#NETGAME – NEXT LEVEL EDUCATION: GAMIFICATION AND DIGITAL TEACHING METHODS FOR THE GENERATION OF TODAY

VIRTUAL REALITY: NEW MEDIUM FOR TRAINING PURPOSES

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Abstract:
The use of video games, interactive tools and technological platforms for educational purposes has become a major trend in contemporary society. Research has shown that the gaming component has a major implication on a student's learning process, supporting intellectual, emotional and social wellbeing. (Kiryakova et al., 2014). Is this the same for professional training? To what extent can these techniques be applied to train security forces – i.e. Law Enforcement Agencies and Intelligence Agencies? This article analyses the potential of Blended Virtual Reality Solutions to train professionals in the security sector, showcasing the VR training experience developed by Rex Te.ch. in cooperation with Agenfor International within the EU-funded project JSAFE (Judicial Strategy Against all Forms of Violent Extremism in Prison, Grant No. 763714), designed to counter radicalisation processes in prison and to enhance situational awareness.

Keywords: *Blended learning model, Virtual Reality, Netgame, prison radicalisation, digital forensics, situational awareness*.

Introduction

Contemporary society continuously faces a technological revolution that includes, among its milestones, the introduction of the World Wide Web and its infiltration into our everyday lives, the universal mobile accessibility, the Internet of Things and, lastly, the application of artificial intelligence to develop new technological solutions (Feki et al., 2013). The advent of the pandemic (COVID-19)

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accelerated this process, and it underlines, as Fish (2020) stated, that "the evolution of technologies is no longer an option, but rather the only possible choice." Among other technological solutions, the last decade has witnessed an exponential growth in the use and development of Virtual Reality (VR). In fact, VR has now found a place of honour alongside influential media such as telephones, the Internet or television – its uniqueness reflects in the fact that it merges many technologies into one single medium (e.g. computer, head-mounted display, headphones, motion sensor, space detection cameras) making it adaptable to different contexts and uses (Tubul-Lavy and Bianchi, 2020). Specifically, VR has been used and experimented as a learning tool. In education, VR has been found to be beneficial for four main reasons: (1) it enhances the performance and trainees' focus; (2) it turns mistakes into opportunities to learn; (3) it allows a customisable experience; and (4) it extracts beneficial data (Tubul-Lavy and Bianchi, 2020, p. 8-9). The benefits are often intensified by the fact that VR includes a game-factor that has shown to enhance the learning process. (Tubul-Lavy and Bianchi, 2020, p. 8-9).

This article argues that VR is undoubtedly beneficial for educational purposes and will demonstrate this by analysing the case of training that targets adult professionals in the field of security. In fact, Law Enforcement Agencies (LEAs) often appear to lack sufficient experience to carry out their tasks properly due to the structural criticalities of their job, the high-risk scenarios they often encounter in their daily job, and their job schedule – which do not allow them to spend a significant number of hours in training. In order to support this statement, this paper first analyses the advantages of using VR for training purposes in general terms and compares traditional learning methods to VR-based methods. Secondly, the authors describe the training experience of Rex Te.ch in cooperation with Agenfor International within the EU-funded project J-SAFE (Judicial Strategy Against all Forms of Violent Extremism in Prison, Grant No. 763714), which used a recently developed VR prototype to train LEAs, including intelligence officers, on the prevention of radicalisation in prison and situation awareness. Finally, the importance of using innovative technologies combined with VR, in order to support improving intelligence analysis and training analysis methods is outlined.

In the interest of academic accuracy, before continuing, it is worth clarifying the terminology used in this paper. Virtual Reality (or VR) refers to an environment that isolates the users from the real world, influencing their emotions through tools such as graphics, motions, and sounds, among others. As Martín-Gutiérrez et al. define it, it is a "whole simulated reality, which is built with computer systems by using digital formats. Building and visualising this alternative reality requires hardware and software powerful enough to create a realistic immersive experience" (Martín-Gutiérrez et al., 2017).

Serious gaming relates to games and video games that are applied with the aim of achieving a given strategic objective (Zyada, 2005). Serious gaming identifies new categories of both information gathering and knowledge acquisition, combining games with serious educational purposes. The innovation of the serious gaming concept is that games are used not only for entertainment, but rather for education and teaching purposes. Another important term is machine learning, which refers to a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention. An advanced machine deep learning keeps learning independently based on previous results and stores the data for later use, like a human brain - this is the reason why we also call machine learning a neural network (SAS, 2020). Finally, the Blended VR Solution refers to a new method of delivering training, in which innovative Virtual Reality solutions are adopted and combined with online synchronic and a-synchronic lessons, so that the learning-by-doing approach can be exploited in a wider frame of the learning process, adapting to different needs and sectors (Tubul-Lavy & Bianchi, 2020).

The paper adopts both a qualitative and quantitative approach that illustrates the value of using VR as a training method. Authors have relied on a variety of sources to research this topic, predominately including primary academic papers as well as newspapers. In conjunction to this, part of the article includes the authors' first-hand experience in developing a VR training tool and relies on the training assessment data developed by Agenfor International in order to show the possible benefits of VR in the security field.

Virtual Reality Advantages and Disadvantages

When it comes to Virtual Reality as a new medium, it can be considered a new world that can be interfaced with other technologies in order to get added value. The hidden possibilities in Virtual Reality and the features that are added to the technology every year herald the users the unlimited potential of its application. With the advancement of Virtual Reality technology, especially in the last decade, we have witnessed significant improvements, such as device size reduction, resolution improvement, home computer interfaces, wireless content broadcasting, mainstream accessibility, accessory interfaces such as ARDUINO (more info can be found in (Barrett, 2012)) and audio accessories like Woojer - which offers a sensation solution to feel the music based on forced feedback in low frequencies. Recently, significant upgrades have also been observed, such as eye-tracking, hand tracking, adding a sense of smell and collecting a range of biological data, such as EEG (electroencephalogram), pulse, blood pressure and much more.

All of these can be bundled into one device that can be used in order to implement advanced Artificial Intelligence (AI) systems. The combination of VR and AI can even break the boundaries of the imagination and create intelligent environments (Luck et al., 2000) that will evolve over the years. Machine learning, as part of the AI process, can create learning environments that evolve on their own - for instance, where a virtual environment changes depending on the specific person using the Head Mounted Display (HMD). A similar form of machine learning is used in the field of internet advertising, in which information about users is collected, processed, and, as a product of this, a relevant advertisement is displayed for that user.

Moreover, as briefly outlined above, VR is beneficial for training and education purposes, especially when used combined with the serious gaming component. Serious gaming allows the users to complete tasks and achieve results within the virtual environment, by competing with each other and by putting theory into practise in a very quick and dynamic way. Indeed, research and experiments have shown that the learning-by-doing approach provided by VR, as well as the high level of engagement of the trainee, are to be considered essential in the learning process, and they allow a higher level of performance, if compared to more traditional ways of teaching (Lesgold, 2001).

Four main characteristics of the benefits of VR and serious gaming should be highlighted in greater detail. Firstly, VR enhances the performance and focus of trainees. In Oculus (2019), Connect Isabel Tewes presented an experiment, involving two participants, asking them to perform the exact same task (performing the same medical surgery). The first participant was trained to perform the task with traditional manual guides and use of VR simulation, while the second one was instructed with traditional manual guides only. The virtually guided participant took 50% less time to perform the task and, crucially, did not require the assistance of a professional, while the traditionally trained participant frequently required assistance, and performed the task with lower results than the first participant. In the same presentation, Tewes (Oculus, 2019) demonstrates how VR can enhance learning and collaboration, explaining how performing a collaborative activity within virtual reality centralises most activity in the shared space without distractions. Tewes described car designers who were able to complete an assigned task in 20 hours of activity, which would otherwise usually take many months.

Secondly, VR turns mistakes into opportunities. Making mistakes can be a fear of any trainee but VR allows each trainee to attempt tasks and fail and, by doing so, to explore different ways of solving a problem without having to overcome the consequences as in the physical world. In the virtual world, it is possible to make mistakes that otherwise may cost injury, damage, and even death in the real world (Wang et al., 2018). This way of learning offers relief for the trainees and strengthens their creative side. At the same time, the use of VR is a strength for the trainees as they feel committed to reality, and as such, they make decisions in real-time, which makes them experience the situation as if it were real (Kahn et-al., 2018).

Thirdly, VR allows a customisable experience. As emphasised by Masie (2017), VR has the ability to personalise the learning experience -

as the trainee's control and change the environment from their own perspective. This allows the trainees to choose the speed with which they acquire the knowledge and adapts the course to their own preferences and needs. It also offers methods of handling and adjusting content according to the feedback provided by the users and thus the content can change automatically and repeatedly. It is possible to determine a range in which the content changes according to the operator's decision and thus also allows the situation in the learning process to be made more difficult or easier (Donga et al., 2020).

Finally, one of the greatest advantages of VR is that it allows operators to produce quantitative analysis and statistical data beyond qualitative analysis. Tools such as eye-tracking, biofeedback accessories for measuring sweating, blood pressure, and heart rate, and even Electroencephalography (EEG) devices provide data that can be extracted from the process and create feedback to improve the products. Eye-tracking systems make it possible to objectively examine game times and sources of fear in VR (Reichenberger, 2020).

The gaming factor is also worth underlining. Indusgeeks (2019), a specialist in game-based training, explains that gamification is a key training tool and that, from a trainer perspective, VR training saves a significant amount of money and resources, while also streamlining the organisation. VR training brings real value as an educational tool and offers a comprehensive solution for the entire training chain. In the learning process, the organisation has lower costs both in terms of infrastructure and in the cost of training time, as well as requiring fewer staff members to implement and support it. The trainers are free to distance themselves and assess the actual training process since the process is run automatically in VR and thus the trainees can lead themselves with the help of guidance from within the virtual world. The quality and efficiency of the process improves the trainee's level of enjoyment and shortens the learning time, enabling more knowledge to be transferred in a shorter time. Crucially, these benefits raise users' satisfaction with the whole process and offer a more accurate and often faster service.

In conclusion, through their technical capabilities, VR and serious gaming reinforce and enhance the purposes of the training and, in many respects, grant users certain benefits which would not be possible using more traditional ways of teaching and learning. Furthermore, using the data we can gather through the Machine Learning process, we can even control the level of immersion of the participants and influence their performance while monitoring objective metrics and changing content in order to influence these metrics. It can also allow players certain abilities in the experience if they succeed to control their physiological metrics. These are interactions that cannot be controlled in most of the existing media, placing Virtual Reality as a unique medium with the highest monitoring and control capabilities (Houzangbe et al., 2020).

Thus far, the authors have outlined the benefits and the potential of VR, but as a new technology, it has to overcome several obstacles and risks. First, testing a new technology that is unfamiliar to the users can create deterrence and a reluctance to face a new challenge. Most often, older generations tend to use technology that is familiar and convenient for them, as opposed to new technologies, which younger generations tend to be more open to. This may be an obstacle to implementing Virtual Reality in older organisations in which trainees are of a higher average age.

In addition, compared to the training performed so far in the physical world, developers must overcome the challenge of creating realistic environments that behave in the same way as reality in order to attract users to use Virtual Reality. Furthermore, the timeframe that can be spent in an immersive experience is limited and breaks are sometimes necessary in order to allow the user to re-adjust between activities. A large amount of *stimuli* on the human brain, the considerable use of screens, and sometimes even discomfort in wearing a helmet can affect the experience.

Finally, unlike in the real world, the likelihood of technical glitches is high during the practice of a virtual environmental scenario due to the technical complexity that accompanies the desire to give the user the most immersive experience. For these kinds of experiences, the developers may use a number of technologies, including the Virtual Reality system or cloud systems, as well as interfaces for Haptics accessories such as sensors or distance sensors - as used by the developer of Agenfor International's VR training prototype, examined in the following section of this article.

Case study: Rex Te.ch and Agenfor International's VR training prototype concerning prison radicalisation and scenario awareness

Within the framework of the EU-funded project J-SAFE (Judicial Strategy Against all Forms of Violent Extremism in Prison, Grant No. 763714), a VR training prototype was developed and tested to support LEAs into two areas of the prison administration that were found to be crucial for the staff: countering processes of radicalisation within prison – including conducting digital forensics extractions and analysis – and scenario awareness for training activities.

Implementation of the Case Study

The first topic, training on radicalisation, was conducted due to the fact that prisons seem to be among several potential hubs for indoctrination and proselytism (Basra and Neumann, 2020). In fact, in the prison environment, crimes and violence are normally more usual than in the outside society and personal grievances result from rigid contextual limitations. As a consequence, in prisons it is easier for extremist individuals to exploit radicalising agents in order to recruit and indoctrinate more vulnerable subjects.

Together with threats existing within prisons, there are also risks coming from outside the walls of the prisons. In fact, it is very common for external objects, such as mobile devices or USBs, to be smuggled into prisons by external visitors or even by drones (Il Messaggero, 2020), allowing the inmates to get access to further contraband and contacts. This does not only enhance the process of radicalisation, but also allows the potential continuation of inmates' illegal activities outside the prison facilities. This phenomenon is spreading worldwide, as mobile and digital tools are becoming essential in pursuing illegal activities and increased access to small and silent drones is making smuggling operations even easier and less risky. These new technological changes require very careful attention and readiness on the part of the penitentiary staff, who are asked to face new threats, look at new e-evidence and collect new data.

Based on the reality outlined above and acknowledging the importance of the prison system in the realm of security and prevention for countering radicalisation, it is extremely important that the prison staff and the penitentiary administration be put in the position to understand this phenomenon and, consequently, react to and prevent potential violent acts inside and outside the prison walls, ensuring a safer and more secure society.

In recent decades, in order to ensure a high level of readiness by the prison administration to counter such delicate and continuously changing phenomena, several training courses for prison staff have been developed, aiming to raise awareness and to help detect potential indicators of crime and evidence as fundamental components of the preventive measures.

In the case of the J-SAFE training, the VR component aimed to supplement the more traditional way of teaching and learning, offering an enhanced experience which improves the overall objective of the course and lets the participant experience an immersive learning by doing approach. The Virtual Reality modules were built upon a highly realistic reproduction of real environments, where LEAs and prison staff can enter into the simulated scenario and analyse the behavioural changes of a fictional character by monitoring, analysing and performing several tasks and activities. The use-case scenario used within the training of the J-SAFE project has been built upon 10 different real cases of radicalisation in prison and upon the knowledge acquired through research activities within the framework of several EU-funded projects. The training approached a sensitive and dynamic topic, and therefore, it applied a direct and active involvement of the trainee, by fostering an understanding of behavioural and violent dynamics and by analysing the processes of human behavioural changes, based on the well-known psychological exploration of the staircase to terrorism from the criminologist Fathali M. Moghaddam (2005).

In addition to the theoretical course on processes of radicalisation in prison, the penitentiary staff were equipped with basic knowledge on the importance of digital and mobile forensics, especially when dealing with crimes such as international terrorism and other serious crimes. In this regard, the Virtual Reality solutions simulate the environment for conducting a prison search, allowing the trainee to enter into a recreated virtual cell, looking for a hidden mobile device. As soon as the trainees find the illegal device, they are asked to perform a series of actions to maintain the integrity of the data on that device, as the first and most important part of the digital forensic procedure. To gain a deeper understanding of the forensic procedures for mobile and digital extraction, the Handbook for Prison Police and Security (Bianchi, 2021) has been drafted within the above-mentioned project J-SAFE.

The training courses were developed using a highly interactive virtual platform, called a Multiplayer Platform (MP), which allows users to interact, communicate, watch videos and presentations, grasp and look at virtual objects, perform tasks and compete against each other, while being in the same virtual room, even if physically in different geographic locations. This particular characteristic of the MP Platform showed itself to be extremely helpful in the time of COVID-19, helping participants to overcome restrictions to travel and participation in international training activities, or when social distancing is restrictive, and therefore the access to the prison sector is limited.

As part of the training process, a dedicated team was established, consisting of content developers, integrators, representatives from LEAs and training developers. The development of the course was carried out on the basis of Virtual Reality technology and made use of the appropriate equipment supported by a computer for visual processing. The training system was a starting point for saving resources in the training process, improving the system mobility and performing training anywhere outside the prison walls, offering the ability to perform training in several different geographical places without spending too many human resources (as the training was performed mainly in Virtual Reality) and, above all, improving the trainees' learning ability with a learning-by-doing approach.

In order to create a more realistic encounter within the experience, each participant has an avatar representation based on real facial features of the participant. A communication channel is opened through the Virtual Reality device so that participants can communicate and talk to each other. During the activity, the participants were able to interact with each other by moving and passing objects in the virtual world and discuss the tasks they were required to perform in the virtual environment. To enhance this further, serious gaming was used to demonstrate and employ investigative and forensic tools in the learning environment and promote competitive learning among the participants. The system was built with advanced cloud technology that fully complies with the data privacy regulations of the GDPR. The developed platform is an important tool which helped us in dealing with the current pandemic situation and allowed us to continue training activities despite it. More crucially, it allowed us to reap all the benefits of quality experiential learning and further exploit the machine learning and artificial intelligence analysis, which will allow further boundaries to be broken and improve the user experience.

Methodology applied and results

In order to evaluate the VR training prototype, a very structured methodology has been followed. While the training itself covered a broader number of European countries, only the case of Italy is here analysed in detail in order to give a quantitative assessment of the prototype developed.

In terms of demographics, 36 Italians participated, mainly males between 45-55 years old with more than 20 years of experience in their job. For most of them it was the first time they experienced VR in their life. All Italian professionals were prison staff, both from the prison police, prison intelligence and administrative staff.

In terms of evaluation, 21 professionals over 36 completed the evaluation questionnaire. Despite having no or little experience with VR, 76.19% of the participants found VR more beneficial than traditional training and positively evaluated the increase in interaction, focus, engagement and entertainment, as well as the variety of scenarios and the involvement in real-life environments often difficult to test in normal training (i.e. training in prison cells).

In terms of usability of the technology, 60% of the participants found the technology easy to use. Nevertheless, all the participants agreed that the content and course structure were easy to follow and all stated that the content will help them professionally.

While the case analysed is small, results are very positive and so far the VR technology developed can be considered successful and should be taken as a first step toward innovative and effective trainings in the field of security.

VR in the security sector: Situation Awareness Measurement

So far, the authors have discussed solutions for LEAs, targeted towards penitentiary staff in order to assess and monitor radicalisation processes that lead to violent extremism, using VR solutions. In this section, the use of such technologies for measuring scenario awareness through VR and Machine Learning will be outlined and how innovative technologies can be of support in improving intelligence analysis and training.

The term situation awareness is described by Endsley as a state of knowledge resulting from "the processing of elements in the environment within a volume of time and space (Level 1), the comprehension of their meaning (Level 2), and the projection of their status in the near future (Level 3)" (1995). In order to achieve a high level of situational awareness, it is essential that the operators gain enough experience to properly react to different emergency situations, and therefore they must combine high focused training with operational experience.

The VR has the potential to combine these two essential elements into one single action: in fact, by training operators through VR, they simultaneously receive the necessary level of training on the one hand, but at the same time, as an immersive and highly engaging tool, it also allows the recreation of different scenarios and implementation of acquired skills in dynamic and emergency situations.

VR is majorly effective when used as an alternative for situations that may be considered dangerous or critical, or even impossible in real life (Strickland, 2010). If we think about fire emergency training done in a traditional way, compared to that done using VR, we suddenly understand the huge impact this innovative technology may have. In fact, traditional training does not consider that people react very differently if under stress or facing dangerous and unstable situations. VR training, on the other side, lets the user train in a real-situation environment, where trainees are able to sense fear, fire, and disorder, and therefore, they react as they would react in a real emergency situation (Macedonia, 2002) while avoiding the complications, the costs, and the danger linked to a real simulation.

The virtual simulation allows the trainer to understand what to avoid and how to better address the risks related to the specific crisis while also allowing the trainees to focus on and analyse their reaction and the dos and don'ts, in order to be more prepared in case of real emergency. Similarly, it is possible to re-create riots in virtual environments, which can be used by LEAs to better address their reactions in conflict situations of social unrest. Again, a virtual simulation of a riot lets the agent sense the dangers around him/her and therefore, to train on how to immediately and correctly respond to it. Furthermore, these kinds of training increased the user involvement, thanks to the aid of tools such as motion detectors, virtual reality, controllers, and interactive multiplayer platforms (Baur et al., 2018).

Last, but not least, it is important to mention the machine learning component and the analysis of data. As briefly stated before, being trained in a Virtual Reality scenario allows the trainer and trainees to gather several data in order to better focus the analysis afterwards and therefore, to better implement training activities and situational awareness. The tools mentioned in the previous paragraphs of this paper – such as eye-tracking, biofeedback accessories for measuring sweating, blood pressure, and heart rate, and even EEG (Electroencephalography) devices – provide data that can be extracted from the process and can be used for understanding criticalities and risks, but also strengths and weaknesses of the trainees.

This characteristic should be considered deeply valuable, especially when training Intel agencies and measuring situational awareness. It should be additionally considered that, sometimes, training in the field is not possible due to the high risks associated with them. The recreation of the scenario through a virtual simulation supports LEAs in familiarising themselves with hostile environments, without putting themselves in danger. The use of VR in the security sector should be seen as highly beneficial, but it is still in an initial phase and empirical research must be further developed in order to see the results on a significant scale. The security world is moving in this direction and it is upgrading and adapting its technologies in order to be competitive and ready to confront the new challenges in security today and in the future.

Conclusions

Based on the analysis and examples provided in this paper, it can be stated that new technological solutions, such as Virtual Reality, combined with machine learning and serious gaming, can and should be used to train practitioners and professionals in the field of security (especially targeting Law Enforcement Agencies and Intelligence Agencies).

Looking to the future, the use of these technologies for training purposes, will become an essential component of the system for the development of information gathering and analysis through machine learning. Systems of this type will be able to give us a high level of prediction adding value to the training process and assess and measure situational awareness in a proper way, and even adjust certain content according to the analysis obtained. Based on the measured parameters it is possible to create corresponding situations in Virtual Reality – for example, radical prisoner encounters with positive religious leaders, enhancing positive interactions, and much more – aiming to support not only the training and learning process, but also to build a safer and more secure society. The authors believe that already existing systems with proven knowledge and experience from tangent fields will form a mature ground in the implementation of such systems. Beyond that, in this time of COVID-19, when human contact is reduced to the minimum, VR technologies are of added value in keeping the training and the trainee active and engaged, while also allowing people to meet and interact virtually, avoiding the potential spread of virus that we may encounter in the physical world.

Especially for LEAs and Intelligence Agencies, the application of virtual reality in training is of central importance in order to contribute to security, counter-radicalisation and situational awareness strategy activities. An important and additional value arises from the ability to host joint training between forces in different countries, fostering knowledge sharing and avoiding unnecessary travel and expenses.

Furthermore, the authors believe that, with each passing day, the world is exposed to new technological capabilities that will require us to learn and effectively adopt them and, of course, apply them to existing systems in the most strategic way possible.

References:

1. Alcañiz Raya, M., Chicchi Giglioli, I. A., Marín-Morales, J., Higuera-Trujillo, J. L., Olmos, E., Minissi, M. E., ... & Abad, L. (2020). Application of Supervised Machine Learning for Behavioural Biomarkers of Autism Spectrum Disorder Based on Electrodermal Activity and Virtual Reality. Frontiers in Human Neuroscience, 14, 90.

2. American Psychiatric Association Division of Research. (2013). Highlights of Changes from DSM-IV to DSM-5: Somatic Symptom and Related Disorders. Focus, 11(4), 525-527.

3. Barrett, S. F. (2012). Arduino Microcontroller: Processing for Everyone!. Synthesis Lectures on Digital Circuits and Systems, 7(2), 1-371.

4. Basra, R and Neumann, P. (2020). Prison and Terrorism: Exremist Offender Management in 10 European Countries, ICSR. Retrieved from: https://icsr.info/wp-content/uploads/2020/07/ICSR-Report-Prisons-and-Terrorism-Extremist-Offender-Management-in-10-European-Countries_V2.pdf

5. Benny Goedbloed. (2020, July 17). Robots, scanners and thermal cameras: technologies in prisons and the coronavirus pandemic. Retrieved from https://www.penalreform.org/blog/robots-scanners-and-thermal-cameras-technologies-in-prisons/

6. Better Life VR (2020). Retrieved from https://vr2go.co.il/better-life-vr/

7. Bianchi, S. (2018, February). Radicalisation: No Prevention without Juridicalisation, Agenfor International Foundation. Retrieved from: https://www.agenformedia.com/publication/radicalisation-no-prevention-without-juridicalisation/.

8. Bianchi, S. et al. (2021, January 13). Handbook for Prison Police and Security, J-SAFE Project, Judicial Strategy Against all Forms of Violent

Extremism in Prison JUST-AG-2016-03, Retrieved from: https://jsafeproject.eu/handbook-prison-police-security-2/

9. Boucsein, W. (2012). Electrodermal activity. Springer Science & Business Media.

10. Checa, D., & Bustillo, A. (2020). Advantages and limits of virtual reality in learning processes: Briviesca in the fifteenth century. Virtual reality, 24(1), 151-161.

11. Dimsum daily. (2020 March 24).Body temperature screening robots to be used in prison by the Correctional Services Department. Retrieved from: https://www.dimsumdaily.hk/body-temperature-screening-robots-to-be-used-in-prison-by-the-correctional-services-department/.

12. Edge, C., Hayward, A., Whitfield, A., & Hard, J. (2020). COVID-19: digital equivalence of health care in English prisons. The Lancet Digital Health, 2(9), e450-e452.

13. Ellis, W. E., Dumas, T. M., & Forbes, L. M. (2020). Physically isolated but socially connected: Psychological adjustment and stress among adolescents during the initial COVID-19 crisis. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, *52*(3), 177.

14. Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human factors*, *37*(1), 32-64.

15. Farley, H. S. (2018). Using 3D worlds in prison: Driving, learning and escape. Journal for Virtual Worlds Research, 11(1).

16. Feki Mohamed Ali et al. (2013, February). The Internet of Things: The Next Technological Revolution. *IEEE Computer Society.* Retrieved from: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6457383.

17. Fish, D. (2020, April). Il settore tecnologico in tempi di pandemia e oltre, Janus Henderson Investors, Retrieved from: https://www.janushenderson.com/it-it/advisor/article/examining-the-tech-sector-through-the-pandemic-and-beyond-emea/.

18. Georgiou, M. The coronavirus pandemic and prison mental health. Posted on June 9, 2020, Retrieved from: https://blogs.surrey.ac.uk/sociology/2020/06/09/the-coronavirus-pandemic-and-prison-mental-health/

19. Global Trend Report (2020), Penal Reform International, Thailand Institute of Justice. Retrieved from: https://cdn.penalreform.org/wp-content/uploads/2020/05/Global-Prison-Trends-2020-Penal-Reform-International-Second-Edition.pdf

20. Gunaratna, R. (2011). Terrorist rehabilitation: a global imperative. Journal of Policing, Intelligence and Counter Terrorism, 6(1), 65-82.

21. Martín-Gutiérrez, J. et al. (2017). Virtual technologies trends in education. *EURASIA Journal of Mathematics*, Science and Technology Education, 13(2), 469-486.

22. Il Messaggero (2020, April 28). Drone con sei cellulari "atterra" nel carcere di Secondigliano: intercettato da una sentinella, Il Messaggero. Retrieved from: https://www.ilmessaggero.it/italia/drone_carcere_secondigliano_cellulari-5197436.html

23. Kiryakova, G., Angelova, N., & Yordanova, L. (2014). Gamification in education. Proceedings of 9th International Balkan Education and Science Conference.

24. Lesgold, A.M. (2001). The Nature and Methods of Learning by Doing. University of Pittsburgh, 56(11), 964-973.

25. Luck, M., & Aylett, R. (2000). Applying artificial intelligence to virtual reality: Intelligent virtual environments. *Applied artificial intelligence*, *14*(1), 3-32.

26. Marone, F. and Olimpio, M. (2019, March 4). Jihadist Radicalisation in Italian Prisons: A Primer, ISPI. Retrieved from: https://www.ispionline.it/it/pubblicazione/jihadist-radicalization-italian-prisons-primer-22401

27. Milellal, L. (2020, October 6). Nel 2020 scoperti 1.761 cellulari in carcere. E Bonafede inventa un reato che non c'era, La Repubblica. Retrieved from: https://www.repubblica.it/cronaca/2020/10/06/news/nel_2020_scoperti_1_761_cellulari_in_carcere_e_bonafede_inventa_un_reato_che_non_c_e_-269688658/

28. Miller, M. R., Herrera, F., Jun, H., Landay, J. A., & Bailenson, J. N. (2020). Personal identifiability of user tracking data during observation of 360-degree VR video. Scientific Reports, 10(1), 1-10.

29. Moreira, J. A., Reis-Monteiro, A., & Machado, A. (2017). Higher education distance learning and e-learning in prisons in Portugal. Comunicar. Media Education Research Journal, 25(1).

30. M. Zyada, Michael. (2005, September). From visual simulation to virtual reality to games. IEEE Computer, vol. 38, no 9. PP. 25-32.

31. Pfeiffer, J., Pfeiffer, T., Meißner, M., & Weiß, E. (2020). Eye-tracking-based classification of information search behaviour using machine learning: evidence from experiments in physical shops and virtual reality shopping environments. *Information Systems Research*, *31*(3), 675-691.

32. SAS (2020). SAS Insights, Machine Learning: what it is and why it matters. Analytics Insights. Retrieved from: https://www.sas.com/en_us/insights/analytics/machine-learning.html#machine-learning-workings

33. Sukabdi, Z. (2015). Terrorism in Indonesia: A review on rehabilitation and deradicalization. *Contemporary Voices: St Andrews Journal of International Relations*, *6*(2).

34. Telecompaper. (2020).TIM donates 1,600 mobile phones and SIM cards to Italian prisons. Retrieved from: https://www.telecompaper.com/news/tim-donates-1600-mobile-phones-and-sim-cards-to-italian-prisons--1331449

35. Tett, L., Anderson, K., McNeill, F., Overy, K., & Sparks, R. (2012). Learning, rehabilitation and the arts in prisons: a Scottish case study. *Studies in the Education of Adults*, *44*(2), 171-185.

36. Sukabdi, Z. (2015). Terrorism in Indonesia: A review on rehabilitation and deradicalization. Contemporary Voices: St Andrews Journal of International Relations, 6(2).

37. Ticknor, B., & Tillinghast, S. (2011). Virtual reality and the criminal justice system: new possibilities for research, training, and rehabilitation. *Journal For Virtual Worlds Research*, *4*(2).

38. Tripodi, S. J. (2014). Emphasis on rehabilitation: From inmates to employees.

39. Lavy Zvi Tubul, Bianchi S. (2020). Adopting Virtual Reality: Can we all benefit from superpowers?. *Agenformedia.com.* Retrieved from: https://www.agenformedia.com/publication/adopting-virtual-reality-can-we-all-benefit-from-superpowers/.

40. Wahidy, R. (2020).Using Virtual Reality for Inmates Rehabilitation, Justice Trend Magazine. Retrieved from: https://justice-trends.press/using-virtual-reality-for-inmates-rehabilitation/

41. Winkler-Schwartz, A., Bissonnette, V., Mirchi, N., Ponnudurai, N., Yilmaz, R., Ledwos, N., ... & Del Maestro, R. F. (2019). Artificial intelligence in medical education: best practices using machine learning to assess surgical expertise in virtual reality simulation. Journal of surgical education, 76(6), 1681-1690.