Co-funded by the European Union

Digital Literate in VET by Cybersecurity Training with Immersive Technologies

CybARverse

CybARverse pedagogical guidelines

Document prepared by:

Fundatia EOS – Educating for an Open Society with the contribution of SCP, LIA, CCS and Tech.mt project partners

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CYBARVERSE

PROJECT SUMMARY

CybARverse is an Erasmus+ co-funded project which supports IT as well as non-IT teachers and trainers' digital skills development, through the use of immersive technologies. The focus of this project is to train the target group on how to recognise and react correctly to cyberattacks. It promotes cyber security awareness, the implementation of the Digital Education Action Plan (Actions 5 and 7) as well as national agendas, and contributes to a more digital, greener and more inclusive teaching and learning.

Project no: 2022-1-LT01-KA220-VET-000089116

Objectives:

- To promote professional, personal, and digital skills among VET teachers and trainers in the field of cybersecurity.
- To incorporate modern and immersive technologies into VET cybersecurity training.
- Structured qualification of teachers and trainers to become cybersecurity aware and literate.
- To ensure the sustainability of the project results.

Project implemented by:

LANGAS | ATEITI

SCP School of Certified Professionals

CYPRUS COMPUTER SOCIETY

Tech.mt MALTA - LEADING THROUGH INNOVATION

eos FUNDAȚIA EOS ROMÂNIA

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1 INTRODUCTION

The utilization of modern technologies in training is currently trending. Education professionals are constantly seeking efficient and effective educational methods that align with the desires of learners and society, incorporating psychological and pedagogical insights through the latest technological advancements. The potential applications of technology in training have grown exponentially and are expected to continue expanding in the future.

Education is moving towards a future where teachers and technology collaborate to provide learners with the necessary knowledge and skills for their professional endeavours. It is unimaginable to think of life today without technology, as it profoundly influences how we live, work, and learn. Trainers play a crucial role in effectively implementing relevant technologies, resulting in improved learning outcomes and increased learner motivation. The following guidelines are intended for both IT and non-IT trainers to understand and implement modern digital media in their training practices.

The mission of the CybARverse project is to train current and future educators to be prepared for the challenges of tomorrow by providing tailored support and educational innovations for teachers and trainers.

At the inception of the CybARverse project, we acknowledge the potential of innovative technologies such as Augmented Reality (AR), Virtual Reality (VR), and video to enhance classroom and live training experiences, making them more effective, efficient, personalized, and of higher quality, thereby motivating individual learners and teams.

Augmented Reality refers to the enhancement of the visible reality through computer-generated interactive holograms, which serve purposes such as guiding and explaining non-visible processes. Specialized technology, such as smart glasses (AR glasses), smartphones, or

tablets, is required to view these holograms. The use of smart glasses allows trainees to have both hands free during live training while interacting with the glasses.

360° video enables users to immerse themselves in a digitally generated environment. It is utilized for documenting real environments and aiding user orientation in space. It represents a "simpler" form of Virtual Reality (VR). Interactivity is facilitated through the integration of buttons for accessing additional information, such as videos, 3D objects, web links, and more.

Currently, there is limited or no experience in employing AR, VR, and video in cybersecurity classroom and live training.

2 HARDWARE AND SOFWARE

The field of smart glasses and its associated hardware and software is experiencing rapid and constant development. Although the technology itself is not new, recent advancements in computing and storage media have made smart glasses more accessible. However, the availability of suitable and professional content for specific working and learning environments, such as cybersecurity training, remains a challenge.

Like any new or modern technology, smart glasses go through a cycle of hype. Initially, there are high expectations, followed by a period of disillusionment, and ideally, eventually proving to be productive. The consulting firm Gartner releases an annual hype cycle of new technologies, and augmented reality (AR) and virtual reality (VR) were featured on it until 2018. Since then, both technologies have progressed from being "technologies to watch" to being widely used. Gartner has since predicted the emergence of "immersive workspaces." Immersion refers to the concept of being fully engaged and embedded in digital-enhanced (AR) or completely digital-generated (VR) learning and training environments.

The industry is driven by economies of scale. Hardware gets over time lighter, more powerful, and more affordable. This normally results in more software capabilities due to faster processors. If the relevant software tools are available more applications are possible in a shorter amount of time.

Decisive factors for buying smart glasses are:

- Field of view
- Control options
- Refresh rate (for visualization stability and latency)
- Weight
- Battery duration
- Operating System
- Price

THE WILD IMMERSIVE COLLABORATION FOR TEAMS

2022 Business VR Headset Comparison Chart (Q1)

	Meta Quest 2	Pico Neo 3 Pro	HP Reverb G2	Valve Index	Vive Pro 2	Vive Pro
						
Official Support in The Wild	☑	☑	☑	☑	☑	☑
Resolution / Eye	1832 x 1920	1832 x 1920	2160x2160	1440x1600	2448 x 2448	1440x1600
Refresh Rate (HZ)	90/120	90	90	144	120	90
Field of View	100°	98°	114°	130°	120°	110°
Weight	503g	620g	544g	570g	850g	563g
Tracking	Inside-out	Inside-out	Inside-out	Base Stations (more equipment = more precise hand tracking)	Base Stations (more equipment = more precise hand tracking)	Base Stations (more equipment = more precise hand tracking)
Type	**Standalone** (no wires, less powerful processor) + **option to wirelessly stream or tether** to a PC with a cable	**Standalone** (no wires, less powerful processor) + **option to wirelessly stream** to a PC	**Tethered** (wired to your PC, more powerful, can run larger models)	**Tethered** (wired to your PC, more powerful, can run larger models)	**Tethered** (wired to your PC, more powerful, can run larger models)	**Tethered** (wired to your PC, more powerful, can run larger models)
Price	$299	💼 $699	$599	$999	$1399 | 💼 $1599	$1199 | 💼 $1399
Summary	A great standalone headset for personal or business use. What you lose in processing power you gain in easy setup and freedom of movement. AirLink and the Link cable makes this a great option for running larger models as well.	A fantastic Enterprise standalone (or optional PC-streaming) headset focused on privacy and control, with ability to deploy software through Multiple Device Managers.	An affordable, high-res, tethered headset for running large models from your PC.	A top-of-the-line gaming headset. Base stations and wires require more setup and configuration, but create a smooth and powerful experience in-headset.	A top-of-the-line gaming headset. Base stations and wires require more setup and configuration, but create a smooth and powerful experience in-headset.	An older but still powerful gaming headset. Base stations and wires require more setup and configuration, but create a smooth and powerful experience in-headset.

Figure 1: 2022 Business VR Headset Comparison Chart (Q1)[1]

As we can see in Figure 1, the VR headset market offers a range of options tailored to business needs, highlighting differences in resolution, refresh rate, field of view, and price among leading models, which are critical factors for companies to consider when investing in virtual reality technology for their operations.

[1] 2022 Business VR Headset Comparison Chart (Q1),' The Wild.
Available at: https://thewild.com/blog/architect-getting-started-with-vr

3 IT AND NON-IT TEACHERS TRAINING EXPERIENCES WITH AR AND VR

IT and non-IT trainers across various industries are increasingly recognizing the potential of augmented reality (AR) and virtual reality (VR) technologies to revolutionize their training programs. While VR has gained significant prominence in the current training landscape, offering immersive simulations in safe environments, cost-effective alternatives to hazardous activities, and the ability to acquire and practice operating procedures, AR complements VR by seamlessly blending the physical world with digital information and providing additional benefits.

Virtual reality (VR) has emerged as a dominant force in training due to its ability to create realistic and immersive experiences. Trainees can be transported to simulated environments where they can practice tasks, make decisions, and refine their skills without any real-world risks. By replicating complex scenarios, VR enables learners to gain hands-on experience in a controlled setting, fostering a deeper understanding of various concepts and improving decision-making abilities. Moreover, VR training enhances spatial awareness, allowing individuals to navigate and interact with simulated objects and environments, which further contributes to skill development.

On the other hand, augmented reality (AR) enriches the real world by overlaying digital information onto the physical environment. AR technology enables trainers to visualize spatial data, such as 3D models, diagrams, or instructional videos, directly within the trainee's field of view. This visualization enhances comprehension and retention of complex concepts by

providing a visual context. AR also facilitates real-time communication between trainers and trainees, allowing for remote assistance and collaborative problem-solving. Furthermore, AR devices, such as smart glasses, offer hands-free access to technical information, enabling trainees to access relevant instructions or guidelines without interrupting their workflow.

Both AR and VR technologies have shown immense potential in enhancing training effectiveness. However, there are still challenges that need to be addressed to optimize the training experiences. One significant challenge lies in the hardware requirements. VR often demands high-performance computing devices, specialized headsets, and motion-tracking equipment, which can be costly for widespread implementation. Similarly, AR devices need to be lightweight, comfortable, and affordable for extended use.

Another challenge lies in the software development aspect. Creating immersive VR environments and seamless AR overlays requires robust software tools and platforms. Trainers and developers need access to user-friendly authoring tools that enable them to design, customize, and deploy training experiences without extensive coding knowledge. Additionally, interoperability and compatibility between different hardware and software systems need to be addressed to ensure seamless integration and accessibility.

Despite these challenges, the potential benefits of AR and VR in training are undeniable. As technology continues to advance and costs decrease, the adoption of AR and VR solutions in training is expected to accelerate. Trainers from both IT and non-IT backgrounds are actively exploring these technologies to create engaging, effective, and efficient training experiences that revolutionize how knowledge and skills are imparted to learners.

4 SURVEY BASED ON TRAINING NEEDS ANALYSIS

CybARverse project partners have conducted in their countries an online survey for determining the qualification needs among VET teachers and trainers concerning technical and pedagogical needs to integrate digital media and cybersecurity training into existing teaching and learning environments. This online survey included 20 questions.
The results collected by each project partner country have been analyzed and interpreted and can be found in the national reports that were developed.

Section 4 of the Pedagogical guidelines document delves into the targeted analysis of this survey, based on the latest findings regarding VET teachers and trainers' familiarity, experience, and eagerness to embrace augmented reality (AR), virtual reality (VR), and 360-degree videos within educational settings. This section examines the VET teachers responses to the survey questions related to their use and familiarity with immersive technologies (Question 8), school support for integrating advanced technologies (Question 10), their interest in receiving cybersecurity training using technologies like VR, AR, or 360 videos (Question 11), the importance of using immersive technologies in education (Question 14), their comfort level with using innovative technologies for teaching (Question 15), the ideal duration for a cybersecurity training session based on AR, VR, or 360 videos (Question 16), the anticipated benefits from cybersecurity training using these technologies (Question 18), and the effectiveness of training using VR, AR, or 360 videos compared to traditional teaching methods (Question 19).

The insights gathered offer a nuanced understanding of the readiness and areas of need among educators for integrating these cutting-edge technologies into their pedagogical repertoire, aligning with CybARverse mission to advance digital and cybersecurity proficiency through immersive learning experiences.

In exploring the integration of digital media and cybersecurity into VET teaching, the answers to the survey questions across the CybARverse project partners has unveiled varied perceptions among educators regarding the following topics:

4.1 Familiarity with Immersive Technologies

The comparative analysis of familiarity with VR, AR, and 360-degree videos across Malta, Cyprus, Lithuania, and Romania highlights varying levels of engagement with these technologies. Malta and Cyprus participants show a moderate to high familiarity, especially with VR, suggesting a potential for these countries to lead in educational technology adoption. However, Cyprus has higher unfamiliarity rates for AR and 360-degree videos, indicating a need

for targeted educational interventions. Lithuania's focus on cybersecurity training suggests different educational priorities, making direct comparison challenging. Romania shows strong familiarity with VR but lesser with AR and 360-degree videos, pointing to a gap that could be addressed through focused training. Overall, while interest in these technologies is present, targeted educational programs could enhance understanding and application across all countries.

4.2 School Support for Technology Integration

The answers provided by VET teachers and trainers to this survey question revealed the following information:

- **Malta:** Showed a balance between moderate and high levels of support, with the most common rating being 3 (moderate support), followed by a significant perception of high support.
- **Cyprus**: Exhibited a notable lack of support with the majority (41%) indicating they receive no support, and only a small fraction (12%) affirming they receive support.
- **Romania**: Indicated moderate support as the most common rating (46%), with a balanced distribution across the support spectrum.
- **Lithuania**: Shows a distribution leaning towards moderate to good support, with the most significant number of respondents indicating a moderate level of support.

Comparatively, Lithuania and Malta seem to have a better perceived support level for integrating AR/VR technologies in teaching than Cyprus, which has the most significant reported lack of support. Romania exhibits a moderate level of support similar to Lithuania, with a smaller portion of respondents feeling fully supported. This comparative perspective underscores the varying degrees of institutional support across the countries, with an overarching indication that while there is some level of backing, there is room for improvement to fully embrace these technologies in educational settings.

4.3 Interest in Cybersecurity Training

The consolidated data for the answers registered to this question showed the following results:

Interest Rating Breakdown:

No interest (Rating 1): Shows a range from 0% in one data set to 12% in another, indicating that a minority of respondents across countries are not interested in receiving cybersecurity training through immersive technologies.

Neutral/Little interest (Rating 2 and 3): Combines for a range of 11% to 59% across the data sets, which signifies that there is a considerable portion of the respondents who are on the fence or have a moderate interest in such training.

Interested (Rating 4): Fluctuates between 15% to 31%, reflecting a significant group of respondents who are positively inclined toward receiving such training.

Very interested (Rating 5): Ranges from 39% to 51%, demonstrating that a substantial number of educators are highly interested in receiving cybersecurity training with VR, AR, or 360 videos.

***Comparative Insights*:**

High Interest: There is a clear trend of high interest in using immersive technologies for cybersecurity training, with the highest rating (5) consistently receiving a significant percentage of responses across the various countries.

Moderate to Low Interest: A notable segment of educators express either a neutral stance or little interest, which could suggest a need for more information, exposure, or perhaps concerns about the practicality or effectiveness of such training methods.

Minimal Disinterest: The consistent low percentage of respondents indicating no interest (rating 1) suggests that outright opposition to using VR, AR, or 360 videos for cybersecurity training is uncommon.

The data across the project partners' countries indicate a generally positive response to the integration of VR, AR, and 360 video technologies in cybersecurity training programs. The majority of respondents show moderate to very high interest, with very few expressing no interest at all. This demonstrates an openness to innovative training methods and acknowledges the potential of immersive technologies to enhance the cybersecurity training experience.

To maximize the effectiveness of such programs, it would be beneficial for educational institutions to address the concerns of those who have expressed moderate or little interest and to provide additional information or trial opportunities to increase the comfort level with these technologies. This approach could help in converting moderate interest into enthusiasm, further broadening the acceptance and effectiveness of immersive technologies in cybersecurity education.

4.4 Importance of Immersive Technologies in Education

Immersive technologies such as Virtual Reality (VR), Augmented Reality (AR), and 360-degree videos are emerging as significant tools in the education sector, especially within Vocational Education and Training (VET). Survey results regarding the importance of immersive

technologies in education provide insight into VET teachers' attitudes towards the importance and integration of these technologies in teaching:

- **Results from Malta** highlights a varied perspective on immersive technologies, with 27% viewing them as very important and a total of 58% considering them as important to very important for teaching. This suggests a positive recognition of their benefits in education, though with some room for greater acceptance.
- **Responses from Cyprus** indicate a strong inclination towards the importance of immersive technologies, with a majority of respondents acknowledging their significance in teaching. Specific percentages are not provided, but the narrative suggests a positive trend towards recognizing their educational benefits.
- **For Romania**, feedback on the importance of immersive technologies in teaching shows strong support: none of the respondents rated these technologies as of low importance, with a significant 68% of educators viewing them as important or very important. This demonstrates a robust endorsement of the potential benefits that VR, AR, and 360-degree videos offer in educational settings.
- **In Lithuania**, educators' responses reveal a balanced view on the importance of immersive technologies, with 27% rating them as very important and a combined 49% indicating they see these tools as moderate to very important. This indicates an acknowledgment of their value, with potential for growing interest.

***Comparative Analysis of the results*:**

Recognition of Importance:

All four countries demonstrate a recognition of the importance of immersive technologies in teaching. Romania has the highest percentage (50%) considering it very important, followed by Malta (27%), Lithuania (27%), and Cyprus.

Lack of Disregard:

Notably, in Romania, no respondents considered immersive technologies to be of low importance, suggesting a strong consensus on the value of these technologies.

Moderate Importance:

The responses from Malta, Lithuania, and Romania all include a moderate importance category, with Lithuania having the highest percentage (33%) of respondents in this category.

Variation in Less Importance:

Malta and Lithuania have respondents who consider immersive technologies to be of lesser importance, with Malta having a higher combined percentage (27%) for ratings 1 and 2.

The data indicates potential for the increased integration of these technologies into educational curricula and the need for continued exposure and training for educators to leverage these tools effectively.

4.5 Comfort Level with New Teaching Technologies

Exploring educators' readiness for technology, our survey reveals their differing comfort levels with innovative teaching tools:

- **For Malta**, the survey responses indicate a mixed comfort level among educators with using new innovative technologies for teaching. The overall feedback suggests that educators' familiarity and ease with technologies such as AR, VR, and 360-degree videos vary. This diversity in comfort levels reflect a broad range of experiences and attitudes towards integrating these technologies into the educational process, highlighting the need for targeted training and support to enhance teachers' confidence and competence in utilizing these innovative tools;
- **In Cyprus**, approximately 1/4 of the respondents felt very comfortable with new technologies (24% in AR, 21% in VR, and 26% in 360 videos), with a small percentage (5%) stating they didn't feel comfortable at all;
- **For Romania**, a majority of respondents (54%) are very comfortable using new innovative technologies for teaching, indicating a high level of adaptability and confidence among educators in leveraging these tools;
- **In Lithuania**, about a quarter of VET teachers feel very comfortable using technologies such as AR, VR, and 360-degree videos for teaching, showing they are prepared to integrate these innovative tools. Yet, a small portion (5%) is completely uncomfortable, pointing out that despite widespread enthusiasm, some educators still encounter difficulties or reservations. This situation emphasizes the need for offering support and training to ensure all educators can effectively use these technologies.

***Comparative Analysis*:**

Comfort Levels: There's a variance in comfort levels with using innovative technologies for teaching among the countries. Romania shows a higher percentage of educators feeling very comfortable, indicating a strong adaptability towards technological advancements in education.

Adaptability: Romanian educators demonstrate significant adaptability and forward-thinking, as evidenced by the majority feeling very comfortable with new technologies. In contrast, Lithuania shows a more distributed comfort level, with a noticeable percentage of educators not feeling comfortable.

Need for Support: Across the responses, it's implied that while there is enthusiasm for integrating technology into teaching, there also exists a need for more training and resources to increase comfort levels, particularly noted in Lithuania's balanced spread of comfort levels.

The survey's findings on educators' comfort levels with innovative technologies like AR, VR, and 360-degree videos point to a clear conclusion: while there's a positive tilt towards the adoption and integration of these tools in teaching, the comfort level among educators varies significantly across the four project partner countries. ensuring they can fully leverage the potential of innovative tools in their teaching methods.

This variation underscores the importance of continued support and training to enhance educators' proficiency and confidence in using these tools, facilitating a smoother integration of technology into educational frameworks across different regions.

4.6 Ideal Duration for Cybersecurity Training

Based on the responses received, the following data were obtained:

Malta:

Short Sessions (20-30 minutes): Preferred by 62% of respondents, indicating that the majority value substantial but concise sessions.

Flexible Shorter Sessions (10-20 minutes): Chosen by 27%, showing a preference for more compact training modules.

Very Short Sessions (5-10 minutes): Selected by 12%, pointing towards a desire for very brief, topic-specific training.

Cyprus:

Short Sessions (20-30 minutes): Most respondents (30 out of 49) find this duration ideal, aligning with Malta's preference for substantial sessions.

Lithuania:

Varied Responses: 15% of respondents could not specify an ideal duration, with some suggesting extreme durations of 1-10 hours, indicating uncertainty or a wide range of preferences.

Romania:

Short Sessions (20-30 minutes): The significant majority (75%) prefer this duration, consistent with Malta and Cyprus, emphasizing the value of focused yet comprehensive sessions.

Flexible Shorter Sessions (10-20 minutes): Preferred by 18%, similar to Malta's findings.

Very Short Sessions (5-10 minutes): Favoured by 7%, the least popular option but still noted.

Comparative Insights:

Across the four countries, there's a clear consensus for short sessions lasting 20-30 minutes. This duration seems to strike a balance between depth of content and the intensity of immersive learning experiences.

There is a recognized value in having the flexibility to accommodate shorter sessions, with a notable minority in each country expressing a preference for 10-20 minute sessions, likely to fit training into tight schedules or to address specific topics efficiently.

Very short sessions of 5-10 minutes are the least preferred option but still represent a need for ultra-concise content delivery, which may be suitable for certain learning contexts or audiences.

The uncertainty or extreme range of responses in Lithuania suggests a need for further investigation to understand the specific training needs and preferences in that context.

The data reflects a general trend towards favouring short, focused training sessions utilizing immersive technologies for cybersecurity training across Malta, Cyprus, and Romania, with Lithuania showing an outlier in response consistency. This preference underscores the importance of designing engaging, compact training modules that effectively convey necessary information within a brief timeframe, without overwhelming the learners.

4.7 Training Benefits

The survey results related to the expected benefits of using VR, AR, or 360 videos for cybersecurity training highlighted the following aspects:

1. **High Expectations for Immersive Training**:
    - **Malta**: Educators expressed significant anticipation for the benefits of immersive technologies in cybersecurity training, particularly for areas like IoT attacks, social media threats, phishing, grooming, malware, and social engineering.
    - **Cyprus:** A majority of participants believed they would significantly benefit from immersive training, with percentages ranging from 33% to 41% across various skills.
    - **Lithuania & Romania**: Both countries showed consistent high ratings across various cybersecurity areas, with percentages ranging from 25% to 43% for significant benefit from immersive training.
2. **Areas of Emphasis**:
    - **Malta**: Certain areas such as social media threats, phishing, grooming, and malware received particular emphasis for immersive training.

- **Cyprus, Lithuania, & Romania**: While not explicitly mentioned, consistent high ratings across various cybersecurity areas suggest a broad recognition of the potential benefits of immersive training.

3. **Resistance to Change**:
    - **Malta**: Some educators showed resistance to adopting new technologies for teaching, indicating potential challenges in implementing immersive training methods.
    - **Cyprus, Lithuania, & Romania**: There's no explicit mention of resistance to change, but the overall positive outlook suggests a readiness to embrace immersive technologies for cybersecurity training.
4. **Consistency in Ratings**:
    - **Cyprus, Lithuania, & Romania**: Across all regions, there's a consistent trend of significant anticipation for the benefits of immersive training, with similar ratings for various cybersecurity areas.
5. **Key Areas of Interest**:
    - **Malta**: Focus on specific areas like social media threats, phishing, grooming, and malware.
    - **Cyprus, Lithuania, & Romania**: No specific focus mentioned, indicating a broad interest in using immersive technologies across various cybersecurity domains.

The data suggests a general optimism towards these technologies across various cybersecurity areas, with notable differences in the level of perceived benefit among different topics and countries. For instance, certain areas like grooming, cryptojacking, and DDoS attacks have a higher percentage of respondents indicating a "Significant benefit," reflecting a belief in the strong potential of immersive technologies for complex and specific cybersecurity challenges.

Comparatively, topics like social media threats, malware, and ransomware receive a more moderate response, indicating variability in how these technologies are valued for different aspects of cybersecurity training. This variability could reflect differences in educational approaches, technological infrastructure, or specific cybersecurity training needs across different regions.

Overall, VET teachers responses highlights a positive outlook on immersive technologies for cybersecurity education, with variations that suggest areas for focused application and further investigation into their effectiveness in different educational and geographical contexts.

4.8 Effectiveness vs. Traditional Methods

The detailed survey results across Malta, Cyprus, Lithuania, and Romania regarding the perceived effectiveness of VR, AR, and 360 videos in education compared to traditional classroom-style training, revealed the following data:

- In Malta, opinions are varied with a significant portion of respondents showing agreement or neutrality towards the effectiveness of immersive technologies.
- Cyprus's results indicate a general belief in their effectiveness, though specifics are not provided.
- Lithuania's and Romania's feedback further supports the positive perception, with a notable portion of respondents in Romania strongly agreeing with the effectiveness of these technologies.

The data across these countries showcases a trend towards recognizing the potential benefits of immersive technologies in enhancing learning experiences, with varying degrees of agreement and neutrality suggesting a blend of enthusiasm and cautious optimism.

5 QUALIFICATION CONCEPT

In modern education, integrating technology into teaching and learning scenarios has become increasingly important. When it comes to using technologies like Augmented Reality (AR), Virtual Reality (VR), and videos for cybersecurity training, several pedagogical frameworks can help ensure an added educational value. Two such frameworks are the SAMR model and Bloom's Taxonomy. Below we are exploring how these frameworks that can be applied to enhance cybersecurity training with AR/VR and videos in cybersecurity:

5.1 SAMR Model:

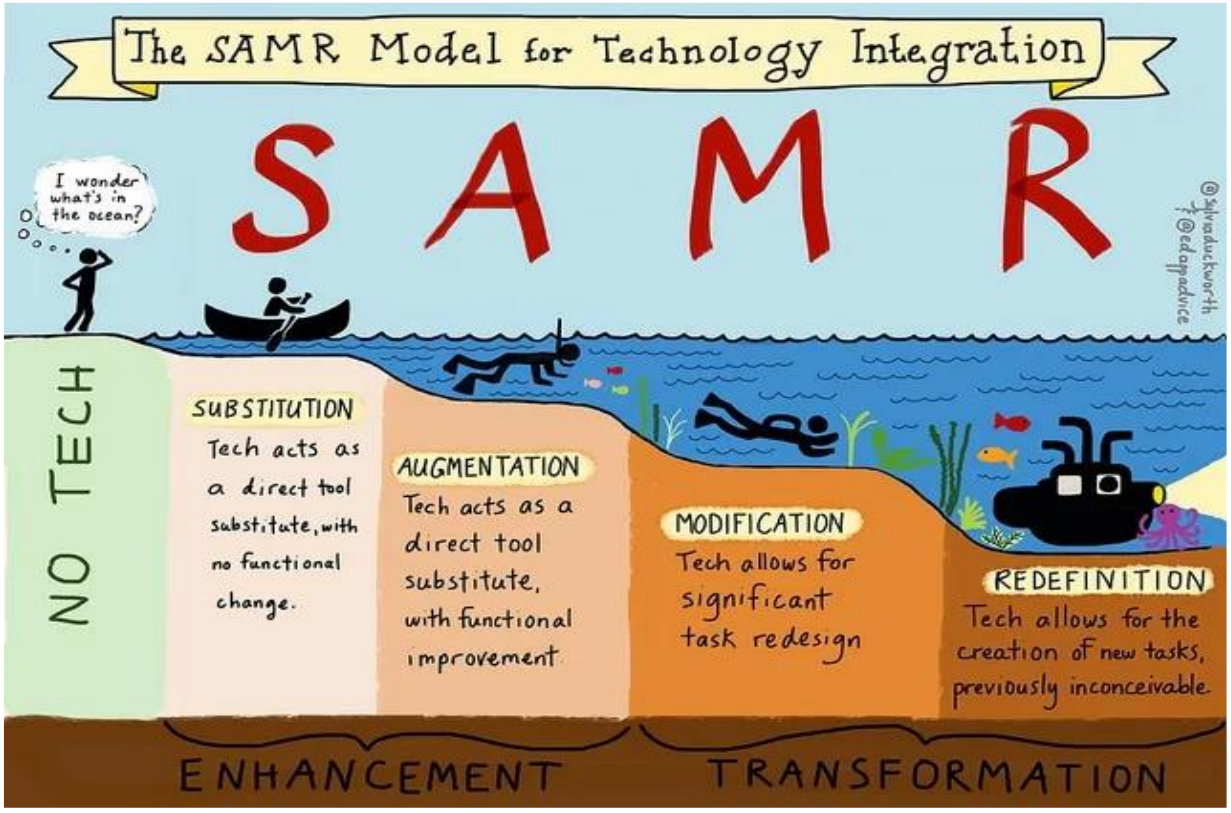


Figure 2: The SAMR Model for Educational Technology Integration[2]

As illustrated in Figure 2, the SAMR Model outlines a progressive framework for integrating technology in educational settings, moving from basic substitution to redefinition, where technology creates entirely new educational possibilities.

[2] Figure 2 source: "The SAMR Model for Technology Integration," accessed from Talk Tech with Me

The SAMR model (Substitution, Augmentation, Modification, Redefinition) categorizes technology integration into four levels based on its impact on teaching and learning:

Substitution: At this level, technology is used as a direct substitute for traditional methods without significant changes in the learning process. For instance, using AR to display text-based information on a screen.

Augmentation: Technology enhances the learning experience by adding some functional improvements. For example, using VR to simulate real-world cybersecurity scenarios, providing a more immersive and engaging experience compared to traditional case studies.

Modification: Here, technology allows for significant task redesign. In cybersecurity training, this could involve using AR/VR/WEBVR/VIDEOS to create interactive simulations where learners actively engage in identifying vulnerabilities and implementing solutions.

Redefinition: At the highest level, technology enables the creation of new learning experiences that were previously not possible. For instance, using AR to watch and interact with cybersecurity challenges virtual space, transcending physical limitations.

5.2 Bloom's Taxonomy:

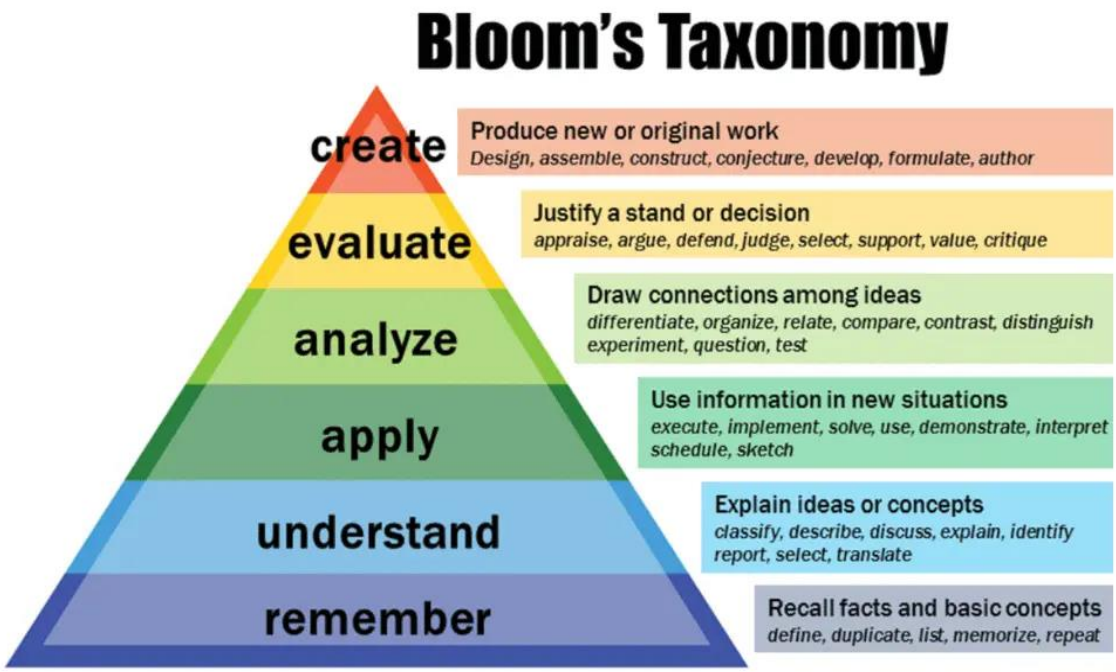


Figure 3: Hierarchical Representation of Bloom's Taxonomy in Educational Objectives[3]

[3] Figure 3 adapted from Salisbury University, 'Bloom's Taxonomy Action Verbs.' Available at: Bloom's Taxonomy Action Verbs

As depicted in Figure 3, Bloom's Taxonomy classifies educational objectives into different cognitive levels, and the trainer can select the steps that will be more logical to help in teaching students specific outcomes or units.

Below you will find the steps involved in the bloom's taxonomy:

- **Remembering**: Using videos to present cybersecurity concepts and procedures for learners to recall later.
- **Understanding**: Creating AR/VR scenarios that allow learners to comprehend complex cybersecurity concepts through interactive experiences.
- **Applying**: Using AR/VR to simulate practical cybersecurity situations, enabling learners to apply their knowledge and skills in context.
- **Analyzing**: Providing video-based case studies where learners analyze security breaches and identify vulnerabilities.
- **Evaluating**: Using AR to create interactive simulations where learners evaluate different security strategies and make informed decisions.
- **Creating**: Tasking learners to design innovative security solutions using AR/VR technology.

5.3 Pedagogical Added Value for Cybersecurity Training:

- **Engagement**: AR/VR and videos can captivate learners' attention and make complex cybersecurity concepts more accessible, thereby enhancing engagement and motivation.
- **Real-world Application**: Immersive experiences through AR/VR can replicate real-world cyber threats and scenarios, enabling learners to practice in a safe environment.
- **Active Learning**: Interactive simulations foster active learning as learners actively participate, make decisions, and witness outcomes in real time.
- **Personalization**: AR/VR and video content can be tailored to individual learning preferences, providing a personalized learning experience.
- **Critical Thinking**: Through analyzing and evaluating scenarios, learners develop critical thinking skills by assessing risks, making judgments, and proposing solutions.
- **Collaboration**: AR/VR can facilitate collaborative problem-solving, where learners work together to address complex cybersecurity challenges.

Long-term Retention: Visual and interactive content aids memory retention, increasing the chances that learners will retain and apply their knowledge.

You can find the qualification concept here

6 TECHNOLOGY-ENRICHED LEARNING SCENARIOS IN CYBERSECURITY

In the dynamic landscape of education, integrating technology into learning scenarios has proven to be a transformative approach, particularly in disciplines like cybersecurity. On the Erasmus CybARverse Project we are teaching cybersecurity to IT and non-IT trainers by adopting technology-enriched learning scenarios to amplify the educational experience and outcomes.

Below we are analyzing some of those benefits and how this technology enriched lesson plans can help the educators integrate and teach about Cybersecurity in either new or existing courses.

1. **Enhanced Engagement and Interactivity**: Technology facilitates interactive learning experiences, capturing students' attention through virtual simulations, such as the CybARverse AR/VR simulations. This engagement leads to better information retention and a deeper understanding of complex concepts, such as cyber threats and defense mechanisms.

2. **Global Collaboration and Connection**: Technology connects globally the students and knows no boundaries, enabling students to collaborate with peers and experts worldwide. Through video conferencing and online discussions, students gain diverse perspectives and insights, enriching their understanding of global cybersecurity issues.

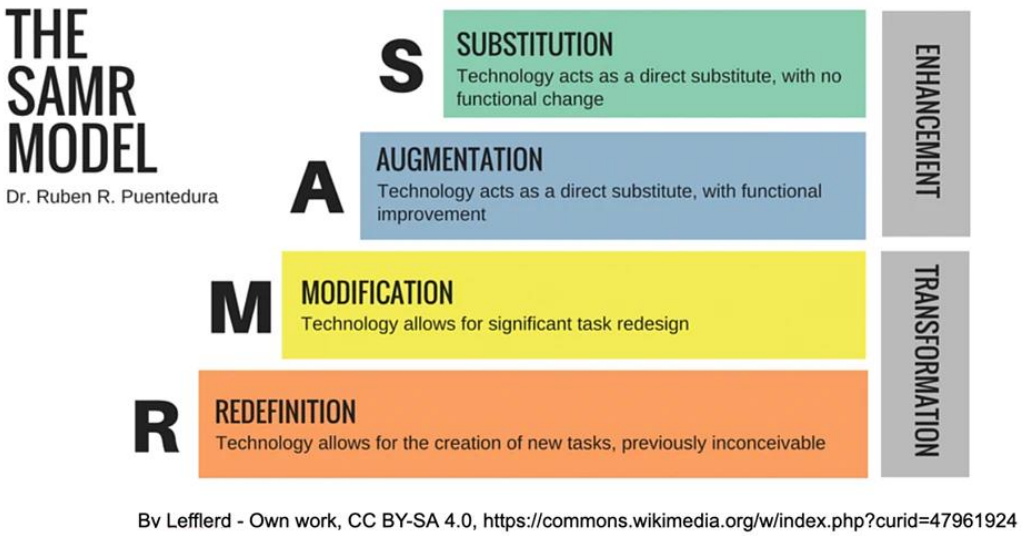
3. **Adaptive Learning Paths:** Digital platforms can tailor learning experiences based on students' progress and individual learning styles. In the CybARverse project we are using a Learning management system (LMS) to access the content, ensuring students receive the right level of challenge and support anywhere in the world
4. **Immediate Feedback and Assessment:** Technology allows for instant assessment and feedback, offering students timely insights into their understanding and areas for improvement. In our project we are using the LMS which integrates Quizzes, interactive exercises, and automated grading systems enhance the learning process while reducing administrative burden.
5. **Accessibility and Inclusivity:** Technology levels the playing field by catering to various learning abilities and preferences. It ensures that students with diverse backgrounds and learning needs can access and engage with educational content, fostering an inclusive learning environment.
6. **Rich Multimodal Learning Content:** Digital resources like videos, infographics, and interactive diagrams offer multiple entry points to understanding complex concepts. This variety accommodates different learning styles and reinforces understanding.

You can find the 17 lesson plans of the courses at www.cybarverse.eu.

7 APPENDICES

APPENDIX 1: Formulation of learning objectives (Bloom)

APPENDIX 1: Formulation of learning objectives (SAMR)



APPENDIX 2: Scenario planning template

SCENARIO

Name Lesson plan

LESSON PLAN Time – 45 minutes

Learning objectives:

1. ……..
2. ……..

Learning Content phase	Learning outcome	Teaching /Learning objectives	Learning Activities (actions and teaching methods to meet the objectives)	Communication and Collaboration form	Resources, tools, and media
Introduction and orientation - 20 minutes					
Lesson Execution – 15 minutes					
Evaluation – 10 minutes					

APPENDIX 3: Evaluation

Evaluation

LEARNER FEEDBACK (CLASSROOM TRAINING AND LIVE TRAINING)

Scaled questions (suggest 5-point scale).

Question	Yes/Very much/ A lot			No/ Not at all	
Did you find the session/course well organised and structured?					
Did you find the process straightforward to follow?					
Do you feel that your understanding of the topic has increased?					
How satisfied are you with your performance of the tasks?					
How confident are you that you can use what you have learned at work/in an independent project?					
Did you find it easy to recover from mistakes or misunderstandings?					
Did you find it easy to get answers to any questions you had?					
Was the technology (VR) comfortable to use?					
Was it easy to find your way around the technology?					
Was it easy to move from one step to the next using the technology?					
Did you feel that the technology helped you learn?					

8 REFERENCES

- https://tips.uark.edu/using-blooms-taxonomy/
- https://www.powerschool.com/blog/samr-model-a-practical-guide-for-k-12-classroom-technology-integration/
- https://vibe.us/blog/samr-model/