SIMULATION TECHNOLOGY IN THE TRAINING APPLICATION OF CADETS

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This paper was developed as part of a long-term strategy for the organization's development Land operations.

Abstract: This manuscript presents the results obtained in a study of the importance of a system based on live simulation resources in training Defence University students in combat drills. This training is essential for understanding how to conduct combat operations and how the commander should manage the activity. In confronting the considerable sums spent on the acquisition of modern simulation systems, a research question was formulated to ascertain the impact of these resources on the educational process. The results of the research will be used as an important argument for the level of application and possibly further acquisition of systems. A research sample of almost 200 students was used for the research. The results were statistically processed and conclusions were formulated and discussed. The main result of the article is the statistical difference found between the units using the means of live simulation and the lower results of the groups that did not have these means during training.

Keywords: Artifical Inteligence, Live-Simulations systems, Military Education, Small Unit Tactics,

1 Introduction

Most advanced militaries are gradually increasing their acquisitions in various simulation technologies. Recently, these have not been limited to relatively simple means designed for training drivers or pilots of military aircraft, but also in the field of the first aid (Hatala, et. al. 2005). Constructive simulation systems in the context of (Kyungeun, Gene and Rabelo 2020) and more broadly in (Taura et. al. 2012) designed for training of staffs (Hubáček, Vráb, 2017) and larger units have been successfully used in the Central European environment for the last few years (Šimic 2012). However, modern simulation systems are finally being purchased for ground troops by SAAB (SAAB 2022), which enables training not only for individuals but even for entire combat units. With a focus on the unit's actions in a specific terrain against a specific enemy. The previous variant of this simulator was the MILES (Multiple Integrated Laser Engagement Systems) system (introduced in the Army of the Czech republic in 2002), but it did not achieve the required level of effectiveness in supporting training evaluation (Choi and Changbeom, 2015). The hits captured and evaluated by the system were rather an exception, so if the gunner hit the weapon, the system reported an error. The low battery life was also a problem; the ergonomics of the system really only met basic user requirements. The device was unable to distinguish the effects of various weapons that are now fully simulated by the system, including, for example, artillery fire - area effect in a defined space, or the effects of minefields (Hodický, et. al. 2016) Moreover, the feedback learning and broad-spectrum geolocation-based action evaluation was completely unrealistic with the original system (Borthakur, Pranjal, 2013). The system could not process the data. More broadly described in (Buontempo et. al. 2006).

Although the application of the simulators still poses some ergonomic challenges for soldiers, especially when used for extended periods of time, this is completely offset by the excellent immediate feedback that the equipment provides. The data collection and battery life is sufficient for the implementation of intensive training even over several days. The number of operating personnel is minimal, as is the time for applying the system to training. Data collection directly from the field can be implemented quite well and without loss, even with the ability to capture activity in space and time over several square kilometres.

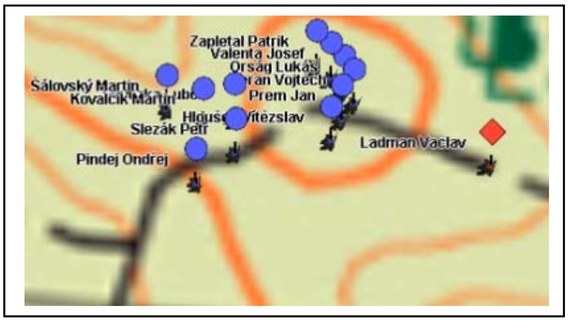
However, the value of using live simulation systems, and in particular the increase in training effectiveness, has so far been rather estimated, and this is especially so in the context of the necessary robust control sample that is required to monitor group development and the increase in synergies among members of small tactical teams (Griffith 1988), (Baker, Salas 1986). Untill now no one has published, even in closed military information databases, the exact data that could be used to argue for the use of these systems.

The article is focused on the publication of experimentally measured data in a direct relation to the evaluation of the effectiveness of simulator-supported training and its confrontation with training without the use of simulation technology. Its basic thesis is to answer the question: "Is there a statistically measurable relationship between the increase in training effectiveness in direct relation to the use of simulation technology?"

1.1 Technology of Live Simulation

Simulation technologies have been tied to the training of soldiers for quite some time. (Samčović, 2018), (Fletcher, 2009) Their benefits of being able to simulate lethal injuries in a non-lethal manner is a clear and unique benefit. (Smith, 2010). The live simulation system that is part of the experimental investigation belongs to the category of Tactical Engagement Simulation (TES) based on the principles of (Zeigler, Praehofer, and Kim 2000), which allows dismounted or mounted soldiers on vehicles to simulate the effects of direct and indirect fire. In addition to the Czech Army (Mazal et al. 2022), SAAB laser simulators are used by British, Swedish, German, Norwegian, Dutch, and United States forces. The system is conceptually designed as a standard tactical and marksmanship simulator for NATO units (Bekesiene and Prusevicius, 2020), for both armoured vehicles and infantry and anti-tank weapons. The system operates on the principle that an array of sensors reads laser signals initiated by the firing of training munitions (no projectile, they only have an acoustic and pressure pulse in the barrel) and evaluates the accuracy and effectiveness of individual hits. Based on the evaluation, the trainee soldier is then either taken out of combat as dead, marked as wounded including the zone where he was hit, or the vest signals the close impact of the missile by the characteristic sound of the incoming missile. Additionally, the system can assign wounds across the board or take soldiers out of combat in a specific space and time - which is determined by simulating a minefield (where soldiers enter) or an artillery barrage, which is usually indicated to soldiers by the explosions of simulated munitions. The recording of the entire combat action, each shot and missile direction, storing data on who fired, when, from where, where, and with what effectiveness, and the movement of the soliders from the point A to B, and at what speed the soldiers moved can be used for deeper analysis after the combat action has been executed. A recording of the entire event can be projected in real time, accelerated, and synthetic data from the simulator (see Picture 1) can be used to provide total ammunition consumption, total aggregate firing effectiveness, etc. The system can process over four hundred events per second and provides a reliable transfer rate against loss of secure data. In addition, the simulator has a degree of connectivity and can interact with the VBS-4 virtual simulator, etc. (SAAB, 2022).

Picture 1: Record from the SAAB System



Source: Author – The Screenshot from SAAB Simulator

2 Methodology

The research was conducted in March 2022. The control sample (Krč 2019) was a set of first-year students of the Faculty of Military Leadership divided into a total of 38 combat groups (Small Assault Unit/Teams), hereafter referred to as SAT, four of which were equipped with the SAAB system. The individual soldiers were divided into groups and the SAAB systems were assigned to the groups in a deliberately randomized fashion. Among the other things, this was to counteract any potential biases discussed in the paper (Brown et. al. 2009) The number of groups working with simulation technology support was determined by technical constraints in relation to weapons and ammunition quantities and the number of simulators purchased. However, no circumstance such as age, gender or other factors played a role in the creation of the SAT. The specific characteristics of the research sample were:

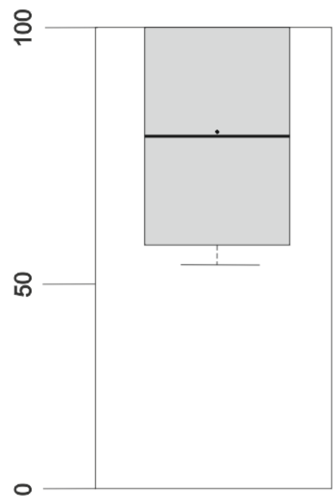
- Age of the subjects (between 19 and 29 years old);
- Education (first year university students with a high school degree),
- Professional experience (all of them were members of the armed forces with up to one year of service who had undergone the same previous military training);
- Medical condition (without any limitations enabling full training to be carried out);
- The same equipment and equipment;
- The same methodology, sequence and didactics of training;
- The same weapons and ammunition for the implementation of training and control measurements for all SATs.

The characteristics of the research sample were determined to eliminate as much as possible the various variables that would be relevant to the outcome and would interfere with the reliability and significance of the conclusions for the base sample.

2.1 Motivation of the Research sample

Research on students' motivation to train was developed using the findings of see (Woogul, Johnmarshall 2012). The research sample consisted of soldiers included in "Generation Z" without exception (Pelech, Holendova 2022). These soldiers require the use of somewhat different methods and means of training for effective teaching, (not least with regard to the impact of the COVID-19 anti-epidemiological measures that affected their training) - see (Cahoon et. al. 2017) for a broader context - than previous generations in the Czech Republic. These were typically shaped by structured teaching methods, particularly in the direct context of frontline teaching. The subject matter, practices and teaching methods in the 'Preparation in the Field' course where the research was conducted. It has been prepared for the research by the application of modern teaching methods, gamification (Rivera, Garden 2021) of training, design-thinking (Tuckwell 2017) applied in partial parts of the training cycle. The questionnaire survey presented to the students during the research showed that 79% rated the training as very interesting and no one in the research sample rated the training as uninteresting or boring and would give it less than 50% on the 100% scale assessing the stimulation to the results see Figure 1. This ensured that the soldiers had sufficient stimulus for personal motivation, which is absolutely necessary for the implementation and especially the formulation of conclusions.

Figure 1: Motivation of students in research

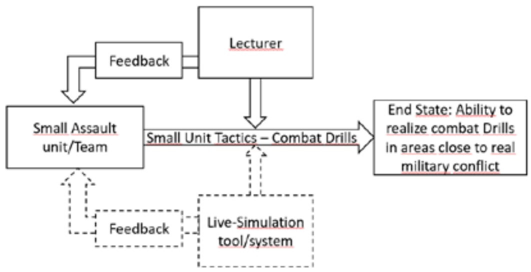


Source: Author

2.2 Realization of the Experiment

The overall training was carried out in the same premises, weather conditions, with identical provision of food, water, sleep and other influences on SAT. The training management and methodology was in charge of one particular person, and the implementation of the training was carried out by the instructors who were identically trained in the subject matter. The system of influence on students during the training is depicted in the following diagram:

Figure 2: Methodology of Education Effect to SAT



Source: Author based on his prior research

Before the training started, the soldiers went through a course (before they were divided into groups) that explained the theoretical aspects of the issue. Already in the previous, conducted research the authors of the article concluded that the training system and the capabilities of the simulator do not yet allow to exclude the instructor who teaches the soldiers the practical implementation of all aspects of the training. Thus, in the training phase, the simulator becomes just another feedback element for the students. However, with somewhat specific feedback that the instructor is unable to provide and is therefore unique. Taking the instructor out of the training cycle would only be possible if the simulator possesses a very advanced artificial intelligence and discrimination capability in the field, incorporating all the influences such as scrub, fog or otherwise reduced visibility, as well as a mode of command (Baker and Salas 1997) and communication in the unit that usually does not rely on verbal communication but on the displacements of the battle signals issued. This would present an extreme amount of data and deep analysis in context, which is currently impossible.

However, it is not possible to provide soldiers with overall feedback on whether they are engaging the enemy or how effective their fire is without the application of a simulator. The instructor see (Barron 2014) of the training tries to convey their experience and explain to them what they are doing right or wrong, but real feedback on the results of the firing does not exist.

Although one of the tools used in training is practice ammunition that forces soldiers to work with the sound, flash effect of firing, or recoil effect and the need to reload magazines, the assigned instructor cannot convey feedback on the effectiveness of firing.

3 Results

After the completion of the training, a control test was implemented for the entire research sample based on the assessment of the achieved abilities of all 38 groups by a group of experts. During this control test, the soldiers no longer used the simulation system. The simulation was therefore only available during the training itself, when the soldiers were acquiring and learning knowledge and skills important for conducting combat operations. During the control test, the soldiers did not have the opportunity to interact with the experts. They came to the individual control test sites randomly. Thus, the experts did not know whether this particular unit had been trained with the SAAB system or not. The results of the groups are shown in the following tables.

Table 1: Descriptive charaktristic for no SAAB support SAT

Type of Assessment	n	Mean	St. Dev.	Median	Min	Max	$Q_{0,25}$	$Q_{0,75}$	Skewness	Kurtosis
Weapon Handling	34	1,118	0,537	1	0	2	1	1	0,110	0,149
Reaction	34	1,382	0,779	1	0	3	1	2	0,008	-0,564
C2	34	1,324	0,878	1	0	3	1	2	-0,124	-1,004
Maneuver	34	1,794	0,808	2	0	3	1	2	0,034	-0,935
Aggressiveness	34	1,676	1,806	2	0	3	1	2	-0,058	-0,644
Reaction Speed	34	2,647	1,412	3	0	5	1	3	-0,072	-0,700
Drills	34	4,382	0,985	5	0	5	4	5	-2,634	8,838
Shooting Training	34	4,074	0,740	4	2,5	5	3,5	4,5	-0,463	-0,807
TOTAL	34	18,397	2,007	18,5	0	22	17,125	22	-0,299	-0,496

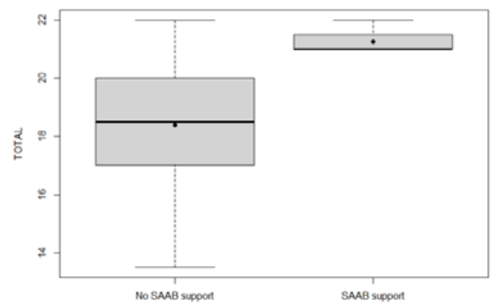
Table 2: Descriptive charakteristic for SAAB support SAT

Type of Assessment	n	Mean	St. Dev.	Median	Min	Max	$Q_{0,25}$	$Q_{0,75}$	Skewness	Kurtosis
Weapon Handling	4	1,000	0,817	1	0	2	0,75	1,25	0,000	-1,875
Reaction	4	1,500	1,291	1,5	0	3	0,75	2,25	0,000	-2,078
C2	4	1,750	0,500	2	1	2	1,75	2	-0,750	-1,688
Maneuver	4	1,750	0,500	2	1	2	1,72	2	-0,750	-1,688
Aggressiveness	4	1,750	0,957	1,5	1	3	1	2,25	0,320	-2,084
Reaction Speed	4	4,000	1,155	4	3	5	3	5	0,000	-2,438
Drills	4	5,000	0,000	5	5	5	5	5	---	---
Shooting Training	4	4,500	0,577	4,5	4	5	4	5	0,000	-2,438
TOTAL	4	21,250	0,500	21	21	22	21	21,25	0,750	-1,688

Students were successively tested in eight individual areas in which they were trained during the training. Each individual area was monitored and evaluated by one selected expert (from a different organisational unit of the Ministry of Defence) with real combat experience or experience comparable to combat experience from direct deployment in a foreign operation. In addition, each area evaluated was assigned an appropriate weight by the training author to reflect its importance to the overall required training output.

The overall result is displayed using a boxplot. This shows the maximum and minimum values, the upper and lower quartiles and the line in the middle of the boxplot represents the median. The point in the diagram then shows the arithmetic mean.

Figure 3: Total Results Shown in the Graph



Source: Author

The graph above shows the importance of the SAAB system and the significant increase in SAT capability that practiced with the support of this technology. Before comparing the groups, a normality test of the data was performed. Due to the small size of the data in the SAT group that practiced with the support of the simulation technology, the Shapiro-Wilk test was used. (Values are shown in the table.) The italics indicate p-value results less than the 0.05 significance level. These values indicate that, in most cases, the data cannot be considered a random sample from a normal distribution.

Table 3: Shapiro-Wilks Test

Type of Assessment	No support	With support
Weapon Handling	*0*	0,68300
Reaction	*0,00047*	0,97190
C2	*0,00048*	*0,00124*
Maneuver	*0,00034*	*0,00124*
Aggressiveness	*0,00065*	0,27250
Reaction Speed	*0,00012*	*0,02386*
Drills	*0*	X
Shooting Training	*0,00993*	*0,02386*
TOTAL	*0,73950*	*0,00124*

Table 4: Statistic Difference (TOTAL)

Statistic Difference	p-value	Difference
Weapon Handling	*0,74921*	*NO*
Reaction	*0,85860*	*NO*
C2	*0,33347*	*NO*
Maneuver	*0,97960*	*NO*
Aggressiveness	*0,97968*	*NO*
Reaction Speed	*0,07775*	*NO*
Drills	*0,10451*	*NO*
Shooting Training	*0,29566*	*NO*
TOTAL	*0,00486*	*YES*

Due to the fact that the data cannot be considered as a sample from a normal distribution, a non-parametric test - the two-sample Wilcoxon test - was used for further analysis. The results clearly showed no statistical difference for individual partial scores between the set using the SAAB technology and the set of groups that did not use this system. However, a statistical difference was demonstrated in the overall scores. Thus, a clear conclusion can be drawn that this technology has relevance in training, which can be argued by the statistically evaluated results. Thus, the simulation technology used is significant in the educational process of soldiers and demonstrably makes it more effective. Thus, its use during the activity of the units clearly contributes to the increase in the capabilities of the teams. Although it cannot be said that it uniformly increases all assessable aspects, overall there is a clear significance.

4 Discusion

The stated research question has been answered. In any case, the fact that the partial aspects evaluated did not show a statistical difference creates the question of how and to what extent each of the partial aspects is stimulated by the simulation technology. Thus, it opens the space for further and deeper research in this area of soldier education. Moreover, not all assessable aspects were included during the examination, but the individual group-sections do exhibit them. One example is the synergy in the unit, etc. Thus, in order to comprehensively express the effect of the simulator, it is necessary to conduct a series of sub-analyses and deeper analyses to identify all the links and the effect of the application of this technology in the training system. Nevertheless, as a pilot study, it is of great importance, especially in the question of further purchases of live simulation resources (at a total cost of more than 3 million EUR), the justification of its application in training plans and the definition of areas for further research.

4.1 Limitations fo the Research

The research was limited mainly in the number of research samples using simulation technologies. This limitation is mainly due to the material availability of the technological elements themselves and the impossibility of installation on different types of weapons currently introduced into the Czech Armed Forces. However, with time and further acquisitions, the importance of this aspect will prospectively decrease. In training, students use off-the-shelf types of weapons, which will be replaced by new models in the medium term. Another significant limitation is the fact that one research element is represented by a group of five soldiers. This is quite demanding with regard to the material, and the dependence on the material increases significantly with each additional sample. Almost 60,000 training rounds for different types of weapons were allocated for the implementation of this training. The entire training for the unit lasted more than 12 days, and the soldiers were in continuous training mode, which means that they were training 12 to 15 hours a day. Also in light of this fact, the findings represent a unique landmark in arguing for the further development and application of live simulation tools to training and their gradual integration into robust simulation systems.

4.2 Impact of Results – Findings

The authors see the importance of the results especially in their uniqueness. Research on the effectiveness of simulation technologies used in SAT has not been carried out to this extent and with subsequent statistical data processing not only in the Czech Republic, but also in the Central European region or even in the European region. The use of simulation technologies in many areas of human cognition and especially in the educational process is quite common. However, in the military and specifically in the activities of ground combat units, it is still a relatively innovative and even unique solution in smaller armies. The multitude of influencing factors rebuilt by multiple soldiers' abilities in the areas of battle management, information transfer and command skills, ability to conduct accurate fire, rapidly reload magazines, and provide sufficient cover and concealment in varying terrain conditions under varying visibility presents a very challenging process for providing feedback. Currently, it is not possible to use a simulator alone without significant instructor support, as the actions of a small infantry unit are dependent on a large group of variables and unfortunately are also heavily influenced by chance. Nevertheless, it has been clearly confirmed that the correct application of simulation technologies brings clear results and makes the educational process of the unit more effective. Thus, this research clearly argues for the use of simulation technology with concrete statistical results and, through the use of a large research sample and a large amount of material (especially ammunition), presents a clear argument for the use of simulation technology while shaping the next direction of research. And, more broadly, it corresponds with the results of (Eldad and Kalderon 2013). In particular, as one of the key factors influencing the effectiveness of small unit combat is capability in the area of leadership, which is also strongly supported by the results of the use of simulation technology. In this area, research more broadly corresponds to the theses of (Polmear 2022).

4.3 Ethical Statement

This research was carried out in accordance with the 2018 European Research Council guidelines. Permission to carry out the research project was obtained from the programme supervisor and the supervisor of the "Preparation in the Field" course in which it was carried out. Participants were provided with all relevant information about the research objectives, participant anonymity, data collection, data storage and further analysis. Participants had every right to withdraw from the study and signed an informed consent to participate in the research.

5 Conclusion and Future Research

In conclusion, it is necessary to state that the results obtained during the implementation of the research will generally become the starting point for follow-up research activities of the authors in the field of education of small military units. Uncovering the deeper links between individuals and determining the weights of each of them, along with understanding the most important desired characteristics of each of the warriors relevant to the conduct of combat and, in particular, to the effectiveness of the entire SAT, is very important for the further development of this field. It will bring the opportunity to focus on the most important aspects of training and developing those components of combat that are most important to the target state. The requirement for the application of effective simulation technology is the cornerstone of all this activity. Only through in-depth analysis and back-testing will it be possible in the future to implement another branch of simulation technology in the form of the application of advanced artificial intelligence, cf. (Landsberg et. al. 2012), which will allow the replacement of the so far necessary feedback element in the form of the training instructor. Without exact data on whether the enemy has destroyed the SAT, or the SAT has eliminated the threat in the form of the enemy, or effectively disengaged contact with the enemy, it has not been possible to realistically prepare units for combat operations at all to date. Training was based on experience and existing proven principles, applying established Tactics, Techniques, Procedures (Spilý and Hrnčiar 2013), (Spilý and Hrnčiar 2022). The possibility of evaluating enemy interventions was only in the realm of imagination. At the same time, the ambition of SAT training is not only to prepare effective combat groups, but to gradually supplement them with additional elements in the form of robotic systems with a formulated degree of application of artificial intelligence capable of further increasing the capabilities of the teams and their effect in engaging the enemy. This is either by simply reducing the SAT's weaknesses - in the area of command, or early recognition of the enemy, but also in the area of increasing its advantages - enabling a faster attack, greater coordination of command, or an increase in the firepower of the attack.

Literature:

1. Aebersold, M., 2016. The History of Simulation and Its Impact on the Future. AACN Advanced Critical Care 27, 56–61. https://doi.org/10.4037/aacnacc2016436
2. Baker, D.P., Salas, E., n.d. Analyzing Team Performance: In the Eye of the Beholder? [WWW Document]. ResearchGate. URL https://www.researchgate.net/publication/11806856_Analyzing_Team_Performance_In_the_Eye_of_the_Beholder (accessed 5.2.23).
3. Barron, L.G., Ogle, A.D., 2014. Individual Differences in Instructor Attitudes Underlying Maltreatment and Effective Mentoring in Basic Military Training. Military Psychology 26, 386–396. https://doi.org/10.1037/mil0000053
4. Bekesiene, S., Prūsevičius, G., 2020. Simulators Usage Assessment for Higher Military Readiness. Challenges to national defence in contemporary geopolitical situation 2020, 114–124. https://doi.org/10.47459/cndcgs.2020.15
5. Berkup, S., 2014. Working With Generations X And Y In Generation Z Period: Management Of Different Generations In Business Life. Mediterranean Journal of Social Sciences 5. https://doi.org/10.5901/mjss.2014.v5n19p218

6. Borthakur, P.P., Sarmah, P., 2013. A Review of Simulation Techniques as an Important Tool for Solving Complex Problems. Int. J. Sci. Eng. Res 4, 474–477.
7. Brown, U., Knouse, S., Stewart, J., Beale, R., 2009. The relationship between unit diversity and perceptions of organizational performance in the military. Journal of Applied Statistics 36, 111–120. https://doi.org/10.1080/0266476080244 3905
8. Buontempo, J.T., Potyrykus, H.G., Kaufman, A.I., 2006. A Symmetric Adaptive Model of Combat. The Journal of Mathematical Sociology 30, 113–136. https://doi.org/10.1080/0 0222500500333266
9. Burroughs, T., Ruth, S., 2022. Cohesion in the Army: A Primary Group Analysis. Military Review.
10. Cahoon, A., McGill, S., Simms, V., n.d. Understanding home education in the context of COVID-19 lockdown [WWW Document]. ResearchGate. URL https://www.researchgate.net/ publication/351816368_Understanding_home_education_in_the _context_of_COVID-19_lockdown (accessed 5.2.23).
11. Choi, S.H., Choi, C., Kim, T., 2015. Optical engineering simulator development for efficient design of MILES gear.
12. DSpace at KOASAS: Optical Engineering Simulator Development for Efficient Design of MILES Gear [WWW Document], n.d. URL https://dspace.kaist.ac.kr/handle/10203/2 15787 (accessed 5.2.23).
13. Fletcher, J.D., 2009. Education and Training Technology in the Military. Science (New York, N.Y.) 323, 72–5. https://do i.org/10.1126/science.1167778
14. Hadas, C., Noyfeld, M., n.d. Person-Environment Fit in Small Army Units [WWW Document]. URL https://journal s.sagepub.com/doi/10.1177/106907279700500102 (accessed 5.2.23).
15. Hatala, R., O Kassen, B., Nishikawa, J., Cole, G., Issenberg, B., n.d. Incorporating simulation technology in a canadian internal medicine specialty examination: a descriptive report - PubMed [WWW Document]. Acad Med. URL https://pubme d.ncbi.nlm.nih.gov/15917358/ (accessed 5.2.23).
16. Hill, D., 2002. Theory of Modelling and Simulation: Integrating Discrete Event and Continuous Complex Dynamic Systems: Second Edition by B. P. Zeigler, H. Praehofer, T. G. Kim, Academic Press, San Diego, CA, 2000. International Journal of Robust and Nonlinear Control - INT J ROBUST NONLINEAR CONTR 12, 91–92. https://doi.org/10.1002/r nc.610
17. Hodicky, J., Castrogiovanni, R., Presti, A.L., 2016. Modelling and simulation challenges in the urbanized area, in: 2016 17th International Conference on Mechatronics - Mechatronika (ME). Presented at the 2016 17th International Conference on Mechatronics - Mechatronika (ME), pp. 1–5.
18. Krč, M., 2019. Metodologie vědecké práce - Portaro - katalog knihovny. Petr Brázda, Vydavatelství, Brno.
19. Landsberg, C., Jr, R., Buskirk, W., Townsend, L., Steinhauser, N., Mercado, A., 2012. Review of Adaptive Training System Techniques. Military Psychology - MIL PSYCHOL 24, 96–113. https://doi.org/10.1080/08995605.2012 .672903
20. Lee, K., Lee, G., Rabelo, L., 2020. A Systematic Review of the Multi-Resolution Modeling (MRM) for Integration of Live, Virtual, and Constructive Systems. Information 11, 480. https://doi.org/10.3390/info11100480
21. Lee, W., Reeve, J., 2012. Teachers' estimates of their students' motivation and engagement: Being in synch with students. Educational Psychology 32. https://doi.org/10.1080/01 443410.2012.732385
22. Maturo, F., n.d. Mathematical-Statistical Models and Qualitative Theories for Economic and Social Sciences | Fabrizio Maturo - Academia.edu [WWW Document]. Academica.edu. URL https://www.academia.edu/64760588/ Mathematical_Statistical_Models_and_Qualitative_Theories_for _Economic_and_Social_Sciences (accessed 5.2.23).
23. Mazal, J., Procházka, J., Zezula, J., Procházka, D., n.d. Vojenské rozhledy - The use of modeling and simulation in the development process optimization of the Armed Forces of the Czech Republic [WWW Document]. URL https://www.voje nskerozhledy.cz/en/kategorie-clanku/vystavba-ozbrojenych-sil/modelovani-simulace-optimalizace-vystavba (accessed 5.2.23).
24. Polmear, M., Volpe, E., Simmons, D.R., Clegorne, N., Weisenfeld, D., 2022. Leveraging faculty knowledge, experience, and training for leadership education in engineering undergraduate curricula. European Journal of Engineering Education 47, 950–969. https://doi.org/10.1080/03043797.2022 .2043243
25. Rivera, E.S., Garden, C.L.P., 2021. Gamification for student engagement: a framework. Journal of Further and Higher Education 45. https://doi.org/10.1080/0309877x.2021.1875201
26. Rom, E., Kalderon, Y., 2013. The Predictive Role of Simulations in Assessing Military Performance. Military Psychology 25, 402–411. https://doi.org/10.1037/mil0000006
27. Saab, inc., n.d. Live training | Saab [WWW Document]. Start. URL https://www.saab.com/products/live-training (accessed 5.2.23).
28. Samčović, A., 2018. Serious games in military applications. Vojnotehnicki glasnik 66, 597–613. https://doi.org/10.5937/v ojtehg66-16367
29. Simic, G., 2012. Constructive Simulation as a Collaborative Learning Tool in Education and Training of Crisis Staff. Interdisciplinary Journal of Information, Knowledge, and Management 7, 221–236. https://doi.org/10.28945/1749
30. Smith, R., et al., n.d. The Long History of Gaming in Military Training [WWW Document]. URL https://journals.sag epub.com/doi/10.1177/1046878109334330 (accessed 5.2.23).
31. Spilý, P., Hrnčiar, M., 2022. Vojenská taktika 1 (Military Tactics No. 1). Akadémia ozbrojených síl gnerála Milana Rastislava Štefánika, Liptovský Mikuláš.
32. Spilý, P., Hrnčiar, M., 2013. Vojenská taktika (The Military Tactics). Akadémia ozbrojených síl gnerála Milana Rastislava Štefánika, Liptovský Mikuláš.
33. Taura, T., Yamamoto, E., Mohd Yusof, N., Goka, M., Mukai, F., Nagai, Y., Nakashima, H., 2012. Constructive simulation of creative concept generation process in design: A research method for difficult-to-observe design-thinking processes. Journal of Engineering Design - J ENGINEERING DESIGN 23, 297–321. https://doi.org/10.1080/09544828.2011. 637191
34. Tiauw, H.G., Buerki-Cohen, J., Soja, N., 2023. The effect of simulator motion on pilot training and evaluation [WWW Document]. research gate. URL https://www.researchga te.net/publication/269063397_The_effect_of_simulator_motion_ on_pilot_training_and_evaluation (accessed 5.2.23).
35. Tuckwell, D., 2017. Still) Educating design thinking, Communication Design. Communication Design.

Primary Paper Section: K

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