifications to the work. However, the material cannot be reused for commercial purposes. No user can make a profit from materials licensed as CC BY-NC. Anyway, a person modifying the materials is not required to use the same licence for the derivative works.

- CC BY-NC-SA: the material can be redistributed and modified, but it is mandatory to give credit to the authors, specify that this licence holds, and retain an indication of previous modifications to the work. However, the material cannot be reused for commercial purposes. No user can make a profit from materials licensed as CC BY-NC-SA. In addition, in case of modifications, the new or modified materials are required to be licensed analogously to the original ones.
- CC BY-NC-ND: the material can be redistributed, but it is mandatory to give credit to the authors and specify that this licence holds. However, it is neither possible to reuse the material for commercial purposes, nor to modify it. No user can make a profit from materials licensed as CC BY-NC-ND, as it is to distribute new material based on materials having the same licence. This is the strictest licence of the Creative Commons family.

On the other hand, knowing these licences is also important when planning to use OERs other people produced. Indeed, depending on the situation, it could be appropriate to check specific attributes. First, for example, if a teacher wants their students to produce material starting from a base others gave, and to publish their production as user-generated content, a licence containing the ND attribute is inappropriate, since it forbids such a possibility. Second example, if someone needs OERs as part of a commercial product to be sold for money, they cannot rely on materials licensed with the NC attribute. Third example, in other contexts, for instance if someone is choosing background images or decorative elements, it may be better to look for CC0 resources in order to have a "clean" use, since giving attribution for those elements could make users think that the authors gave a relevant contribution, while in fact it is a secondary material. Whenever Creative Commons licences are not stated there could be other kinds of free or restrictive licences, and one should check the specific terms of use of the owner. With respect to this, there are several websites that function as repositories of OERs and are the best places to look for freely usable materials. One of them is represented by MERLOT,[24] a database of access to online learning materials and content creation tools, supported by an international community of educators, learners and researchers.

[24] See https://www.merlot.org/.

Creating a learning community: Tools to facilitate interactions, collaborations and peer discussion

Especially in online, hybrid and blended courses, creating a virtual community is crucial to keep students engaged and enhance motivation. Several activities can support the development of a learning community. The following list exemplifies some of them.

- Using forums for asynchronous communication. In forums, students can open new discussions and reply to the posts. When dealing with a forum, it is important to pay attention to the subscription mode that regulates if students are notified when a new post is published and if they have the possibility to subscribe and unsubscribe to the forum. Single posts can also be graded; this could be useful to stimulate participation.
- Creating a glossary to share a terminology in the discipline that is the object of the course. The Glossary activity allows the creation of a shared glossary to which students can contribute, adding and modifying entries. The glossary entries can be automatically linked to the course pages, so that whenever a concept word appears in a text, the corresponding glossary entry can be recalled in a popup window. The entries can also be graded.
- Using a glossary to introduce each other. In online courses, to enhance the sense of belonging to a community, it is possible to create a glossary for the learning community and, at the beginning of the course, ask participants to add an entry containing their presentation and a picture. The block "Random glossary entry" can be then added to the course homepage and linked to this glossary. It will show the picture and description of one different participant whenever the course page is refreshed.
- Adding synchronous activities. For synchronous communication, the "Chat" activity can be used. Moodle platforms are often integrated with web conference tools, which can be used to organise synchronous meetings. They enable interaction among participants and with the teacher.
- Creating shared repositories. Using the "Database" activities, students can add entries filling a predefined form, which can include: text, files, images, drop-down lists, radio buttons, checkboxes and other kinds of fields. Teachers have to define the fields to be included in the form and prepare templates for the add entry form and for the preview form. Similarly, the "Podcast" activity enables the creation of a shared podcast,

where students can add episodes. Differently from the Database, the "Add episode" form is predefined. These activities can be used, for example, to develop a shared research project or to share documents created by students.

- Using group activities. If a "Group mode" is enabled in the course settings, Moodle can also be used to carry out collaborative activities. Groups can be defined in the "Groups" settings (under "Users") in the course administration. Activities such as assignments can be designed as group activities. In this case, one student's submission and the relative grade will apply also to the other group members.
- Using wikis for collaborative projects. The Wiki activity allows students to create collaborative documents by building pages together. Students can edit pages, add comments and see the editing history.
- Administering students targeted questionnaires. It enables teachers to detect their expectations and take into account students' opinion in constructing the environment, allowing to put the students at ease and making them enthusiastic to participate in the activities and the community.

English Medium Instruction (EMI)

In nations where English is not the predominant first language, English medium instruction (EMI) describes the use of the English language to teach academic subjects besides English itself for internationalisation purposes, better acquisition of the English language and better career prospects. Given the increasing demand for using English for instructional purposes in higher education in L2 or multilingual contexts, it is now even more crucial to concentrate on and consistently update policies and best practices. The following list draws on both existing guidelines and the personal experience of the authors in the field, focusing on using EMI in synchronous and asynchronous online learning environments:

- Establish clear priorities and learning outcomes. Although the EMI practice certainly promotes linguistic development, disciplinary content is the primary learning outcome. Students' linguistic proficiency may be a pre-requisite to attend the course or an additional learning outcome itself: this must always be clarified in the course syllabus and course materials planned accordingly. Assessment should reflect this choice.

- Self-assess the language proficiency as a teacher and encourage students to do the same by using CEFR self-assessment grids.[25] Independent (B2), advanced (C1), or proficient (C2) learners may face different challenges and have different learning strategies. Especially in asynchronous contexts and in mixed-ability classes, create adaptive learning paths based on the students' different levels.
- Familiarise with the main theories of L2 vocabulary acquisition in order to gain awareness of your students' linguistic difficulties.
- Use and reuse OERs. Drawing on already existing English-language materials taken from OER repositories may diminish the need for designing a course from scratch. When this is not possible, asking colleagues or available language experts for assistance and support minimises the risk of mistakes or misunderstandings. Here are some examples of repositories with resources in English: Applied Math and Science Educational Repository,[26] Commonwealth of Learning,[27] Khan Academy,[28] GALILEO Open Learning Materials,[29] Merlot,[30] OER Commons,[31] Open University.[32]
- Provide clear and explicit instructions. Instructions should be provided possibly both in written and oral form, repeating and highlighting the most important details and avoiding the use of idiomatic language to prevent misunderstandings. Also, establish clear policies as to whether the students' L1 is allowed or whether an English-only approach should be prevalent. This issue is even more pressing in online contexts since often students ask their questions in a written form (using the chat in synchronous courses and the forum in asynchronous ones). According to the literature, the use of translanguaging practices such as allowing students to ask questions in their L1 during tutorials or forums may be beneficial to maximise interaction and help learners with lower language proficiency.

25 See https://www.coe.int/en/web/portfolio/self-assessment-grid.
26 See https://amser.org/.
27 See https://www.col.org/.
28 See https://www.khanacademy.org/.
29 See https://oer.galileo.usg.edu/.
30 See https://www.merlot.org/merlot/index.htm.
31 See https://oercommons.org/.
32 See https://www.open.ac.uk/.

- Simplify language without oversimplifying concepts. Using the specialised technical language of the field and at the same time non-technical language to unravel it both enriches students' vocabulary and helps them cope with the challenges of studying in a foreign language.
- Rephrase to repair communication breakdowns: in asynchronous courses, use your experience to anticipate points that may need to be rephrased and offer a variety of materials and exercises where the same concepts are explained in different ways.
- Use compensatory strategies: speak slowly and vary intonation; check the pronunciation of the most commonly used words in the specific field; use circumlocution when not remembering a word; make use of visual aids; avoid the excessive use of filler words (such as "hmm", "so", "like"); work on grammatical and lexical cohesion; use a thesaurus while preparing the lessons to look up synonyms and expand the repertoire. The same strategies can be applied when recording asynchronous videos.
- Structure the lecture (introduction, body, conclusion) and use set phrases and anchors in order not to get lost and to help students following the lecture.
- Provide language support. Although academic/content-related needs and specialised vocabulary should be the primary focus of language support, communication and effective interaction is key to keeping students motivated and engaged. In case of synchronous online courses, ask students questions and encourage them to do the same; use signposting phrases to anticipate lesson contents at the beginning and summarise them at the end; provide slides in advance; pre-teach technical vocabulary and provide glossaries and keyword lists. In the asynchronous environment, make up for the lack of interaction with review games and activities for vocabulary learning (Moodle offers a wide choice of quiz options); as mentioned before, design adaptive exercises.
- Provide scaffolding for independent study. One of the reasons EMI may be used is to give students access to publications in English. Especially in case of asynchronous courses, providing language scaffolding tools such as glossaries or vocabulary front-loading is essential. Students may also be prompted to install a free ebook reader on their devices and connect

it to a monolingual or bilingual dictionary, thesaurus or AI translation tool; in addition, they may also be encouraged to use free software that simplifies reading, such as Rewordify.[33]

- When giving a lecture or recording video lessons, focus on accuracy. The pronunciation may display L1 features, but it should generally be accurate in terms of intonation and stress. For a more natural pronunciation, remember that the English language tends to stress lexical words (nouns, verbs, adjectives and adverbs) instead of grammatical terms like articles, prepositions and auxiliaries; also components that need to be emphasised in a sentence are given prominence. When checking the pronunciation of a word, do not forget to check word stress too (using online dictionaries with audio pronunciation is of great help).
- Provide scaffolding in the 4 language skills. Be aware that the asynchronous learning environment tends to favour passive linguistic skills (reading, listening) rather than active ones (speaking, writing): provide templates to guide students; create brief quizzes to assess student understanding, such as multiple choice, cloze, matching and short answer questions; use sample assignments and rubrics to help students understand expectations; encourage students to learn how to self-assess.
- Adapt student engagement strategies. Depending on the student population, or target audience in open online courses, but also on the level of confidence with the English language, teachers may need to provide examples that are more culturally accessible, and decide whether to use anecdotes, humour and metaphorical language.
- Be consistent with the chosen variety of English. Avoid alternating between, for example, British English and American English spelling and pronunciation to prevent confusion.
- Make formative and summative assessment consistent with learning outcomes. As far as language mistakes are concerned, in EMI literature there is a general consensus that students must be given feedback throughout the course in order to help them use the English language more effectively. However, for written exams, content lecturers should only concentrate on communication as a goal and the use of specific terminology and discourse, ignoring the precise correction of grammatical errors. In oral

[33] See https://rewordify.com/.

exams, characteristics of multilinguals such as sporadic code-switching or non-standard language usage that does not interfere with communication or hinder comprehension should not be punished.

References

ActivePresenter. Online: https://atomisystems.com/activepresenter/
Apache OpenOffice. Online: https://www.openoffice.org
Applied Math and Science Educational Repository. Online: https://amser.org/
BigBlueButton – Virtual Classroom Software. Online: https://bigbluebutton.org/
Camtasia Screen Recorder, Video Editor. Online: https://www.techsmith.com/video-editor.html
Commonwealth of Learning. Online: https://www.col.org/
Creative Commons. Online: https://creativecommons.org/
Galileo Open Learning Materials. Online: https://oer.galileo.usg.edu/
H5P – Create and Share Rich HTML5 Content and Applications RSS. Online: https://h5p.org/
Khan Academy. Online: https://www.khanacademy.org/
Merlot. Online: https://www.merlot.org/merlot/index.htm
Microsoft Office. Online: https://www.office.com/
Microsoft Teams. Online: https://www.microsoft.com/microsoft-teams/
Moodle Academy. Online: https://moodle.academy/
Moodle Documentation page. Online: https://docs.moodle.org/402/en/Main_page
OBS Studio. Online: https://obsproject.com/
OER Commons. Online: https://oercommons.org/
Open University. Online: https://www.open.ac.uk/
R: The R Project for Statistical Computing. Online: https://www.r-project.org/.
Rewordify. Online: https://rewordify.com/
Self-Assessment Grids (CEFR). Online: https://www.coe.int/en/web/portfolio/self-assessment-grid
VLC. Online: https://www.videolan.org/vlc/
Webex. Online: https://www.webex.com/
Zoom – One platform to connect. Online: https://zoom.us/

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Simulation and Simulation Technologies

From their beginning, when they were implemented in the educational and training environment, simulations reflected the need to increase the effectiveness of personnel preparation (from an individual to a coordinated staff) for events and situations that are very difficult to carry out – to prepare in a real environment. Currently, simulation technologies have fully established themselves in the educational and training environment in the form of:

- instrumented simulation (also referred to as live simulation)
- virtual simulation
- constructive simulation
- distributed simulation (a universal term that also refers to a combined simulation, also called blended simulation)

Instrumented simulation

The instrumented simulation focuses on the possibility of approximating the behaviour of real individuals and groups/teams equipped with fundamental tools and systems that simulate their activity (e.g. handgun – real, but simulating fire using a laser beam). In other words, an instrumented simulation enables an operation to be carried out that is led by real individuals (soldiers, police, paramedics, etc.), crews and operators who use real weapons with practice and imitation ammunition. Instrumented simulation is practical training in real conditions or training areas with real participants equipped according to standards, solving a specific crisis in a real workplace. The technologies of this simulation are oriented towards bringing the training of individuals and teams closer to the conditions occurring in an actual situation using accurate technical means and systems equipped with special sensors. The means of instrumented simulation emphasise the equality of chances of all parties involved, using the advantage of the knowledge of the environment, stimulating creativity and competition in

[1] Armed Forces Academy of General Milan Rastislav Štefánik.

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the search for possible solutions. By using accurate technical means, systems and vehicles, individuals and groups consolidate practical habits in real activities applied directly in an actual deployment. The positives of instrumented simulation are, for example:

- activities in a natural environment with the possibility of evaluating the performance of tasks by individuals as well as groups
- using accurate technology without modifying it, quick and easy installation of simulation tools on the technical equipment
- strengthening the habits of actual use of technical means or systems without additional actions
- the possibility of creating deceptive activities and sources of threat in a real environment

Instrumented simulation is minimally applicable in terms of its purpose and uses for combating hybrid threats; however, for the completeness of the information on simulation technologies and their possible use, it is necessary to pay attention to it.

Virtual simulation

Virtual simulation has seen significant development over the past 20 years. Its justification is growing in connection with the preparation of people in leading positions and crisis managers to solve and prepare for various crises, including hybrid threats. It is a dynamically developing technology in the field of modelling and simulations. It is part of the general tendency to incorporate new means, forms and methods into specific aspects of the information development of society as a whole. Virtual simulation can be defined as a unique method of training that uses computer technology with a graphic engine to faithfully imitate various objects and procedures of the natural environment in a synthetic environment. It is mainly used to train individuals, vehicle crews and small team/unit leaders to conduct operations in an artificial environment identical to the real one. The representation of virtual reality in computer technology primarily focuses on two of the five senses: sight and hearing. It is a technology that enables interaction with the world generated by computer technology. Virtual simulation can be classified as physical, interactive and humanoid simulation. Physical, virtual simulation – its representatives are physical imitations of real systems

or reductions and imitations of systems. Interactive and humanoid simulations are of the same class and represent a system in which entities and users interact with a synthetic environment, such as simulators or trainers (like simulators for drivers).[2] Virtual simulation provides sensations to training entities in virtual reality with technological means and devices whose feelings are mediated by sight, hearing and touch. This technology, creating virtual reality, is built into technical means and systems. For the needs of training and education of crisis managers, they are pioneering assembled in the form of *reconfigurable virtual simulators* at the Armed Forces Academy in Liptovský Mikuláš, Slovakia (hereinafter referred to as "AFA"). For this purpose, the simulator trainer is used to train the crews, considering the expected activities and to train mutual coordination and cooperation within the team and a specific tactical unit. Drawing attention to the leadership, there are also team leader simulators at the AFA. The team leader simulator is technically based on the same principle as the reconfigurable one. While the reconfigurable is focused on equipment and its crew, the team leader simulator is focused on the person and their role inside the (various) teams. Generally, the virtual simulation shows an individual's view of the digital space – the terrain (the digital database) and the created synthetic situation (primary technical means, the surrounding environment, citizens, the wounded, to whom he will provide first aid, etc.). The positives of virtual simulation in general, for example:

- enable intensive repetition in the training of psychomotor reactions when operating equipment, leading to their automation
- allow creating situations that, in an actual case, could lead to damage to the given system
- enable the elimination of threats to health or life
- let the activity of training entities be constantly analysed and evaluated in online mode
- enable the performances of the training entities to be repeated, compared and corrected immediately after the parts of the training
- enable, through a synthetic space that is identical to the real environment, to conduct activities even where it would not be possible in reality
- significantly influence the ecological and economic aspects (energy consumption, fuel, elimination of environmental damage, etc.)

[2] Çayirci–Marinčič 2009.

Despite the mentioned benefits, only a few simulators are introduced in the educational process at educational and training workplaces. The reason is mainly their narrow focus on practical issues. The high purchase price reinforces this reason. However, in case of virtual reality tools, it is advantageous to get simulators that are characterised by a certain modularity. In other words, for the needs of education and training of crisis managers and hybrid warfare, such as rescue and decision-making units in hybrid warfare, developing such a specialised virtual simulator would cost considerable financial, personnel and time resources. Therefore, a specific alternative is the already mentioned reconfigurable virtual simulators, which have a broader (modifiable) application and are more financially profitable.

Constructive simulation

Constructive simulation is the most widely used, in terms of time, the longest applied and most commonly used simulation, which has universal use and a broad spectrum of use. It is often referred to as a universal method. As a rule, it is applied in a distributed form when several computing systems are connected via a computer network or can be used independently on a specialised hardware element. Constructive simulation is fully utilised to train personnel responsible for an operation or situation's planning and decision-making phases. This way, personnel are prepared for individual leadership positions and management functions in command, control and verification of planning and decision-making activities. Constructive simulation can also be specified as an artificial entity (model) representative of a realistically behaving human, real technology or a particular unit. Such a model is defined according to actual data regarding its tactical-technical data, behaviour and representation. In constructive simulation, a real object (human being, vehicle, technical device, system, living creature, etc.) is replaced by a model – an entity. It is, therefore, a simulation where synthetic beings, vehicles, systems or technical means move in a virtual environment and, depending on the simulated activities, also perform appropriately assigned tasks.[3] Artificial entities actively behave according to defined algorithms, which are programmed in separate property classes (level of entity behaviour). The operation of such a simulation is realised through the user interface, and the visualisation of the generated situation and the generated environment is projected onto a digital map, which contains all relevant

[3] Hubáček–Vráb 2012.

topographical data and characteristics of the phenomena and objects that enter the simulation. Constructive simulation is applied in two distinctive levels in favour of other types of simulations.[4] This distinguishing level expresses the level of detail of synthetic entities; that is, the size of the given entity is described. These levels in each environment are divided into:

- Systems with a low and high degree of aggregation. This means that all entities in the system are models of physically existing natural objects (elements) and have predefined semi-automatic behaviour. They are applied to higher-level units. Entities independently or in defined groups based on entered commands simulate activity and status depending on their physical properties, conditions of the digital spatial database, meteorological factors and technological limits of the given real representatives. These behave and tactically manage autonomously from the defined level of entity properties. Such behaviour can be autonomous and automatic, but in case of a dynamic, complicated simulation, an intervention requires a solution on the part of the management officer so that the thought intention of the management officer is realised.
- Systems without aggregation. This means that each entity represents individuality and technical means. Grouping them is possible, but each representative is controlled by a separately defined algorithm characterising its behaviour.

Constructive simulation is based on mathematical methods and has many advantages that stimulate its continuous development and expansion into new application areas in education and training. Like any other simulation method, constructive simulation also has shortcomings and limitations. The main advantages of constructive simulation methods are the following:[5]

- makes it possible to simulate threat sources economically and effectively, destructive processes of destruction during a hybrid war or any other crisis situation
- makes it possible to create an environment that is very close to the actual conditions of an emergency and the stages of the crisis
- allows to simulate a crisis taking place in different geographical regions, in different climatic conditions, with various forces and means

[4] Andrassy 2011.

[5] Grega–Bučka 2013.

- constructive simulation models form essential components in other types of simulations and crisis management activities; they represent a universal unifying basis for all groups of simulations
- they reduce the damage caused by exercise from an ecological point of view, and the environment is not disturbed by such training
- its universality results from the applied mathematical basis
- quantification of phenomena and processes enables their more accurate analysis in the decision-making activities of management bodies
- allows for modelling and simulation at any level, similarity or with any degree of generalisation objects, phenomena and processes at the selected level (tactical, operational, strategic)
- enables an objective expression of the impact of terrain and other environmental factors on crisis processes situations, as well as crisis management activities
- gives the possibility of high-quality registration of the course of exercises and their use for a more objective evaluation of their results and formulation of conclusions and recommendations for theory and practice
- the usefulness of constructive simulation in solving the problem of crisis management and, within it also, hybrid war is evident
- mediates the possibility of connecting constructive simulation systems with simulation systems of other categories
- establishes a measurable factor to determine the results of the operation of individuals and teams
- documents the course of solving the situation in a 2D and 3D display
- offers partial and comprehensive statistical data
- records the planned and actual activity of the units
- enables the search for optimal solutions when using forces and resources
- enables future managers to take risks due to their own decisions

Certain shortcomings of constructive simulation include:[6]

- no simulation can replace actual activity
- models of constructive simulation are based to a decisive extent on a rational basis, which means that emotional, ethical and purposeful aspects are suppressed

[6] Grega–Bučka 2013.

– using simulation systems requires excellent precision from the workers of specialised workplaces, mainly when filling databases about technology, crowd reactions, characteristics of chemical substances, fuel models and others

As mentioned above, constructive simulation is usually implemented in a distributed form. Its basis is the implementation of the so-called Computer-Assisted Exercises (hereinafter referred to as "CAX"). Such a form of preparation can be characterised as a sophisticated method of training commanders, management staff, officials and workers of crisis staffs of state components, with the help of which processes and events arising or being created during the implementation of a specified activity of the decision-making process, planning process or process of command and control are played out. Constructive simulations and their CAX are the ideal forms of training and education in crisis management, mainly due to their universality, broad application support and ease of implementation.

Distributed simulation

In a synthetic environment, where different types of simulations located in other places are interconnected, a complex environment is created to simulate highly interactive activities.[7] The meaning and effect of distributed simulation is the participation of virtual models whose behaviour is controlled autonomously (computer-controlled components), virtual models that are controlled by real exercisers, live subjects with instrumented means and constructive models in a joint exercise, which create the so-called blended simulation referred to as distributed interactive simulation.[8] In the distributed simulation, all entities and models interact with each other except instrumented entities. The result of the activity of these (instrumented) entities is transformed into a synthetic environment, and it is not possible to influence them in any way since it is an actual situation performed by real people. Therefore, simulated entities from the environment of virtual simulators and entities from the domain of constructive simulation are usually involved in the distributed simulation for the needs of crisis management training. This situation (simulation) creates

[7] Bučka et al. 2012.

[8] Andrassy–Grega 2013.

a unique environment where they intervene, for example, simulated transport and evacuation components and other simulated entities controlled by actual crisis staff and operation centres. The crews are forced to react to all the stimuli that come to them from various sources, and this is made possible by distributed simulation with participating entities. A simulated crisis situation is generated through the interaction of virtual entities, which arises during the action of a crisis event. Entities act under time stress and under constant pressure from the constituents who control them. Virtual entities from the constructive simulation environment can represent evacuated components, support units or assets meant to make the training situation more complex and thus put control authorities under pressure and stress. Their main task is the coordination and cooperation of all components involved in eliminating the consequences of the simulated situation, including hybrid threats. Distributed simulation offers an advantage that other simulations do not have. In one preparation cycle, the participating parties (trainees) can take turns in individual positions. This factor allows for understanding the solution of a simulated emergency situation from different perspectives. It creates conditions for the components to clarify the problem both from the point of view of the executive and the management. This fact is positively perceived by students who use simulation technologies and those who create tactical and organisational formations.

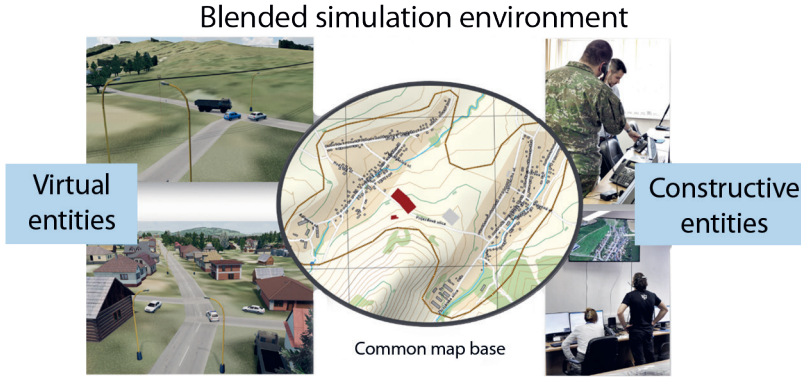

Figure 1: Principles of distributed simulation
Source: Compiled by the authors

Distributed interactive simulation develops operational and tactical thinking of management officials and, subsequently, of the executive departments, respect for the staff's decisions and acceptance of the departments involved in solving the emergency.

Conclusion

Choosing the best technical and methodological solution for simulating hybrid warfare threats is necessary to highlight the most important elements of such simulation. To get as close as possible to the real world, it is required to consider not only the technical method of simulation but also the environment that causes emotional and ethical reactions of users. It is also critical that the chosen simulation system should have as many options as possible for modelling hybrid threats. In this case, the instrumented simulation has minimal possibilities. The same situation is occurring concerning the repetition of conditions. Because of the real-world involvement, repeating the same condition using instrumented simulation is almost impossible. In this case, the other two simulation methods based on an artificial environment are better. The second crucial characteristic of a hybrid warfare simulation is supporting the decision-making process during the hybrid threat elimination. This feature, although present, is least supported in the instrumented simulation.

Table 1 compares all three simulation methods. Each feature is scored from 1 to 5 points: 1 – unsuitable for hybrid warfare simulation; 5 – most suitable for hybrid warfare threat simulation. The two most important features of the hybrid warfare simulation are highlighted in yellow.

Table 1: Evaluation criteria for HW simulation – the higher the coefficient, the more suitable the simulation method

Evaluation Criteria for HW simulation		**Instrumented simulation**	**Virtual simulation**	**Constructive simulation**
The reality of the environment	Technical meaning	5	4	3
	Emotional and ethical meaning	5	5	2
The scope of Hybrid Warfare scenario modelling options		1	3	5
Repetition of the same conditions of the simulation		2	5	5
Simulation difficulty for	Staff	3	3	5
	Users	5	5	3
Suitable for the training of	Psychomotor reactions	5	4	1
	Decision-making process	2	4	5
Evaluation of tasks for	Individuals	5	5	3
	Group(s)	5	4	5
Financial requirements	Initial costs	3	2	5
	Modality	3	5	3
Suitability coefficient		3.67	4.08	3.75
Coefficient of embedded simulation	**3.91**	*Instrumented*	*Virtual*	
	3.71	*Instrumented*		*Constructive*
	3.92		*Virtual*	*Constructive*

Source: Compiled by the authors

The suitability coefficient represents the average value of points in every feature. Using another simulation method to eliminate individual shortcomings in each technique is advisable. This offers a distributed form of simulation (see the relevant section above), where one method compensates for the shortcomings of the other. The comparison of distributed simulations is shown in the table, and the combination is marked orange. The highest coefficient acknowledges that using distributed simulation as a combination of virtual and constructive simulation tools is the best way to simulate hybrid threats. For this reason, the following chapter describes only these components of the simulation system.

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Technical Means for Implementing Simulation in the Field of Hybrid Threats

In general, exercises in a distributed environment represent the highest level of interaction and offer the maximum degree of reality, effectiveness and informative value. Distributed exercises for preparing crisis teams with the support of individual simulations can offer many analyses and experiments that cannot be verified or practised under normal conditions and circumstances. Therefore, the basic technical requirements for implementing distributed simulation using virtual simulators and constructive simulation tools will be presented below.

Reconfigurable virtual simulator

A reconfigurable virtual simulator (hereinafter referred to as "RVS") is a virtual simulation tool. It is primarily intended for tactical training of individuals, crews and operators focused on developing basic tactical and communication dispositions in command and control for training cooperation within the crew and unit. The simulator can be configured for different types of ground and air entities.[2] It has an interface for interconnections using standardised protocols, which guarantees compatibility with other simulation tools working with the same protocols and standards. The simulator consists of the following main parts – the simulator computer system and individual cabins, the configuration of which depends on the selected RVS modification. The simulator cabins represent one piece of equipment, and each is divided into three parts – the position of the intervention commander, the driver's position and, respectively, the position of a gunman. Due to the need to support training in various areas of crisis management, the RVS can be configured as any means of transport. At the AFA, the following possible configurations are involved.

[1] Armed Forces Academy of General Milan Rastislav Štefánik.
[2] VR Group 2022.

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- RVS in ambulance, firefighter, police modification
- RVS in modification of civil passenger vehicles, trucks, buses
- RVS in a helicopter, infantry fighting vehicle, T-72 tank, Land Rover modifications

The RVS in the modification of ambulance, firefighter, civilian vehicles, and police is intended to support the tactical training of the driver of the mentioned vehicles when it is necessary to supplement their tactical training with a vehicle – an entity for ensuring medical assistance, safety and for rescue and firefighting activities. In this case, the RVS modified and configured as a civilian vehicle can represent the population's evacuation group and is also intended as a supporting element of training. All these configurations are for trainees (driver and passenger), who can perform tasks of an informative nature, such as e.g. visual survey.

Figure 1: Reconfigurable virtual simulator
Source: Picture taken by the authors

Figure 2: RVS Ambulance, visualisation in 3D space and the driver's view
Source: MÄK VR – Vantage s. a.

The RVS in the bus or truck modification is designed to support the tactical training of the vehicle driver when it is necessary to supplement the training with means for evacuation, transport, or material transfer. The bus and truck are intended for one trainee driver. All the RVS configurations mentioned above and their working positions have:

- sight available, with the help of which the trainee can see in front of the vehicle
- there are also rear-view mirrors in the field of vision, which complete the observation information
- the displayed dashboard of the given vehicle on which the devices with information on speed, engine speed, engine temperature and fuel consumption are shown
- there is the possibility of changing views and outlooks
- vehicle control is carried out similarly to the actual vehicle

The RVS in the helicopter modification is used for tactical training of the Mi-17 helicopter crew. It is a non-combat helicopter designed to transport cargo or people and is intended for a team consisting of a pilot and a co-pilot. It can also be used for possible fire extinguishing with the support of a Bambi bag. The Bambi bag is an integrated firefighting system designed to extinguish fires from the undercarriage of a helicopter.

Figure 3: RVS Helicopter visualisation and 3D view of the pilot and co-pilot
Source: MÄK VR – Vantage s. a.

The controls of the pilot and co-pilot work positions allow for the following:

- starting and stopping the engine part with a sound effect
- helicopter flight by the standards
- change the display of views
- the co-pilot can overtake control of the helicopter from the pilot
- evaluate flight data from visualised devices (compass, altimeter, GPS locator, etc.)

The RVS in the infantry combat vehicle modification can be cited as an example of combat equipment. This modification is used for tactical training of the infantry combat vehicle crew. The configuration enables the function of all BMP-2 devices necessary for tactical training.

The configuration consists of 3 workplaces – driver, commander and operator gunner. The driver has devices that give him information about the vehicle's state; during the drive, he can "open" the hatch and drive the vehicle in a marching position where no devices obstruct his view. He can freely look around by tilting the steering wheel. The gunner can only change the turret's position after turning on the stabiliser. The turret stabiliser is turned on by setting the runner on the joystick; it is possible to fire with a weapon:

- rapid firecannon
- machine gun
- anti-tank guided missiles

Figure 4: RVS visualisation of IFV[3] in 3D and the view of the driver and gunner
Source: MÄK VR – Vantage s. a.

[3] IFV – Infantry Fighting Vehicle.

The RVS in the Land Rover modification is used for tactical training of the combat vehicle crew. The configuration enables the function of all devices necessary for tactical training. The design consists of 3 workplaces – driver, commander and operator gunner. The driver has devices that give him information about the vehicle's state; the driver and the gunner (machine gunner) can change the weapon's position and fire. RVS in a distributed environment can simulate a large spectrum of model situations that real training entities perform; they can also implement training in a synthetic environment, all with high demands on specific activities. In an educational and training environment, these separate RVS are used to improve communication, practice tactical procedures when approaching an intervention, and check coordination skills when passing convoys. It can be concluded that their contribution to training is in the:

- coordination of procedures
- verification of specific skills
- improvement of the tactics of intervening technical entities, modules
- description of the logical sequence of events, activities and steps in the preparatory and executive phases of interventions

RVSs represent a specific alternative to real virtual simulators. During their construction, emphasis was placed on the financial solution and the system's modularity. The desired multifunctional use directly reflects the elimination of certain control elements in the equipment, and their independent use is sometimes limited. Therefore, they must be used with other simulators and constructive simulation tools in a distributed environment.

WASP constructive simulation tool

The WASP software application is a unique constructive simulation software tool that allows you to simulate human activity, technologies and events associated with human behaviour in an artificial (simulated) environment. It is designed for computer support of individual and tactical simulation of entities, technologies and events in a synthetic virtual environment. WASP is created to generate forces (Computer Generated Forces, CGF) and create a synthetic virtual environment to support individual and tactical simulation, creating scenarios and tasks. It is a fundamental building block for CAX support. During these exercises, the system enables interaction between all its users, displaying the situation and influencing

the course of the simulation using user-controlled entities with semi-automatic behaviour located in the simulated environment. The system allows it to create scenarios with CGF and obstacles, control the course of exercises, control computer-generated forces and dynamically respond to training requirements.

WASP develops trainees' tactical skills, thinking, individual psychomotor skills, and cooperation of trainees in case of personal training with the help of a wide range of targets, used entities, and improvement in the command and control process during military and non-military situations.[4] WASP is a tool for stimulating "role-playing" and developing events, activities and accompanying events corresponding to actual conditions. The application software works under the Microsoft Windows operating system; the technical and software solution ensures ease of use, good reconfigurability and the possibility of expanding the system. The synthetic virtual environment of accurate terrains for the WASP system is created in the OTF ver. 8 format and allows the defining of extensive sets of terrain element attributes. Subsequently, a generic synthetic virtual environment is used to develop and prepare scenarios necessary to ensure the simulation. In contrast, a specific MDX format is used for the 3D visualisation of field databases. The graphical user interface enables the preparation and creation of scenarios, supports simulation management and displays the desired outputs corresponding to reality.

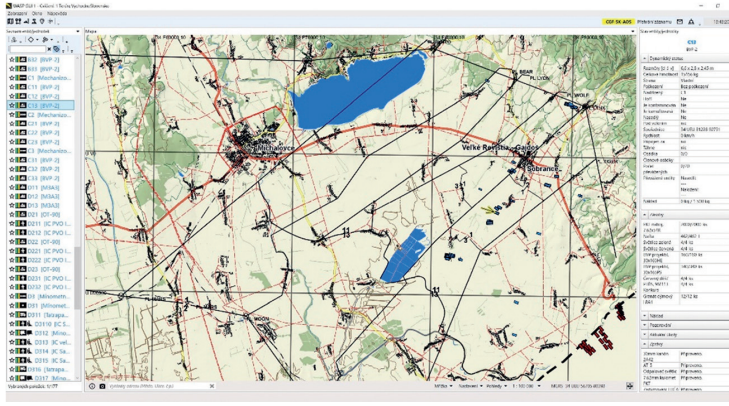

Figure 5: View of the WASP main window
Source: VR Group 2021

[4] VR Group 2022.

Figure 6: Control exercise room where the output from WASP and RVS is combined
Source: Picture taken by the authors

Integral components of simulation tools

Each simulation has two primary components, without which it would lose its validity. The first is communication, and the second is creating the "take-home package" from each completed CAX.

Communication system

Communication is one of the essential elements of all simulations. Without communication technology, providing any (not only) simulated exercise would be impossible. Communication technologies in the simulation environment must reflect the training subject's needs. The communication system must be configurable and flexible to the greatest extent possible to ensure all the needs of the training subjects. The configured communication system in the simulation environment is an integrated part of the simulation tools built based on commercial communication technology. This technology enables the operation of simulated communication radio networks (transmitters) and telephone sets with the option of conference selection and allows the simulation of local radio. The entire communication system is designed to communicate with individual simulation tools and to enable the forwarding of its data to the simulation network. This component allows recording the entire course of the exercise synchronously

with the image (2D and 3D visualisation of the simulation), which enables the verification of actual performances with voice messages. Based on transmitted and received information in real-time, which takes place at the horizontal and vertical levels of management, the simulation's entire course unfolds or solves a simulated crisis. The communication system is designed to record individual communication channels and calls of individual participants independently of the simulation and export them to audio formats after specific sequences.

The use of the communication system and its applications enables the evaluation of communication and the submission of information of subordinate subjects to members of the training staff, as well as the submission of orders and information of staff members to subordinate subjects following the situation in the synthetic environment. Other uses of these applications include:

- evaluation of the reaction of subordinate subjects to the order issued by the staff
- evaluation of the time response of subordinate entities to orders from the staff
- evaluation of the management officer's timely response to the information obtained
- evaluation of the time response of subordinate subjects to the situation in the synthetic space

Figure 7: ASTRA communication system, present at every workplace
Source: Picture taken by the authors

Figure 8: Phones with a fully configurable structure (Call Manager)
Source: Picture taken by the authors

"Take-home package"

The entire simulation course is recorded and serves mainly for the evaluation phase. The take-home package is the source of all relevant data from the exercise. It can be given to the exercising subject via video, audio, screenshots and statistical data. Specialised software tools are used to create the individual components of this package. The Logger device uses visualisation and 3D visualisation of the synthetic environment, continuously recording all kinds of actions and activities during the solution of a simulated emergency.[5] The device does not allow the recording to be exported to video formats, but it can be converted to the required video output through a unique converter.

Application software collects statistical data, enabling detailed data registration on the simulation's progress. These statistical data are exported in various formats, such as tables, texts, graphs, or images. This statistical tool records:

- the number of entities in the synthetic environment
- damage to entities or their destruction
- number of fuels consumed
- paths of entities, along which routes any entity moved, etc.

[5] Nečas et al. 2011.

The statistical application ensures the central recording of data of interest from the simulation during its course. It brings the possibility of obtaining detailed relevant data for the overall evaluation and analysis of the implementation of the solved situation or after its parts or phases. Part of the "take-home package" is the creation of the so-called bookmarks with a description of the activity. Bookmarking is a simpler alternative to the video format. It involves creating simple images from the simulation, which serve as relevant background or evidence of the performed (not performed) activity. Such a "take-home package" containing video sequences, communication records, images and appropriate statistical data is given to all participants in the exercise as an optical medium (DVD) or flash drive, respectively uploaded to a cloud service. It can be used for subsequent analysis or as teaching material. However, its creation requires a longer interval (at least a month).

Conclusion

The presented RVS components and the image generator can create a virtual reality environment. Several studies have confirmed that such an environment has elements almost similar to a natural environment for individuals, eliciting a complex reaction involving correlated changes in the emotional state, autonomic activity and postural balance.[6] For the needs of simulating hybrid threats, this system allows simulation of the environment for performing tasks at the operational level (firefighters, police, medical service, etc.) which, for example, can be the elimination of the consequences of accidents and natural disasters. These can result from hybrid threats, such as dam sabotage, a terrorist attack, or civil unrest. All the mentioned aspects are reflected in the virtual environment, and the trainee at the operational level has to deal not only with the technical solution of his task but also with his psychological resistance to stress. The simulation built in this way gives the trainees a realistic picture of the temporal context during the crisis (virtual reality does not allow jumps either in time or from place to place), develops the ability to autonomously solve operational problems with a high risk of intervention from third parties, and builds the individual's psychological resilience in fulfilling time-consuming tasks under mental load. On the other hand, constructive simulation tools like WASP fully

[6] Bzdúšková et al. 2022.

support the simulation environment. The entire time sequence of the simulation is solved by individual events defined in the space of the constructive simulation program. In addition, its elements can react in real-time (or leave a passive flow of events) to individual measures taken by the trainees. This game makes the constructive simulation software an ideal partner for the decision-making body component (for example, the city hall and its crisis staff). Thus, the constructive simulation tool provides a map basis for the simulation process and a sequence of events directly related to the hybrid activity. For example, civil disobedience can result in the blockage of essential transport channels; it can also lead to flooding from a burst dam. The tool of constructive simulation determines the time pace of the entire exercise. It serves to practice the decision-making process using risk management when performing time-consuming and critical tasks. Another vital part of the simulation environment is the communication system. In addition to modelling events stemming from a hybrid threat in the constructive WASP environment, communication systems (phones, ASTRA, PC network) were added another dimension where hybrid threats could be modelled. This is mainly about electronic communication channels. These are implemented in an artificial environment through websites, e-mail accounts, public radio and telephone connections. In every section of this layer, it is possible to apply a hybrid threat by spreading disinformation, interrupting the communication line, or overloading it. If the trainees do not respond to these stimuli in time, the consequences will be reflected, e.g. in the form of civil disobedience. This will be implemented through a constructive simulation tool (a complication for the crisis team) and, thanks to the distributed simulation, will immediately transfer to the virtual space (unexpected obstacles for operatives in the field). This method of simulating hybrid threats greatly helps trainees acquire basic resistance to attacks in the electronic space.

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Bases for Simulating Hybrid Threats

Crisis scenario

Crisis scenarios describe development variants – a past event as a generalised experience or a description of a possible or probable crisis. Due to the unrepeatability of crises on the one hand and the need to learn lessons for the future, crisis scenarios work with an acceptable level of uncertainty of the course of the crisis and alternatives to its course as well as future post-crisis development. This approach corresponds to the degree of knowledge of the security environment and its variability in development in the short, medium and long-term future. Crisis scenarios can be defined as a generalisation of expertise from the development and course of unique events that have a destructive and negative impact on human life, society and social infrastructure, their accepted values, conditions and prerequisites for valuable, prosperous, prospective sustainable development and safe life in the form of elaborated topics. Crisis scenarios mediate the progress and chaining of isolated and interconnected essential processes and events in time and space dimensions. Based on their depth and degree of scientific knowledge, crisis scenarios are also part of security theory, the security policy of states, and tactical as well as strategic planning. Crisis scenarios also become part of the system of training crisis managers as an essential tool for expanding their competencies and abilities to solve specific crises and increasing their readiness to solve possible variants of crisis situations in the future. It is precisely for these purposes that typical crisis scenarios are developed, which are a generalisation of knowledge of the primary phases of crisis development to a specific type of threat, e.g. fire, flood, war conflict, hybrid threats, with an appropriate degree of abstraction from the concrete and unique. Type crisis scenarios further define the primary groups of activities of the aid and rescue management entities, as well as forces and means to minimise the negative impact of activated destructive forces and

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processes. They make it possible to know the individual type of threat in a given security environment, point out the basic variants of the development of a crisis, and present a basic model of the activities of the management and executive forces of rescue and counter-reaction to crisis processes. Typical crisis scenarios have a fixed structure according to the mission of a specific type of scenario. We can consider the following model as the standard structure of a crisis scenario:

- source of threat, circumstances and cause of the crisis, harmful and destructive effects – consequences, standard spatial and temporal course and stages of development of the crisis
- reaction and measures of parts of the security system – crisis management to the emergence and increase of threats to parts of the social system from the crisis in question; measures and activities until the end of the crisis and threat, basic measures for restoration, reconstruction and minimisation of the recurrence of the situation – risk
- activity of affected and threatened systems and persons in all stages of the crisis

Design of the structure of a typical scenario for a hybrid threat

In creating crisis scenarios of hybrid threats, attention was and is mainly devoted to identifying decisive – main risks and factors that activate hybrid threats and potential threats and release unexpected adverse events, energies, substances and processes. In crisis scenarios, descriptions of possible variants of development in linear or branched procedures are developed with an emphasis on their relevance, science and reality. An essential factor for creating hybrid threat crisis scenarios is also the *target audience* (trainees) and the goals for which the simulation will be carried out. In this context, from the point of view of the selection of scenarios, the trainees can be divided into the following groups:

- high school and university students
- workers in the state administration, personnel in local government
- military personnel

Each of the mentioned groups has defined different goals:

- *High school and university students:* The goal is to learn about the nature of hybrid threats and possible ways to combat such threats. The primary

goal is to point out the complexity of hybrid threats and their potential impact on the real development of the situation.
- *Employees in the state administration:* For the mentioned audience, the exercise scenario must focus on forms of hybrid threats and ways to fight against them. The scenario should support knowledge regarding how individual state institutions are connected and their role in eliminating hybrid threats. The set scenario should also fully evoke critical thinking in the trainees.
- *Military personnel:* The focus of the exercise should reflect the needs and specifics of Military–Civilian Cooperation (CIMIC) and involve hybrid warfare in the Military Decision-Making Process (MDMP). To develop practical skills for early recognition of the hybrid conduct of an armed conflict, to develop the communication skills of military personnel towards the public, and to prepare military professionals for the risks arising from hybrid threats at the time of a war operation.

A precise definition of the *exercise level* is necessary when creating an exercise framework. The level of the trainees, the geographical area and the complexity of the subject are defined. For this approach, performing a horizontal, vertical and geographical division of hybrid threats is appropriate. The horizontal division is based on the designation of irregular–unconventional methods used alongside conventional warfare. As part of the horizontal division of the hybrid attack, we can count on the topic exercises with phenomena such as fake news, criminal and terrorist activities, etc. Before creating crisis scenarios for practising hybrid threats, it is also necessary to define the vertical level of the practised issue. This consists of the definition of the operative level of the exercise scene. It can be strategic (at the level of states, nations), tactical (larger territorial units, communities) or operational (at the level of local government, purpose-built groups operating in a small area). The last necessary variable for the definition of any simulation exercise is the geographical space and its division where the exercise in question will take place. The process of creating crisis scenarios for practising hybrid threats includes the following stages:
- Determining the content and goal of the crisis scenario for the target audience, the so-called scenario framework. Defining the scenario framework includes defining the central plot situation, the so-called topic, the goal, why we are solving the given case and what we want to achieve with the results. The practical impact of hybrid threats manifests itself, especially

during events that negatively expose society. In such cases, hybrid action acts as a catalyst for the primary problem and causes more damage. In terms of content, it is, therefore, appropriate to choose a scenario where the primary issue will be solved – a "standard crisis". Solving the mentioned problem will be complicated by the hybrid effect on individual aspects of the situation. In case of the civil sector, it will mainly be about maintaining the effectiveness of the rescue system. In case of military personnel, the goal will be to fulfil a combat mission. In the content of the scenario defined in this way, the goal will be to minimise damage by eliminating hybrid threats and maintaining an effective system of rescue and security services or maintaining the dynamics of the military operation.

– Delineation of decisive facts, events, processes and factors, and determination of their importance and interconnectedness is the basic framework of the crisis scenario. Determining the content is based on experience, practical needs and analysis of the security environment, as well as current and future security threats and challenges. The mission of the crisis scenario is expressed and concretised in its goal and answers the question of why we are solving a specific scenario, what do we want to investigate, how large is the number of variables, what are their dynamic relationships, how to integrate them into an understandable plot unit, what are the optimal outputs for the needs of the crisis management.
– Defining the decisive dimensions and limits of the crisis scenario. The reality and scientific nature of the incorporated and accepted limits are conditions for usability and practical and theoretical contribution because they specify the content and create prerequisites for fulfilling the goal of the crisis scenario. We consider the decisive limits and dimensions of the crisis scenario to be:
  • quantitative and qualitative characteristics of the crisis in the destructive, temporal and spatial dimensions – the dimension of the crisis situation (phenomenon)
  • characteristics of the security environment, relations between the environment and the crisis – definition of the positive and negative dimensions of the environment and the crisis
  • interested subjects – forces and means of crisis management, affected and disabled actors (persons, animals, technical system, etc.), their limits (possibility, capabilities, etc.) and activities

  - a group of additional information and characteristics specifying, in a linear and a branched variant, the dimension of the crisis to ensure the consistency of its dimensions
- The process of creating a starting variant and crisis scenario model. Based on the above mentioned requirements and starting points, a group of experts has developed a starting variant of the crisis scenario that best reflects the client's starting requirements.
- Correction of the draft crisis scenario. Based on the analysis of the starting points, the goal and the content of the crisis scenario, the possibility of practical or theoretical use of the scenario is evaluated in the form of an expert or specialist assessment according to its type and purpose. Attention is focused, for example, on the scope of incorporated information, available supporting documents, the time of crisis scenario solvers to complete tasks, etc. Emphasis is placed on the usefulness, practical or theoretical significance of the crisis scenario, e.g. for the needs of crisis management of public administration at the local level, it should mainly deal with the issue of threat sources based on the analyses of specific territory for the needs of civil protection, in case of the armed forces, e.g. the issue hybrid threats that activate a war conflict or a crisis situation of a military nature with the deployment of armed forces. The scenario is modified, supplemented and optimised according to the established requirements for individual groups of crises.
- Verify the correctness and validity of the draft crisis scenario. According to the type and nature of the crisis scenario, the optimal method of its verification is selected, which usually takes the form of a practical verification, e.g. a practical experiment, an exercise, a theoretical proof, e.g. a theoretical model, a mathematical model, or a combined form, e.g. a practical training with a simulated process of the unexpected negative phenomena and events. After a theoretical or practical verification of the correctness of the applied model of the crisis scenario, positive and negative findings are incorporated to an adequate extent according to their significance into the crisis scenario and related documents – plans, methodological guidelines, activity methodologies and the like.
- Include and place the crisis scenario in the existing portfolio (catalogue of typical crisis scenarios, catalogue of specific crisis scenarios). The state and development of the security environment require selecting topics and

developing several crisis scenarios, which cover all anticipated crises and their variants. Newly developed crisis scenarios for hybrid threats must respond to new processes and events, forces and means, be representative, and cover key characteristics of current and anticipated crisis situations. The portfolio of crisis scenarios should cover the entire spectrum of crises, create and present links between individual scenarios and security reality, replace outdated and unrepresentative scenarios with new ones, and thus respond to the dynamics of risks and crises.

Exercise level

The exercise level primarily defines the scenario itself. However, it is also necessary to emphasise the connection with the required technical equipment. Up to the operational stage, when, in addition to team cooperation, the individual capabilities of individuals are also practised, it is possible to use the means for virtual reality fully. With a more significant number of trainees, virtual reality loses its justification, and it is necessary to bring the means of constructive simulation to the fore. Thanks to the aggregation of entities, the latter can very effectively imitate hybrid threats and their impact on target groups. In case of a requirement for a simulation exercise for the security community, the starting points are as follows:

- the range of practised hybrid threats (horizontal division) is limited to:
  - fake news, influencing public opinion through social networks and inciting civil disobedience during a standard crisis – leakage of a dangerous substance
  - cyber threats (attacks) such as password pawning, phishing and security breaches via the USB port
- within the vertical division, the exercise scene is at the operational level of the municipality and the crisis staff
- the geographical space is defined by the area of two municipalities with a population of 1,500 and a base map area of 32 × 15 km

The crisis scenario is chosen to acquire theoretical and practical skills in "combating" hybrid threats in times of crisis. The scenario makes it possible to change the difficulty of the situation, enabling a simulation exercise both for students in the field of crisis management and for members of the crisis staff of municipalities and various state agencies. The following three chapters describe two scenario types. The first scenario type is set in a *civilian environment,* where the crisis defines the problem, and the staff has stressor factors in solving the problem: time and hybrid threats. The consequence of these threats is the disobedience of citizens in the evacuation process. The second scenario type is set in a *military environment* and employs blended tactics by all operational audiences. Within it, the manifestation of hybrid attacks results from the judicious combination of conventional, unconventional and asymmetrical tactics, techniques and procedures (TTP) launched by regular forces and irregular elements.

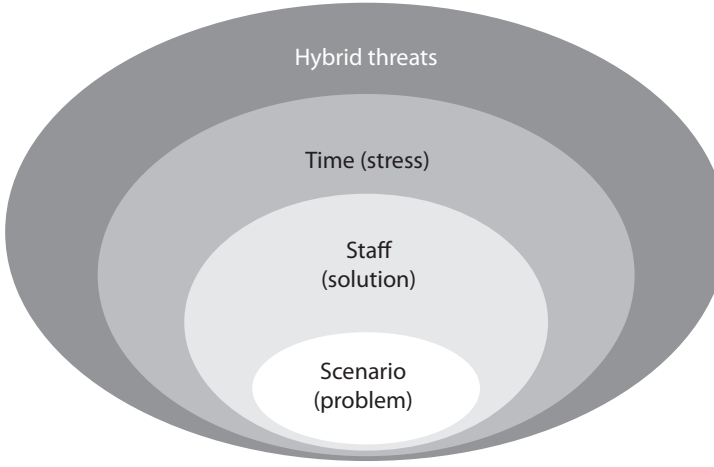

Figure 1: Basic principle of hybrid threat simulation
Source: Compiled by the authors

Conclusion

Considering the mentioned starting parameters, the scenarios prepared for the exercise to support education and prepare the security community for solving the tasks of eliminating hybrid threats should have the following structure:

- general description before the emergence of a crisis
- identification and characteristics of simulated entities
- requirements for visualisation of the external environment
- requirements for visualising the interior spaces of selected objects
- characteristics of the crisis and characteristics of hybrid threats
- specification of the numbers and type of forces and resources used
- anticipated activity of citizens and self-government bodies
- anticipated activity of state administration bodies, special teams and components of the integrated rescue system
- stabilisation phase and post-conflict situation

Zsolt Pastorek – Matúš Grega[1]

Hybrid Scenario Type "Terrorist Attack on the Dam and Flood Wave"

Topic

Crisis staff, evacuation commissions and selected organisations of the state administration, legal entities and cooperation bodies are involved in organising, managing and implementing measures to protect the population from the possible consequences of a hybrid war, such as a threat to a waterworks after a terrorist attack.

Objectives for the exercise

Acquainting students with the possibilities of solving emergencies using reconfigurable simulators and the WASP constructive simulation system:

- practising the basic model of the village's emergency response team in an emergency – a terrorist attack on a waterworks
- practising the implementation of evacuation measures by the evacuation committee
- practising the cooperation of the coordination centre of the IRS, the intervening units of the firefighters and parts of the crisis management at the local level
- verification of mastery of the content of essential public communication and theoretical approaches of crisis management in public administration
- checking the quality of students' readiness to fulfil the basic positions of crisis managers
- verification of the correctness of the decision-making process in the fight against hybrid threats
- generalisation of knowledge from training and its use in the educational process

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Roles and tasks of participants

Table 1: The roles and responsibilities of participants

Role (9 persons)		Responsibility	Call sign
The Crisis Staff	Mayor of Modry	Head of the crisis team, lead of operation	
	Deputy of Mayor	Risk management adviser, city radio	
	Rescue operations coordinator	Drone recognition, flash news for residents	
	Media adviser	Press releases, providing overall information	
	The transportation coordinator	Coordinates evacuation buses	Knight
	Emergency system coordinator	Overview of situation (GPS), record	
	Medical dispatcher	Leading ambulance activity	Phoenix
	Police dispatcher	Directs police engagement	Eagle
	Firefighter operator	Coordinates firefighters' deployment	Dragon
Role (9 persons)		Responsibility	Call sign
The Operational part	3× Firefighter	Driving and engagement of firefighter trucks	Fire 1, 2, 3
	2× Medical assistance provider	Driving the ambulance cars and transport	Med 1, 2
	2× Police	Driving a police car and engaging the police	Police 1, 2
	2× Bus driver	Driving the bus to the designated evacuation places	Bus 1, 2

Source: Compiled by the authors

Initial situation

In the period after (February, date), the security situation deteriorated in Eastern and Central Europe. In recent weeks, the Security Authorities of the Homeland have recorded information that signalled a threat to the territory of the country by terrorist groups. For this reason, the protection of important objects was strengthened, inspection of population protection plans in villages under waterworks were ordered, and readiness of staff and commissions was ordered to be checked.

Special situation

On (May, date) at 05:30, an unknown explosive exploded near the dam of the local waterbody called "Modrá voda". The explosion partially damaged the dam. A crack appeared in the body of the dam, through which approximately 50 m^3/s of water flows uncontrollably.

The resulting situation was assessed as extraordinary, with an acute threat of the dam breaking. The management of the National Water Company informed the crisis management authorities of the state administration, the crisis management authorities of the affected municipalities and the superior departmental units. From 6:00 a.m., the immediate lowering of the water level of the waterbody was started. At the time of the terrorist attack, the local water reservoir was filled to 96% of its maximum volume. There is a direct threat of flooding Municipality Modry.

The town of Modry – The artificial environment for simulation

For simulation, the artificial town of Modry was created:

- *Geographical description:* The town is in the *Liptovská basin,* at the northern foot of the *Low Tatras,* 10 km from the district town of *Liptov.* The town is situated on two terraced plateaus of the northern foothills of the *Low Tatras.* The cadastre of the city is adjacent to the surrounding small villages and the district town. The city consists of the central and industrial parts and the suburbs. In the central part, there is a substantial part of administrative buildings, banks, a hospital with a polyclinic and others. The industrial zone is located between the central part and the suburb and stretches to the southeastern side of the suburb *(Zbrojárska str.).* With a population of 5,260, the city ranks among the medium-sized towns of the district. There are approximately 1,500 residential buildings in the city of *Modry.* The city centre is located at an altitude of 653 m above sea level, and the *Modrá River* flows through the middle of the suburb. A water reservoir has been built on the *Modrá River,* which serves to regulate the flow of the *Modrá River* as an anti-flood measure. It is also a source for the irrigation system of the surrounding fields and is a popular tourist destination in the summer.
- *History:* The town of *Modry* is one of the oldest in the region; its first written mention dates back to 1233. On I and *Končito* near the town,

findings from the Kabarska period were found. Partisan bunkers from the Slovak national uprising in the second WW period have been preserved in *Modranská Dolina* and reconstructed to their original state. Its location and natural conditions constantly influenced the life and history of Modry. Favourable circumstances, especially the proximity of the river, fertile soil, a relatively protected valley in terms of climate, and the town's favourable location were essential factors. In the past, the inhabitants were engaged in agriculture and later masonry. After the arrival of the Polish tribes, members of the Kabar tribe Bielewicz settled in this area. The first written mention of the city is from 1255. It is a document confirming the area's property status from 1150 and is currently located in the church of St Peter.

– *Basic amenities:* The town of *Modry* is a cultural centre where folklore festivals are regularly held. The oldest buildings of the armoury, a former factory for producing artificial fertilisers, also deserve attention. There is a city office, where the city police are also based, a hospital with a polyclinic, a firefighter station and others. The suburb is the seat of the independent *Parish of St Peter,* where important monuments from the 16th century are located, as well as a department store, a kindergarten and an elementary school. The city, with its suburbs and industrial zone, where the Winter Stadium is also located, is an important tourism centre. It is a natural starting point for the *Low Tatras.* There are several accommodation and catering facilities in the city.

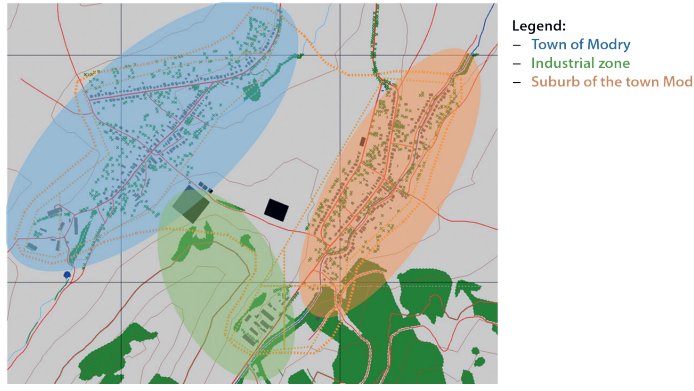
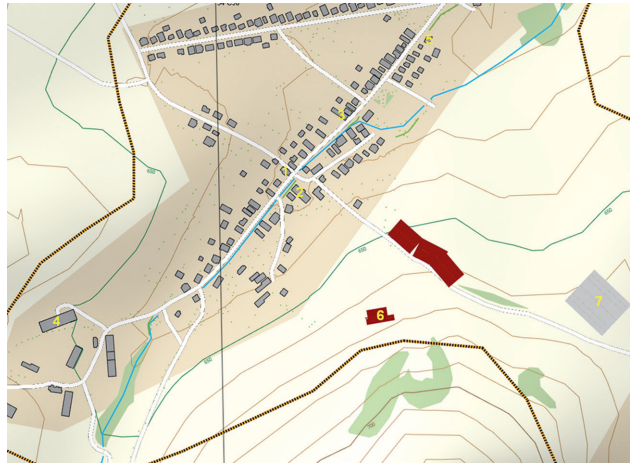


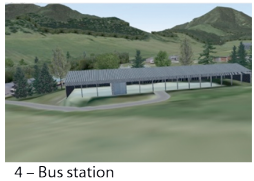
Figure 1: 2D display of Modry city zones (in WASP simulation tool)
Source: WASP



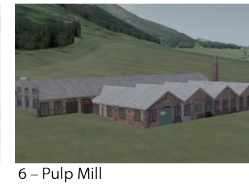

1 – City Hall and City police


2 – Hospital


3 – Firefighter station


4 – Bus station


5 – Police


6 – Pulp Mill


7 – Winter Stadium

Figure 2: Main objects in town Modry
Source: WASP, Unity

1 – Kindergarten

2 – St Peter's Church

4 – Residential home

3 – Shopping centre "CAAP"

5 – Elementary school

Figure 3: Main objects in the suburb of Modry
Source: Compiled by the authors

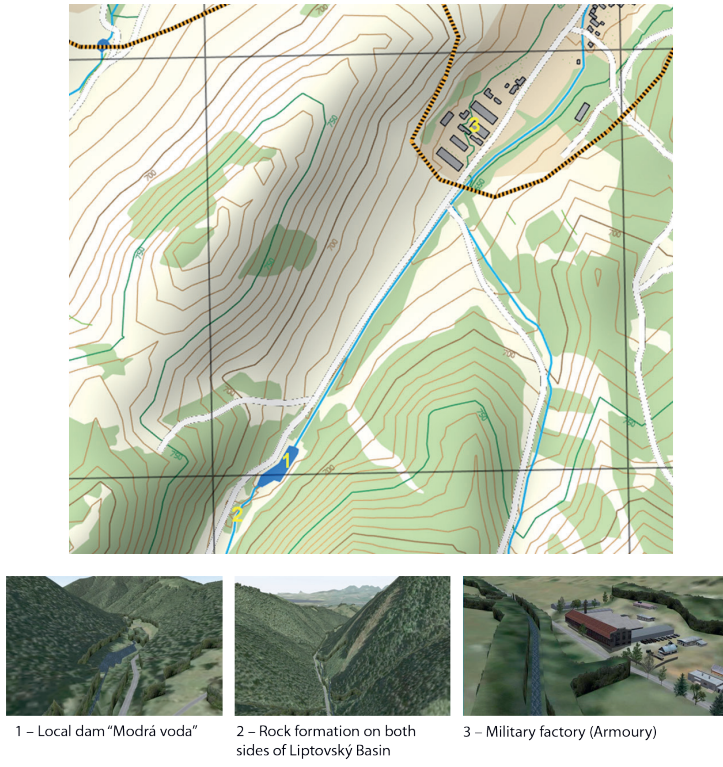


Figure 4: The position of a dam on the southern part of the suburb Modry
Source: WASP, Unity

The "Problem" layer

The "Problem" layer is the backbone of the scenario. This layer describes all the problems caused by the nature of the crisis itself. It contains the definition of the problem, its solution (not the only one; the participant can also find another solution to a particular problem) and the entities of the simulation software needed for the display of such an event (the chart does not contain all the entities used during the simulation, e.g. buildings, roads, maps, trees, or even the fire itself).

Table 2: The "Problem" layer

Institution	Problem	Solution	WASP entities
Arms factory	Request for assistance in securing hazardous substances (pumping vat)	Send fire truck	
Home of Social Services	8 patients + 2 immobile + 3 caregivers	Send bus + 2× ambulance for the removal of immobile patients (one lying, one in a wheelchair)	DOCH 01 – DOCH 13 2× lying patient (DOCH 12 and DOCH 13)
Kindergarten	22 children and four staff	Bus	MS 01 – MS 26
CAAP department store	19 people to evacuate	Self-evacuation – collection point	OBCH 01 – OBCH 19
CAAP department store	Cases of looting	Police assistance	Police – one extra deployable police member in a car
St Peter's Parish	16 believers + parish priest	bus	KOS 01 – KOS 17 (priest KOS 17)
St Peter's Parish	Valuable historical writings from 1255 in a crate	Evacuate Fire 1, Tatra – flatbed takes the box to safety Winter Stadium – elementary school	KOS 01 – KOS 17 Tatra vehicle Tatra box
Holding Pulp Mill	Fire in the building	Fire truck Fire 2	
Primary school	Accident of a child	Ambulance	
People in the village	Self-evacuation	Two groups, one to the east and the other to the west	EVA 26 – EVA 45
Intersection	Jams	Three traffic jams purely by cars	VEH 01 – VEH 04 VEH 05 – VEH 07 VEH 08 – VEH 10
Tractor	A technical breakdown blocks the way	It waits next to the Winter Stadium, blocks the road, if necessary, and is solved by towing Fire 1	Tractor
Police assistant	Police assistance in countering looting – demonstration and crate handling	Able to get in and get out of the police car	Police 1, Police 2
Demonstration	Demonstration also with a bulldozer	Demonstration at the upper intersection	DEM 00 – DEM 13
Demonstration	Demonstration also with a bulldozer	Demonstration at the lower intersection	DEM 14 – DEM 25
Drone	It flies a circuit over the town and makes a video surveillance	Radius 300, height 90 km speed 100 km tilt 4 RAD	Drone
Primary school	Injury to 1 child	Ambulance	

Source: Compiled by the authors

The "Hybrid Threats" layer

To practise hybrid threats, especially cyberattacks, all the participants in the crisis staff (not the operational part) have a mailbox and access to the local website through the user account they set up (name, password required). The model of hybrid treats is based on fake flash news. They are displayed on the town's web homepage and serve as the primary communication channel between the city hall and the citizens. The following hybrid warfare element is a fake social media blog submission, represented in real life by social media like Twitter, Facebook, etc. The next dimension of hybrid threats is e-mail communication. Namely:

- spread the adware with a false URL
- implement the virus for Ransomware with an "MS Word" text document as an e-mail attachment; the malicious code is hidden in the macro of the Word document

The last threat is represented as a *Bad USB.* In this case, a USB memory stick with malicious software is delivered to the recipients. If they plug in the USB stick to a computer, malicious code written in Phyton language is executed and blocks the user's computer.

Fake flash news

Flash news is one of the most efficient communication channels for the crisis staff. A template has been developed to increase the effectiveness of publishing such types of news, as shown in Figure 1. Fake news disturbing this communication concept was delivered continuously during the simulation. The desired response was to deny the report; otherwise, it would cause civil disobedience.

Mail to: modry.news@sc.aos.sk

"Modry Flash News: #CityFlash #NewsInBrief"
For example: "Modry Flash News: Traffic Update – Delays on I-95, plan alternate routes.
#NYCFlash #TrafficAlert"

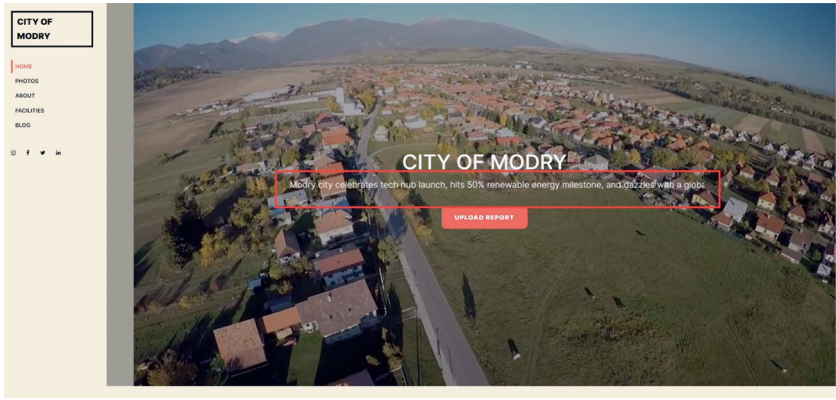


Figure 5: The flash news template
Source: Compiled by the authors

Table 3: Fake flash news delivered to the WEB main page of the town

Ranking of fake flashes	Fake flash	Reaction	Action
1.	There is no threat. The dam is in excellent condition!	There is no mobilisation of citizens	Dementing News, City Radio
2.	They want to evict you for new highway construction!	Demonstrations near a nursing home and at an upper intersection with heavy equipment	Demented message, firefighters on towing and police with deployable policeman
3.	The whole thing is camouflage to steal the factory!	Demonstration at a nursing home	City radio, police with deployable policeman
4.	There is an accident at the Winter Stadium, so do not get on the buses!	People don't board buses; they stay at meeting points	Dementing News, City Radio
5.	There is a free sale in the store!	Traffic jams at intersections	Exit of the police to two intersections with an officer

Source: Compiled by the authors

Fake social media blog submissions

The registered users can submit media blogs for closer information about the citizens. A template was developed to support this activity. On the other hand, submitting fake social media blogs is possible. These fake texts were generated with the help of artificial intelligence (e.g. ChatGPT ver. 4). The fake blog was delivered to the web page in two ways:

1. cracking the user's account, the fake blog was delivered to the city's web page under the name of the hacked victim; this situation is only caused if the user makes a weak password during the registration process to the web page
2. if no weak password was detected, the false text was published on the web page under the hashtag *#TheFlods*

The texts of fake inputs are as follows:

> "Breaking: Allegations Surface of Staged Floods Concealing Illegal Armoury Hoards"

In a shocking twist, recent claims suggest that particular floods are not natural disasters but meticulously orchestrated events designed to cloak illicit armoury storage. The timing and scale of these floods are raising eyebrows, prompting scrutiny of the potential cover-up. Stay tuned as we investigate the evidence behind this startling revelation.

> "Highway Havoc: Construction Halted as Defiant Landowners Resist Unjust Land Grab"

In a surprising turn of events, highway construction comes to a standstill as resilient landowners refuse to sell their properties. Unconfirmed reports suggest that the halt is not due to property disputes but a calculated move by the state to employ evacuation tactics for forced expropriation. Stay tuned for more updates on this alleged government manoeuvre to seize private lands under the guise of public infrastructure development.

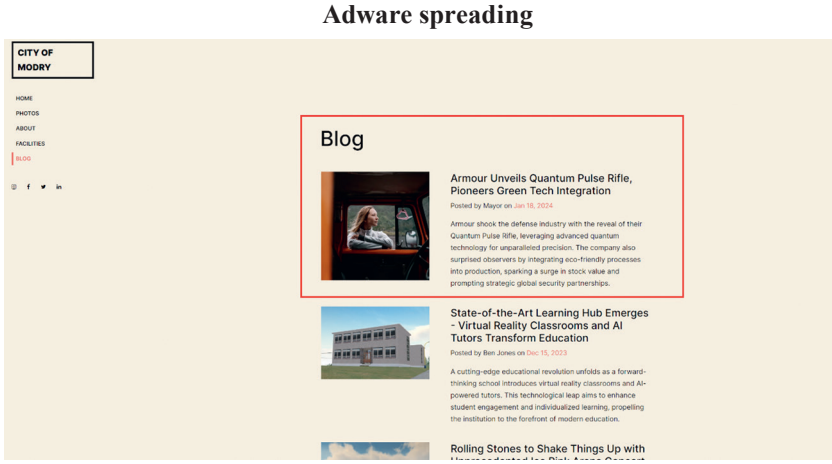
> "Chilling Crisis Unfolds: Ice Rink Stadium Hit by Ammonia Leak, Authorities Downplay Dangers"

In a shocking incident, an alleged ammonia leak at the local ice rink stadium is causing panic among residents. Despite concerns about the potentially hazardous situation, authorities are reportedly downplaying the risks, insisting that the leak is minor and poses no immediate danger. Stay tuned as we investigate the true extent of this chilling crisis and question whether public safety is being compromised in the name of reassurance.

Mail to: modry.news@sc.aos.sk
Modry Press Release
Headline: [Concise Headline]
[Modry], [Date] – Modry [Govt/Dept/Agency] announces [News/Event/Initiative]
[Press Release]
"Text of the press release"
Contact: [Contact Person]
For example:
Headline: Armour Unveils Quantum Pulse Rifle, Pioneers Green Tech Integration
[Modry], [18 January 2024] – Modry [Armoury] announces [News]
[Press Release]
"Armour shook the defence industry by revealing their Quantum Pulse Rifle, leveraging advanced quantum technology for unparalleled precision. The company also surprised observers by integrating eco-friendly processes into production, sparking a surge in stock value and prompting strategic global security partnerships."
Contact: Mayor

Figure 6: Media blog submission template

Source: Compiled by the authors



Pre-prepared e-mails were continuously delivered to all participants with e-mail. After clicking the fake URL presented in the e-mail, for five minutes, full-screen images (mostly cats – because everybody loves cats!) appeared on the user's monitor, interrupting his activity. The wording of e-mails is as follows:

E-mail 1: Subject: *Welcome to the Revamped Modry City Website!*
Dear [Recipient],
We're excited to announce the launch of our brand-new Modry City website! Say goodbye to the old and hello to a fresh, user-friendly experience. Explore the improved features and enhanced design at our new address: http://10.1.69.51:7000/.
Best regards, [Your Name]

E-mail 2: Subject: *Your Invitation to Explore Modry City's Redesigned Website!*
Dear [Recipient],
We're thrilled to unveil the new and improved Modry City website. Please navigate the city's offerings effortlessly at our updated address: http://10.1.69.51:7000/.
It's time to discover a better online experience!
Warm regards, [Your Name]

E-mail 3: Subject: *Exciting News: Modry City's Website Upgrade!*
Dear [Recipient],
We are pleased to announce the launch of the revamped Modry City website. Bid farewell to the outdated version and say hello to a more dynamic platform. Dive into the enhanced features by visiting us at http://10.1.69.51:7000/ *today!*
Best regards, [Your Name]

E-mail 4: Subject: *Unveiling Modry City's Modernised Website!*
Dear [Recipient],
Great news! Modry City's website has undergone a significant makeover. Experience the city like never before by exploring our new website at http://10.1.69.51:7000/. *Discover the improvements firsthand!*
Kind regards, [Your Name]

E-mail 5: Subject: *Your Invitation to Modry City's New Online Hub!*
Dear [Recipient],

We're excited that Modry City's website has been completely overhauled for a better user experience. Visit us at our new address: http://10.1.69.51:7000/ *and enjoy the enhanced features. Your journey through Modry City just got even more exciting!*
Best wishes, [Your Name]

Ransomware

Phishing to the ransomware victims could be realised via e-mail attachment (there is an MS Word text document, the macro of which contains the malicious code). Some examples of the text in the e-mail body:

For the list of victims of the dam breach, see the attached, continuously updated file. If there is any update from your side, or you have noticed a wrong entry, please download the attachment to your computer, update or change the data and send it to The_flods@aos.sc.sk.
We stay with you!
Sincerely
IT support team

There are essentially unlimited possibilities when generating ransomware text. The important thing is to arouse the interest of the victim. The text is more convincing if it also has an emotional charge, e.g.:

The list of properties to be confiscated can be found in the attached Word file. In case of inaccuracies or incorrect entries, download the attachment to your computer, correct the form and send it to The_flods@aos.sc.sk.
We stay with you!
Sincerely
IT support team

The second approach was delivering a so-called Bad USB (an official look-a-like letter is supplied by a human agent, and malicious software is activated immediately after plugging the USB key into the computer). In this case, the letter is only for outlining the situation for this methodology, and it is not necessary to use for infiltrating the Bad USB key by the agent to the "victims":

Henry Clark
Cartographic authority of Northern region
123 Main Street, Modry City, MD 56789
Henry.Clark@email.com, phone: (555) 123-4567

City of Modry
City Hall
456 Civic Plaza
Modry City, MD 56789

February 1, 2024

Subject: Urgent Information – Flooding MAP Update

Dear Modry City Officials,

I hope this message finds you well. I am writing to provide a brief mapping update on the current flood situation in our city.

Please find attached a **USB drive** containing essential information regarding the floods, **including maps of the impact areas**, emergency response efforts, and safety guidelines for residents. This information aims to keep everyone informed and safe during this challenging time.

For immediate inquiries, please get in touch with me at henry.clark@email.com or (555) 123-4567.

Your prompt attention to this matter is greatly appreciated.

Sincerely,

Henry CLARK

Emergency Response Coordinator
Cartographic authority of Northern region

Figure 7: A cover letter for delivering a Bad USB
Source: Compiled by the authors

Zsolt Pastorek – Matúš Grega[1] – Paul Tudorache[2]

Hybrid Scenario Type "An Accident of a Tanker with Dangerous Substance"

Topic

The crisis has to be solved at the municipality level, where a hybrid war is also occurring. Organisation, management and execution of rescue work by the city's emergency crew after an extraordinary event – an accident of a tank truck connected with the leakage of a dangerous substance in the built-up area of a chemical factory. At the same time, it is necessary to respond to hybrid threats in the form of the spread of misinformation and to prevent the situation from escalating to such an extent that the management of evacuation and the implementation of measures in the provision of assistance to the endangered population is threatened in the affected area. The exercise takes place on a 32 × 15 km map with developed agglomerations with a population of 1,500.

Objectives of the exercise

Familiarising students with the possibilities of solving emergencies using RVS and the WASP constructive simulation system and practising the basic model of the activity of the town's crisis staff in an emergency caused by a traffic accident in a chemical factory associated with a possible leak of a dangerous chemical substance, in particular:

- practising the implementation of evacuation measures by the evacuation committee of the city in the example of the evacuation of a local elementary school and a shopping centre

[1] Armed Forces Academy of General Milan Rastislav Štefánik.
[2] "Nicolae Bălcescu" Land Forces Academy.

DOI: https://doi.org/10.36250/01238_08

- practising the cooperation of the coordination centre of the integrated rescue system (IRS), the intervening units of the firefighters and parts of the crisis management at the local level
- the practice of removing the consequences of an emergency by the firefighter intervention unit and the forces of the city's crisis staff
- practising the activities of all components of the crisis team under the influence of hybrid threats
- verification of mastery of the content of basic legal standards and theoretical approaches of crisis management and the fight against hybrid threats in public administration
- checking the quality of students' readiness to fulfil the basic positions of crisis managers
- generalisation of knowledge from training and their use in implementing measures to protect the population from hybrid threats

Overall description

The city of Severny is located in the south border area of Slavland, near the border with Yellowland. 73% of the village's population comprises the Yellowland minority living in the territory of Slavland. The company Builder in the city Severny is an advanced chemical company in Slavland. It represents a successful combination of Slavland technical skills and knowledge with European solid plant management and market-oriented business experience. Builder Severny embarked on an ambitious program of investment, customer service, product quality and environmental improvement. A responsible attitude to business is the primary and permanent principle of the company Builder, which is the main contributor to the development of the economy, environment and social sphere in the region with an impact on the entire economy of Slavland. The company supports healthcare, education, charity, sports and culture projects. The company Builder is located at the foot of the Liptovska Mountain; from the east, its surroundings copy the inner city of the city Vychodny, and from the north, the village of Severny, and to the south, less than 2 km, is the city of Juzny, which is the administrative centre of the given locality. The company operates in more than five countries, has more than 30 production plants and employs approximately 11,000 employees, including 1,800 employees in the region and 1,200 employees in the supply network only in Slavland. More than half of the

employees commute to Builder for work from economically less prosperous Yellowland. In its business, Builder focuses primarily on producing chemicals, plastics and chemical products for agriculture, exploration, mining, and trading of oil and natural gas, as well as biotechnology and genetic engineering. The company is also behind the invention of expanded polystyrene, especially in the construction industry.

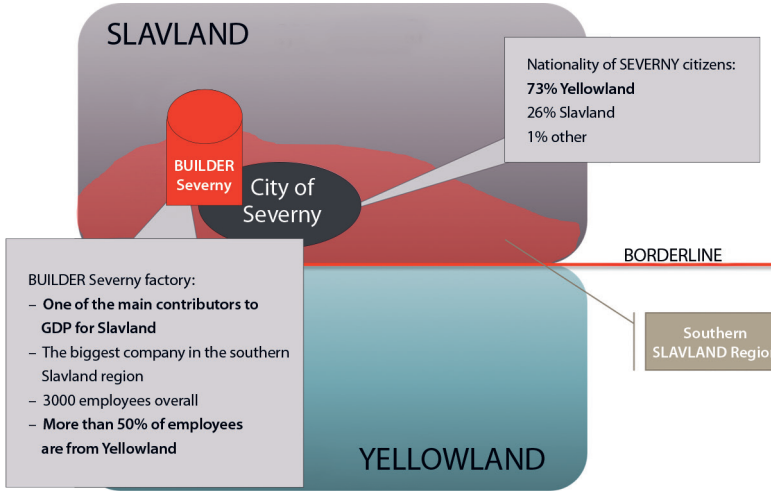


Figure 1: Diagram of the geopolitical situation of the subject
Source: Compiled by the authors

Political trigger of hybrid threats

The extreme right-wing government in Yellowland sees the acquisition of Builder under its administration as one of the possible tools to avert the country's impending economic collapse. For this reason, two years ago, an unsuccessful attempt was made to acquire a majority stake in Builder. This was to be done by causing an unwarranted panic and a subsequent collapse in the company's share price following a media report that its building products contained many toxic substances for humans. The reports also pointed out that the toxicity of the products is a fault of the technology itself and not of the manufacturing process, which

can be innovated. The claims above were successfully refuted by the certification of the company's products by European certification authorities, which made the impact of these accusations on customer confidence and subsequent orders minimal. After an unsuccessful attempt to take over the company, Yellowland began to finance political entities within the framework of the "Association for Open Borders", which last year, with the help of a massive election campaign aimed at supporting the Yellowland minority, won a 40% share in the city council of Severny. Their primary goal is to destabilise the integrity of Slavland by highlighting minority conditions in the region and using the subsequent unstable situation to annex the Southern part of Slavland to Yellowland. This would give Yellowland the production capacity and income of Builder company.

Special situation – The initial state of play for the simulation

At 09:00 a.m., there was a traffic accident involving a truck with a dangerous substance in the company Builder, and a fire broke out afterwards. At 09:10, a company employee called the IRS (Integrated Rescue System) to inform them about the situation. After receiving the information, the responsible authorities of District II of Severny and all IRS components were informed of the problem.

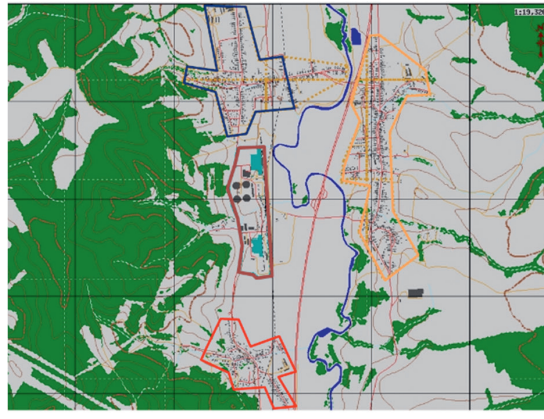


Figure 2: The 2D view of the programmed exercise scenario
Source: OTB ver. 2.5

The following figures represent some particular moments of the simulated crisis event, the solution of which will affect the hybrid action. In this particular case, the OTB ver. 2.5 constructive simulation software (images on the right side) and a virtual environment using the 3D image generator MÄK VR – Vantage (images on the left side) were used for the simulation exercise.

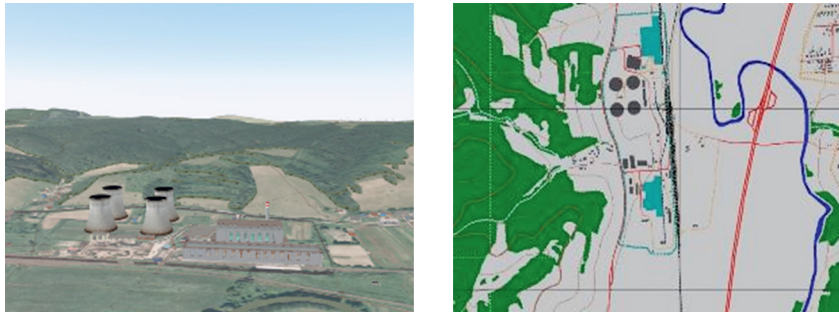


Figure 3: The 3D and 2D views of the Builder company
Source: OTB ver. 2.5; MÄK VR – Vantage

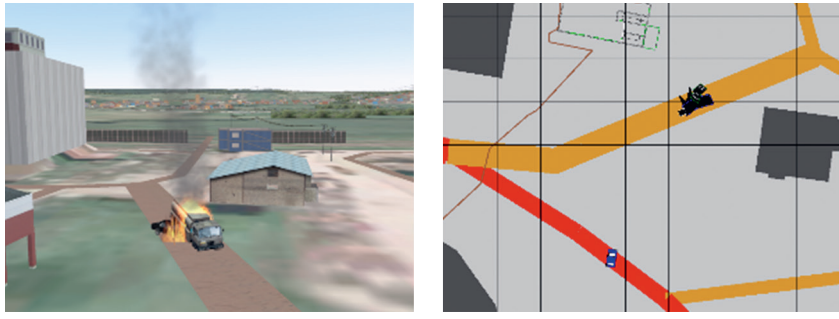


Figure 4: The 3D and 2D views of a collision between a tanker and a car
Source: OTB ver. 2.5; MÄK VR – Vantage

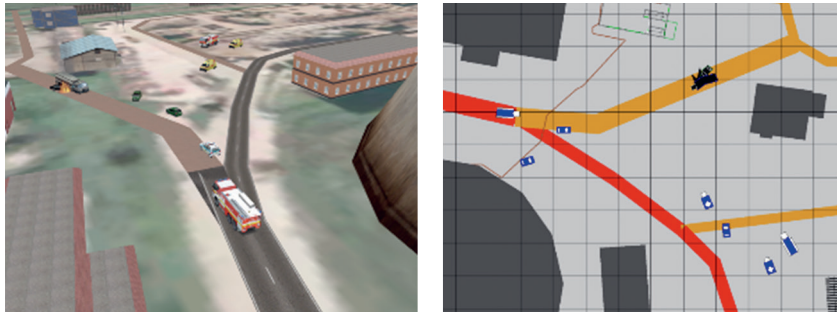


Figure 5: The 3D and 2D views of the responding units at the scene of the accident
Source: OTB ver. 2.5; MÄK VR – Vantage

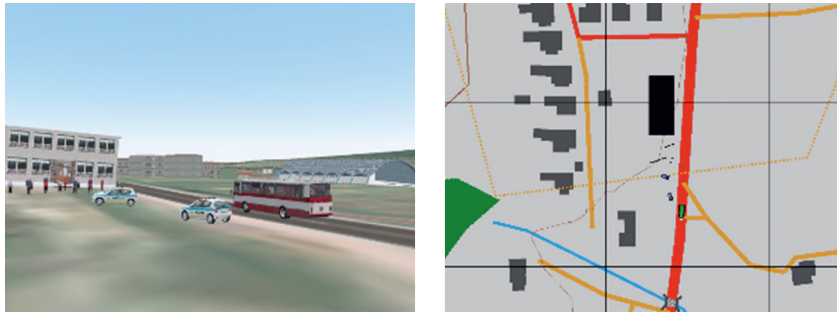


Figure 6: The 3D and 2D view of the controlled evacuation of people
Source: OTB ver. 2.5; MÄK VR – Vantage

The next chapters describe the realisation of the simulation exercise. The method used is the same for both scenarios introduced so far (see the previous two chapters). The hybrid threats layer is also elaborated similarly (presented in the previous chapter) in both exercises.

The group of participants and equipment

The participants (18 people in one simulation round) were divided into three groups, shown in the table below.

Table 1: The group of participants and the used equipment

Primary Group	**The Crisis Staff** – the decision-making body (5 persons) Map, documentation, means of connection, phone book, whiteboard, local radio station (reception and transmission), Office PC with access to the local WEB page of city, overview from the drone
Secondary Group	**Crisis Staff** – coordination part of IRS (4 persons) Digital map with GPS positioning of entities, documentation, means of connection, phone book, local radio reception, Office PC
Tertiary Group	**Operation Part** – on site intervention units (9 persons) Reconfigurable virtual simulatot, map, means of connection, local radio reception

Source: Compiled by the authors

The staff providing the simulation consist of 11 persons:

- *the director of the simulation* and his *deputy* – they keep the pulse of simulation time, record milestones in the development of the situation and prepare the after-action review; the deputy also fulfils the role of so-called *complicator*
- four *operators* – predetermined responsibilities for the activities of entities (objects, persons, natural forces)
- two *IT respondents* – forcing all the hybrid threats at the specified time, supervising the virtual cities WEB page, hacking the user accounts, spreading e-mails (legal requests of media, as well as phishing e-mails)
- one *communication manager* – supervising the communication over the radio and phone, also responsible for the voice recording
- the *simulation supervisor* – triggers the event horizon (simulation milestones that participants cannot influence, restore or bypass) and is responsible for recording the progress of the simulation using an application for constructive simulation

The distribution of workplaces

The primary condition is the physical separation of the groups of exercisers due to approximating the actual situation and the practice of effective communication. The layout of individual simulation groups is shown in Figure 7.

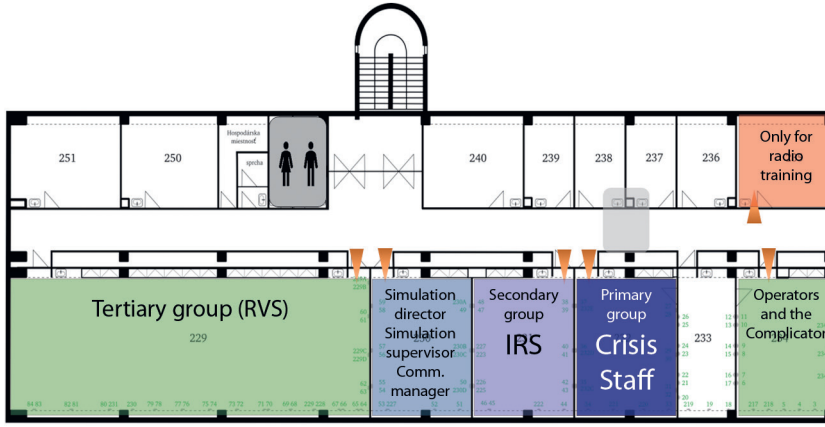


Figure 7: The possible workspace layout

Source: Compiled by the authors

The schedule

Planning a maximum of three simulation iterations in one day is reasonable, especially with students without experience in simulation technologies.

In the preparation stage, the students should learn about the scenario and the main objective of the simulation and divide the participants into three subgroups. Consequently, they should complete a mini-exercise where they know how to use communication tools and other technical aids. The students' level of technical skill must not affect their performance during the simulation. Otherwise, the outputs could be distorted. The mini-exercise should take approximately 15 minutes. Students should perform a simulation right after the mini-exercise. The simulation time is not strictly defined. It depends on the skill and maturity of the cooperation of the exercise participants. Individual milestones and event horizons should be triggered based on group performance. The goal is for the

simulation to exhibit proper dynamics and for the time stressor to always be present, thus multiplying the impact of hybrid warfare.

After-action review and take-home package

The after-action review is essential feedback on the way students prepare. It consists of (not the final list; options are possible):

- The statistics of (un)solved problems are shown in the picture above.
- The feedback of students on the scenario – e.g. what was the biggest challenge?
- The list of consequences of hybrid warfare does not always link directly to the source of the problem. For example, a firefighter car may not reach the fire scene in time because of a lost driver, but distorted communication could also be a consequence of hybrid warfare.
- Voice analysis – reflects the decision-making process and communication nuances.
- Highlights – highlighting certain moments within the team's work.
- Overall discussion with the students.

The take-home package includes all the digital recordings and material necessary to re-analyse and evaluate the exercise. The file structure of such a package is shown in the picture below.

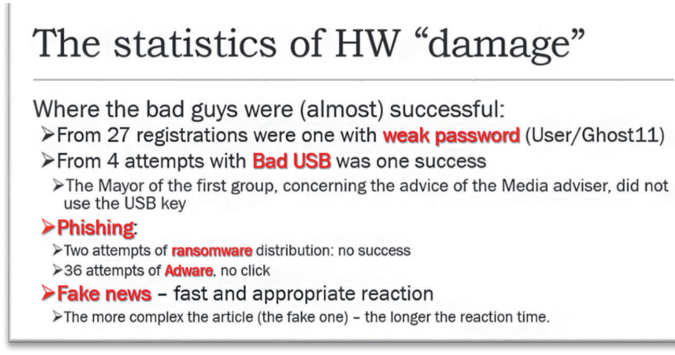


Figure 8: An example of statistics on the success of cyberattacks

Source: Compiled by the authors

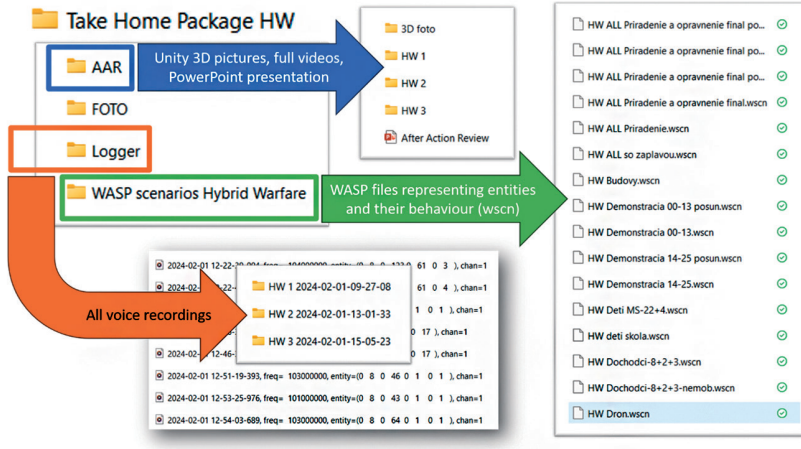


Figure 9: Take-home package file structure
Source: Compiled by the authors

More options for hybrid scenario – A military environment

Instead of a conclusion, this chapter focuses on the hybrid scenario type in the military environment, which comprises three different scenarios, two covering armed combat operations (offence, defence). At the same time, the last one addresses stability operations. The description of the opponents' hybrid footprint can be summarised as:

- hybrid dispersed attack: red forces – regular forces, special operations forces (SOF), irregular elements (guerrilla); blue forces – regular forces
- hybrid retrograde operation (hybrid delay): red forces – regular forces, SOF, irregular elements (insurgent); blue forces – regular forces
- hybrid stability operations: red forces – regular forces, SOF, irregular elements (guerrilla); blue forces – regular forces

The principles of establishing the scenarios' themes are triggered by the hybrid adversary's simulated behaviour and by the scenarios' correspondence with potential strategic-level COAs of the hybrid adversary, such as regional operations, transition operations and adaptive operations.

Objectives of the exercise in the military scenario

The main objective is to familiarise educational audiences with the principle of action–reaction–counteraction in a hybrid context using RVS and the WASP constructive simulation. Other secondary educational objectives are:

- understanding the hybrid behaviour of a tactical opponent through simulations conducted during dedicated scenarios
- simulating the decisive, shaping and sustaining operations within a hybrid operational environment
- acquiring and practising the TTPs necessary to deal with a tactical hybrid adversary
- determining and simulating the centres of gravities (COGs) in the context of hybrid operations, as well as understanding their volatile operational behaviours

Other elements focusing on describing scenarios specific to the military environment (hybrid dispersed attack, hybrid delay, hybrid stability operations) are highlighted in the chapter of the second volume of *Hybrid Warfare Reference Curriculum. Elective Seminars,* entitled *Designing Adversary Hybrid COAs.*

Paul Tudorache – Ramona Herman[1]

Recommendations on Gender Perspectives and Military Effectiveness

Approaching the gender perspective in different fields, particularly in the military, requires a special reflection by including specific gender values, which differ substantially from one society or culture to another. Gender consideration in the military becomes an imperative not only in terms of promoting gender equality, but also from an organisational and operational perspective by creating more diversified and versatile armed forces capable of handling the demanding challenges of ever-changing operational environments.

Deciphering military effectiveness from the gender perspective

In the military field, the gender perspective has multiple implications, some with negative connotations, which are often associated with discrimination, prejudice or stereotyping, and others positive in the form of supporting and valuing diversity within the military forces. In this regard, gender perspective as the respect for "the rights and dignity of women and men, be they civilian or military […] in the performance of their duties"[2] must be strongly taken into account in the military forces and at the level of military effectiveness,[3] the last being understood as the degree of fulfilment of tasks and missions by military personnel (maximising the ratio between results and objectives). Although the military effectiveness has the same meaning, regardless of the operational environment and type of operation, the gender variable brings completely new aspects because it must be analysed from the perspective of the ratio of female–male personnel. Also, to understand the generic picture of the influence of the gender perspective on the military effectiveness, Table 1 highlights some of the main benefits of operationalising gender equality for military purposes, as well as

[1] "Nicolae Bălcescu" Land Forces Academy.
[2] Bumbuc et al. 2023: 119.
[3] IEEE 2012: 11–18; OECD 2011: 3; Egnell 2016: 73.

DOI: https://doi.org/10.36250/01238_09

some potential negative effects which could appear in the situation in which it is practiced improperly, in a diametrically opposite manner.

Table 1: Operationalising gender equality – benefits and potential negative effects on military effectiveness

Benefits	**Methods**	**Potential negative effects**
Exploiting the diversity of the armed forces	A diversified military force can better cover the volume of tasks and missions during peacetime and wartime.	The emergence of non-compliant attitudes (discrimination, marginalisation, etc.) that can damage the unit cohesion and implicitly the fulfilment of tasks and missions.
Increasing fighting power prior to the military operations	The complementarity of the female and/or male personnel ensures the appropriate development of physical component within the fighting power.	The difficulty of operationalising military structures as a result of the existence of physical and mental limitations at the level of both genders (male, female).
Increasing combat power and operational effectiveness during military operations	The complementarity of female and/or male personnel ensures the appropriate application of combat functions, as well as of leadership and information.	Potential limitations for the creation of lethal or non-lethal effects, respectively the achievement of the desired end state.
Improving education of the military personnel	Having personnel with a multidirectional education can contribute to the promotion of a collaborative and participatory attitude for solving problems within the military force, but also those that arise during the relationship with other operational audiences.	The appearance of conceptual dissensions at the level of military personnel, respectively, the difficult relationship of different mentalities during tasks and missions.

Source: Compiled by the authors

Moreover, broadening the context, it can be concluded that the comprehensive approach to military effectiveness from the gender perspective also implies its addressability in relation to other operational audiences such as the beneficiaries (indigenous population, local authorities) or other participants (local or regional

security forces, etc). Consequently, during the international missions, as a rule, the presence of female personnel is beneficial both in the relationship with the local administration bodies and with the indigenous population. Also, this is also valid at the level of the cooperation with local forces, if female personnel are represented within them. On the other hand, there are some discrepancies in the situation of missions conducted in areas of operations belonging to different cultures, such as Muslim ones, where, for example, during key leader engagement (KLE) missions, the use of female personnel is not recommended.

Addressing the gender perspective in hybrid warfare

From the perspective of hybrid warfare, the addressability of the gender perspective is much more demanding and challenging because the context of its analysis is much broader. Therefore, the analyses should be carried out at all manifestation levels, starting with strategic, continuing with operational and ending with tactical. Consequently, at the strategic level of the hybrid war, the gender approach requires reflections on the power instruments such as military, political, economic, social, informational (MPECI) in terms of their correlating mechanisms and specific strategies used to generate offensive (hybrid threats, hybrid attacks) and defensive behaviours (countering offensive forms). Instead, the operational level of hybrid warfare approaches the gender perspective in the context of joint and interdepartmental actions necessary for ensuring a timely response, different from the tactical one where gender aspects are analysed within blended tactics of mixing regular and irregular structures. On the other hand, addressing gender perspective in the study of hybrid warfare is essential for a comprehensive understanding of its impact on different groups within society. As it has been noted, hybrid warfare involves a combination of conventional and unconventional tactics, often blurring the lines between war and peace. Some ways to incorporate the gender perspective in the analysis of hybrid warfare are highlighted in Table 2.

Table 2: Methods to incorporate gender perspective in hybrid warfare analysis

Methods	**Descriptors**
Gendered impact assessment	how hybrid warfare influence both men and women in a different manner; distinct vulnerabilities and risks each gender faces during conflict situations impact of hybrid warfare on traditional gender roles, as the dynamics of the conflict can stimulate existing gender norms
Conflict-related sexual and gender-based violence (SGBV)	prevalence and patterns of sexual and gender-based violence during hybrid warfare; often used as a weapon of war, and its impact can vary by gender how hybrid warfare influences power dynamics and exacerbates gender-based violence, including forced marriage, human trafficking and other forms of exploitation
Displacement and refugees	gender aspects in displacement and refugee situations resulting from hybrid war; women or men can face different challenges in seeking refuge and rebuilding their lives how hybrid warfare contributes to the creation of internally displaced populations and refugees, affecting gender dynamics within displaced communities
Participation and recruitment	roles and experiences of women and men in the military, paramilitary and civilian militias during hybrid warfare recruitment strategies, motivations and the impact of conflict on the gendered division of labour both within and outside traditional military structures
Media and propaganda	how gender stereotypes and norms are reinforced or challenged through media narratives and propaganda during hybrid warfare portrayal of men and women in conflict-related media, as well as the potential use of gender-based messages to influence public opinion and recruit individuals
Humanitarian responses	gender sensitivity of humanitarian responses to hybrid warfare; relief efforts address the specific needs and vulnerabilities of different gender groups role of local women's organisations and their contributions to resilience and recovery in conflict-affected areas
Policy and advocacy	advocate for policies that integrate a gender perspective into strategies to address hybrid warfare importance of recognising and addressing gender-specific challenges in conflict prevention, resolution and post-conflict reconstruction

Source: Compiled by the authors

Addressing hybrid warfare from the gender perspective, researchers and policymakers can develop more nuanced and effective strategies to mitigate the impact of conflict on diverse populations. This approach contributes to an exhaustive understanding of the ever-changing physiognomy and dynamics of hybrid warfare. It is obvious that the comprehensive understanding of hybrid war requires multiple analyses from various perspectives, one of which is that of gender. Moreover, the gender perspective has significant implications both for conventional and non-conventional – asymmetric conflicts, which subsequently generates significant changes at the strategic, operational and tactical military effectiveness.

Acknowledgement

The information provided in the annex is based on the lessons learned from the research project "Military Gender Studies" (2020-1-PT01-KA203-078544), conducted under the ERASMUS+ Program for the time period of December 2020 – June 2023.

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It is of utmost importance to develop a teaching methodology and a simulation that promotes collaboration, engagement and personalised learning. This handbook is an appendix to the three volumes of the *Hybrid Warfare Reference Curriculum* and offers effective teaching methods and simulation tools to bring hybrid warfare closer to various audiences. The handbook promotes creativity, problem-solving and a deeper understanding by offering immersive and interactive learning opportunities beyond the classroom. Simulation exercises have the function to provide flexibility and cater to diverse learning styles. Without the appropriate design and use of methods and tools, it is impossible to spread quality information and create a firm foundation to any course offered to students. Teaching methods and simulation are the toolbox to be used in the right way – for the right job. Teaching methods, if understood and used appropriately can make any interaction between the lecturer and the student a lot easier. As such the handbook attempts to explain and demystify the world of teaching methods and simulation means, whilst it seeks to provide a starting point for their use.

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