# Enhancing Military Exercise Team Performance with Diversified xAPI Instrumented eLearning

**MG Serhii Salkutsan** **Col Andrii Golovanov** **Col Andrii Shyhyda** **Lt Col Maksym Tyschenko**
**znunrnduu@nuou.org.ua** **andre_1975@ukr.net** **shuguda@ukr.net** **tyshchenko@nuou.org.ua**
**The National Defence University of Ukraine named after Ivan Cherniakhovskyi**
**Kyiv, Ukraine**

**Biljana Presnall**
**Jefferson Institute**
**Washington, DC**
**bpresnall@jeffersoninst.org**

## ABSTRACT

Learning analytics has become increasingly sophisticated, but field-tested, high-fidelity indicators of how eLearning content can specifically improve readiness remain lacking outside of controlled laboratory settings. eLearning content has been demonstrated as a functional supplement to traditional on-site exercise pre-training (Ljung, 2018). However, this early research showed only that eLearning could be operationally integrated into an exercise, and it did not offer validated measures of eLearning's efficacy as pre-training. The National Defence University of Ukraine named after Ivan Cherniakhovskyi (NDUU) sought to address this challenge by utilizing xAPI instrumented eLearning content in two computer-aided exercises in 2020 to measure the impact on mission rehearsal readiness. Data collected in the first exercise indicated an 8.4% performance deficit in the control group participants that experienced only traditional physical pre-training materials relative to their eLearning pretrained peers. In the second exercise, the control group showed a 20.45% performance deficit in team performance when matched to treatment groups that received a diversified package of both eLearning course content and a microlearning on-demand eBook.

## ABOUT THE AUTHORS

**MG Serhii Salkutsan, PhD,** has been Deputy Commandant for Academic Affairs at NDUU since 2013**.** He was promoted to major general in 2017. His main scientific research is in theory of military science and theory and practice of military education. He is the author of more than 80 scientific articles and papers.

**Col Andree Golovanov, PhD,** is Chief of the Operational Art Department and an Associate Professor at NDUU. His main scientific research is in theory of military art. He is the author of more than 60 scientific articles and papers.

**Col Andrii Shyhyda** is an Assistant Professor in the Operational Art Department at NDUU. His main scientific research is in theory of operational art. He is the author of more than 40 scientific articles and papers.

**LtCol Maksym Tyschenko, PhD,** is Chief of the Scientific Distance Learning Centre at NDUU. His research and educational activities are focused on Advanced Distributed Learning (ADL) integration in military training. He is the author of numerous publications on information technologies and ADL.

**Biljana Presnall** is Vice President of the Jefferson Institute, a research and education organization based in the US. She leads the digital team on a Department of Defense R&D project to mature the operational integration of ADL in multinational exercises (MADLx).

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## INTRODUCTION

With the rise in complexity of threats and international relations over recent years, multinational exercises have become a major contributor to improved military interoperability and readiness (NATO, 2021). These exercises bring together various actors, both military and non-military, in a controlled environment, but measuring the overall effectiveness of these events is a difficult task (Spirtas et al, 2008). And while many nations utilize Advanced Distributed Learning (ADL) technologies to prepare for such exercises, the event analysis is largely disconnected from the eLearning preparation. Thus, two major issues remain unclear: the degree to which eLearning content actually benefits the mission rehearsals, and the best practices of integrating ADL to make a meaningful difference on training achievement.

The eLearning content which supports military exercises traditionally comes in the form of eLearning courses that utilize Sharable Content Object Reference Model (SCORM) packages to monitor the performance of learners ("Sharable Content Object Reference Model," 2021). SCORM generates researchable data, but the scope of its analytical value is limited. To address this shortcoming, the Experience Application Programming Interface (xAPI) data standard was developed specifically for the learning environment, and xAPI provides the ability to look deeper into a learner's behavior ("Experience API," 2020). The xAPI standard has an extremely granular nature, enabling it to record practically every step of a learning process. In addition, xAPI's high interoperability extends its use beyond traditional eLearning courses to any type of online or offline electronic learning content delivery, contributing to the wide range of analytics known as learning analytics. Hence, xAPI is recognized as a key component in the overall modernization of learning (Walcutt & Schatz, 2019) that enables institutions and organizations to embrace new learning methods. The development of xAPI also advances the movement toward eLearning data standards adoption, which is a steppingstone for better analysis of the efficacy of complex learning and training environments such as multinational exercises.

The Scientific Distance Learning Centre of the NDUU, which is the central eLearning provider for the Ukraine Armed Forces, worked with the NDUU Operational Art Department to develop pre-training aimed at validating eLearning's efficacy in military exercise preparation. To implement the xAPI standard, the NDUU developed the learning analytics infrastructure which included combined elements of pre-training and training to compare the results for correlation between the two. Despite the unique challenges presented by the pandemic year of 2020, NDUU tested these approaches in two NATO readiness exercises.

## METHODOLOGY

This research was conducted using non-experimental control groups in a quasi-experimental design in the context of two exercises: NATO Standards, held from June 17 to 22, 2020; and Joint HQ, held from November 30 to December 18, 2020. Both exercises were executed on the premises of the NDUU with a total of 81 and 140 participants,

respectively. The aim of these exercises was to develop professional competencies in planning and conducting combat action and joint operations according to NATO standards.

The exercises were executed according to an approved scenario and planning procedures that complied with national regulatory frameworks. Participants worked in operations planning groups (combat actions) and performed their tasks in accordance with NATO procedures for operational planning and the exercise scenario. The competencies achieved at the exercises included:

- Ability to plan combat action and joint operations according to NATO standards.
- Knowledge of methodology of JHQ work during operational planning.
- Gaining practical skills of operational planning procedures undertaken by all branches of a management body on a particular level.

Both exercises offered a pre-training eLearning component which started a month ahead of the exercise. The pre-training included the theoretical foundations of operational planning procedures and the work of a joint headquarters, and it addressed the development of operational documents in accordance with NATO standard STANAG 2014.

The NDUU Operational Art Department, rather than the researchers, designated the members of the control and treatment groups. For the NATO Standards exercise, eleven officers were randomly assigned to the control group, and the remainder of the participants were divided into two treatment groups (Group 1 and Group 2). For the Joint HQ exercise, eleven officers were randomly assigned to the control group, and the remainder of the participants were divided into 9 treatment groups (Group 1 to Group 9). Both control groups were given the option to prepare theoretical basics for the exercises independently and without the eLearning pre-training. For all treatment groups, the eLearning component was provided as an integral part of the exercises via the Armed Forces of Ukraine (AFU) ADL Platform. This study analyses the impact of the pre-training on the participants in the treatment groups.

**eLEARNING COMPONENT**

NDUU made a significant effort to match the eLearning component of the pre-training with the training objectives of the exercises. Thus, the courses and materials offered were directly linked to the actual training needs:

- Operations Planning Process
- Joint Headquarter
- STANAG 2014

The online courses in both exercises were run on the Moodle Learning Management System (LMS). The University's electronic instruction traditionally is delivered in SCORM format; however, for these exercises we utilized native xAPI courses with the xAPI Launch Link plugin for Moodle LMS. This plugin enables tracking of learners' activities from a Moodle course and recording them in an external Learning Record Store (LRS). Thus, we were able to collect xAPI data at the designated instance of an LRS only from these courses, without interfering with the rest of LMS activity.

This resulted in a significant number of xAPI activity statements, all representing insights into participant learning behavior during pre-training. In total we collected **126,380** xAPI statements during the pre-training period, with peaks during the first two weeks and the week immediately prior to the exercise. (Figure 1)

We learned that the average time spent on the eLearning platform for the NATO Standards exercise was 3 hours and 46 minutes for 69 participants.

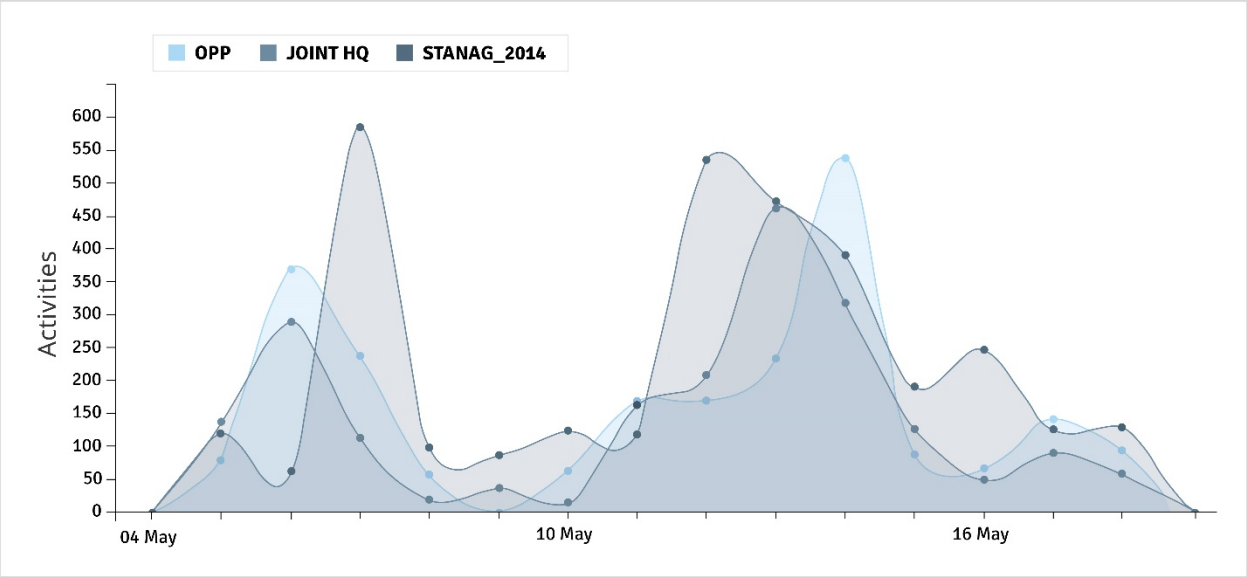


**Figure 1. NATO Standards exercise: eLearning activities stream**

In the Joint HQ exercise, the materials were made available to participants differently: full eLearning courses for Joint Headquarters and STANAG 2014 were offered in the same manner as an xAPI course via Moodle LMS, but the Operations Planning Process (OPP) content was offered as an xAPI enabled Personalized eBook for Learning (PeBL) as a microlearning element following the "just in time learning" concept (Clark, 2010). The control group was again given the option to prepare theoretical basics for the exercise independently.

The time spent on pre-training for the Joint HQ exercise was dramatically shorter than for NATO Standards, with the 125 participants who accessed the recommended eLearning path spending an average of 45.19 minutes in preparation. (Figure 2)

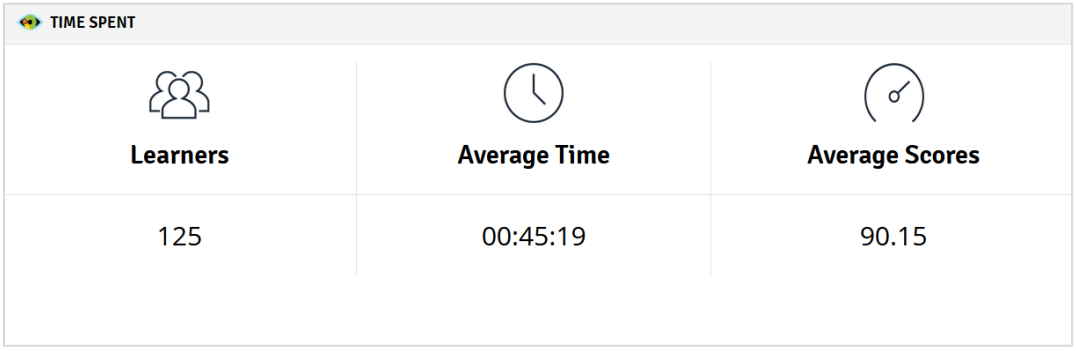


**Figure 2. Joint HQ exercise: pre-training**

Participant engagement in pre-training also was distributed differently for the eLearning courses and the microlearning eBook. We collected **68,145** xAPI statements during the pre-training period, with the eLearning courses visited heavily during the first week after pre-training started and continuing to be important support throughout the exercise. (Figure 3)

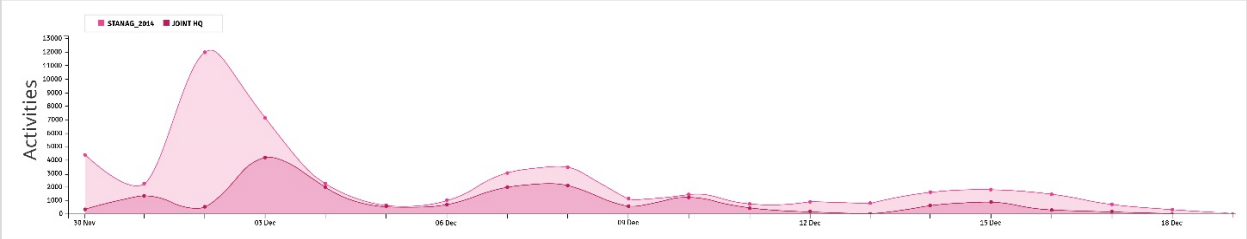


**Figure 3. Joint HQ exercise: eLearning courses activities stream**

The microlearning element peaked immediately before and during the live part of the exercise. The OPP eBook content was aligned with trainee needs for easily accessible NATO operations documents during the exercise. (Figure 4)

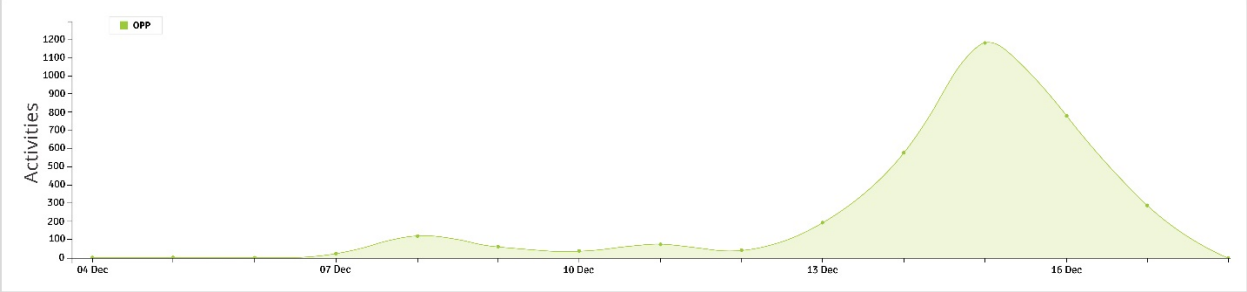


**Figure 4. Joint HQ exercise: microlearning activities stream**

## OBSERVERS' DATA: TEAM PERFORMANCE RESULTS

In the NATO Standards exercise, performance was observed on both the individual and team levels. The seven practical skills (P1-P7) included the fulfillment of command duties; timelines, development, and quality of planning documents; validity of the decisions made; and management of subordinate units. All but one showed a small though steady performance increase during the exercise. Only P7, representing the observers' scores of the quality of the documents, initially was high then fell significantly from the second day of the exercise before rejoining the pattern of the other objectives in a slow and steady rise. These performance results included those of the control group (11 individuals) representing 12% of total participants. (Figure 5)

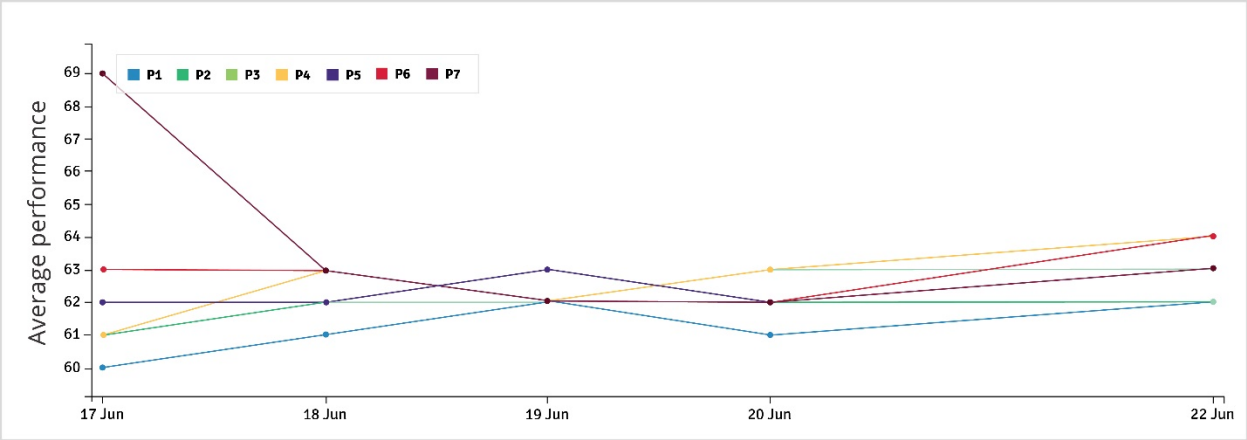


**Figure 5. NATO Standards exercise: average scores for all groups per training objective**

On the team level in the NATO Standards exercise, the two groups which utilized the recommended eLearning preparation as an integral part of the training event dominated overall performance results. They achieved an average of 8.11% higher results for all objectives, and their team averages were higher than those of the control group which did not receive the pre-training. We did see a small achievement difference between Group 1 and Group 2. The team success averaged 62.9% for Group 1 and 64.7% for Group 2. The lower average for the former resulted from some of its team members achieving barely passing individual results of 52-54%, which pulled down the overall team result, in addition to the general tendency of teams to develop unique characteristics during the process (Kozlowski, 2018). The control group averaged 56% team success overall, barely exceeding the minimum and optimal value for the exercise, which the NDUU had designated as at least 50% achievement in pre-training to qualify as an exercise support. (Figure 6)

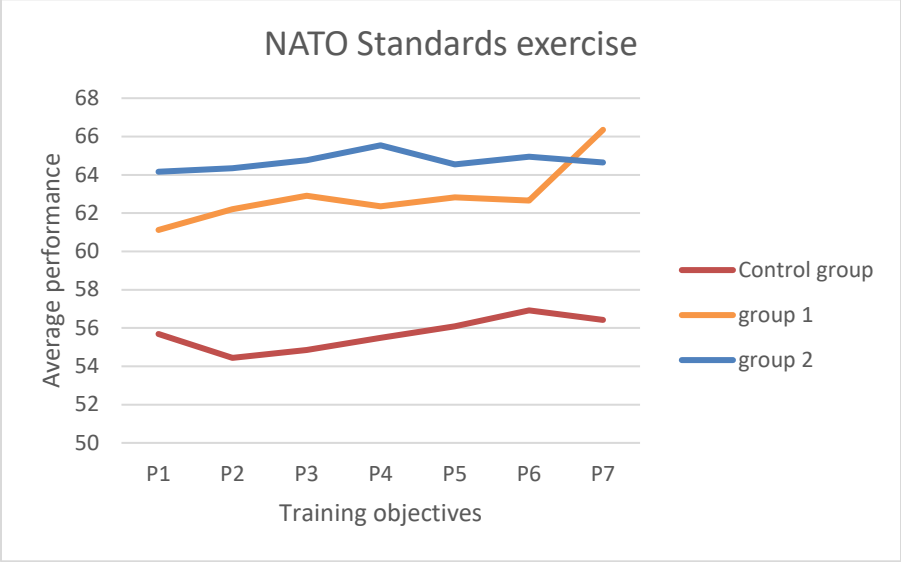


**Figure 6. NATO Standards exercise: observers' data on group performance**

In this sample and based on the control group's lower achievements without the help of pre-training, participant performance in the NATO Standards exercise indicates a correlation between eLearning preparation and training achievements per training objective. (Figure 7)

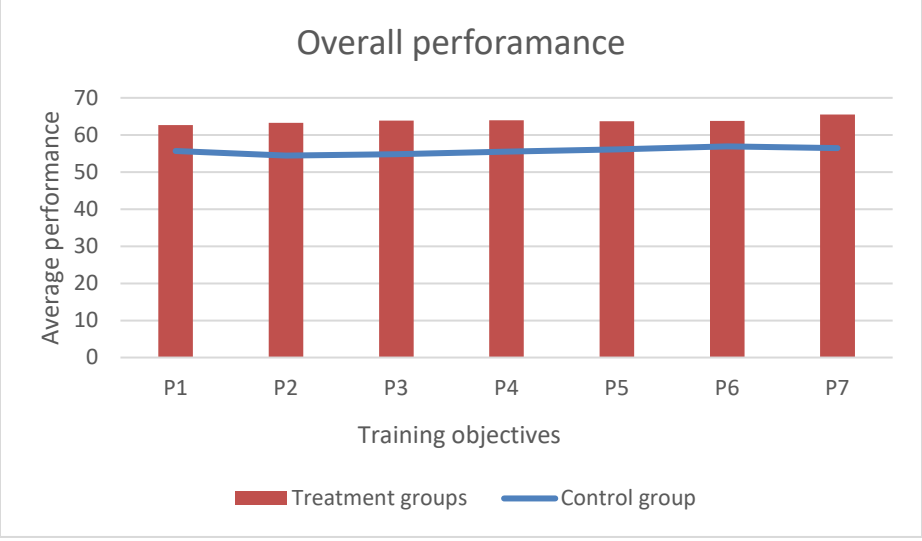


**Figure 7. NATO Standards exercise: overall performance**

In the Joint HQ exercise, there were nine treatment groups and one control group, and their performance was observed against seven training objectives (T1-T7), again on both the individual and team levels. The training objectives were slightly altered from the previous exercise, and days of the event were shorter; otherwise, the aim and circumstances were unchanged. All treatment groups showed a similar competency level. Group 7 scored the highest achievement with an 85.23% rating for training objective T5 (management skill of subordinate personnel). Group 2 scored the lowest achievement with a 72.86% rating for training objective T1 (performance level of official duties). However, the control group showed an average rating 16.2 percentage points lower than all other teams. Its greatest achievement gap came on objective T4 (skills in timely document preparation) with a rating of 60.91%, compared to an average of 78.57% achieved by the treatment groups. (Figure 8)

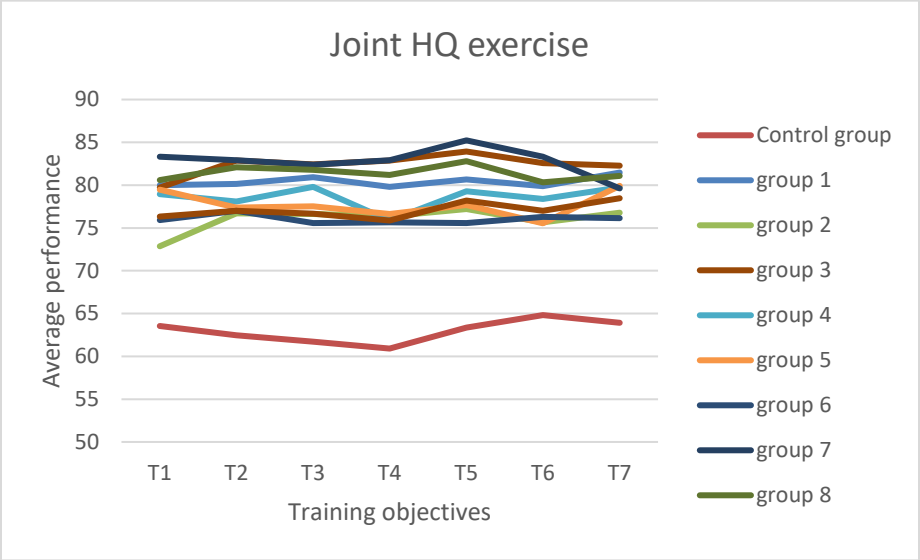


**Figure 8. Joint HQ exercise: observers' data on group performance**

In the Joint HQ exercise, the sample correlation between treatment and control group achievements was larger, indicating stronger covariance between pre-training and higher training achievements. (Figure 9)

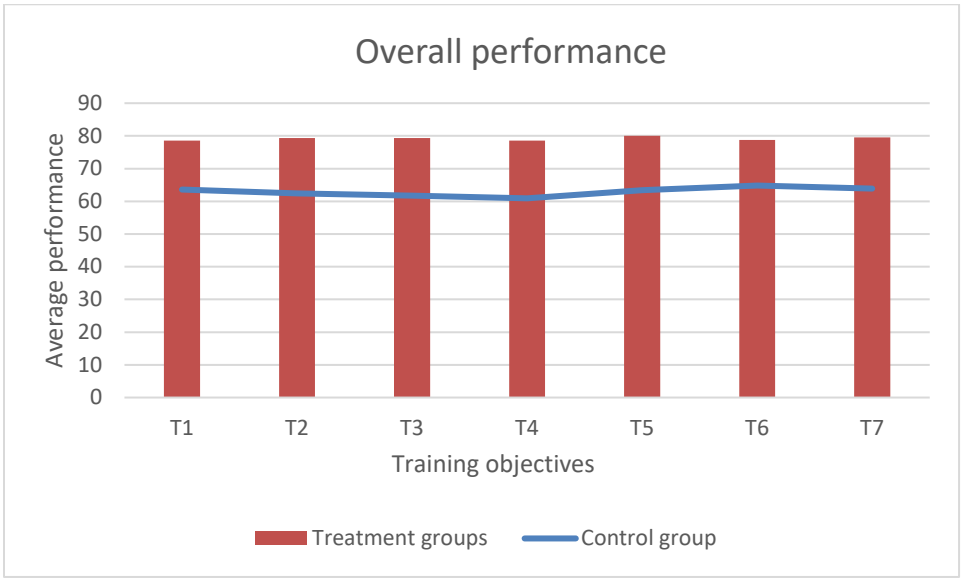


**Figure 9. Joint HQ exercise: overall performance**

## LESSONS LEARNED

In the NATO Standards exercise, we focused on instrumental integration of ADL into exercises, particularly in determining the best practices for LMS integration as a valuable exercise preparation tool. By comparing the training performance results of the exercise groups which received online pre-training with that of the control group without pre-training, we learned the following lessons:

- The exercise control group without the pre-training element showed lower performance on the exercise training objectives and indicated positive covariance between ADL pre-training and exercise training objectives. The participant groups did not represent a randomized sample of the exercise population, limiting the statistical validity of the results, which are nevertheless indicative.
- Native xAPI courses provided significantly more statements and thus the opportunity for granular insight into participants' pre-exercise learning. Based on these insights, the exercise organizers were able to revise the preparation plan to reduce time for participant pre-training.
- Early involvement of the ADL team in exercise planning resulted in careful alignment of the eLearning objectives with the exercise training objectives. This enabled the participants to concentrate only on the needed elements of pre-training tailored specifically to the exercise.
- The learning analytics of the exercise revealed gaps in participant readiness and highlighted the need for pre-training improvement in the next iteration of exercise.

In the Joint HQ exercise, we focused on integrating a wider range of ADL content delivery and determining the best practices for microlearning integration to support a military brigade level exercise. By comparing the performance results analysis of the exercise groups which received ADL pre-training with that of the control group without pre-training, we learned the following lessons:

- The exercise control group without ADL pre-training achieved significantly lower results on the exercise training objectives, indicating again the existence of a positive covariance between ADL pre-training and exercise training objectives. The participant groups did not represent a randomized sample of the exercise population, limiting the statistical validity of the results, but they are strongly indicative.
- The combination of differing types of eLearning content for pre-training gave participants greater flexibility in how and when they utilize the materials. The xAPI data flow showed that introduction of microlearning in the form of eBook provided exercise participants with an immediate, on-demand aid, which resulted in higher exercise performance.

## CONCLUSIONS

In both exercises, the treatment groups which received ADL pre-training significantly outperformed the control groups on training objectives achievements in the exercise. In addition to the group results, the NATO Standards exercise showed a consistent link between individual-level high achievement in pre-training and higher achievement on the observed exercise training objectives, while lower or no pre-training was associated with poorer execution of the exercise tasks.

Our team performance analysis showed the importance of early involvement of the ADL team in exercise planning to closely align the pre-training eLearning objectives with the exercise training objectives. NDUU took care in its preparations to do so, and this was reflected in the consistently high training objectives achievement by the groups which received pre-training. In addition, the Joint HQ exercise illustrated the benefit of offering participants different types of eLearning materials that can be utilized flexibly to significantly enhance the efficacy of the overall exercise preparation and performance. Furthermore, use of the xAPI standard in the pre-training ADL resulted in significantly more data that gave granular insight into the participants' pre-exercise learning, enabling event organizers to maximize the limited time available for pre-training and focus pre-training activities on event achievement.

Although our participant groups did not represent a randomized sample of the exercise population and this study was not intended to rise to level of statistical reliability, the outcomes strongly suggest the paths to measure the added value of eLearning's efficacy as pre-training in multinational exercises and demonstrate the need for further study.

In the next cycle of research, it would be necessary to build in randomization to treatment conditions, or to ensure the ability to address compositional equivalence of groups in the absence of randomization.

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