Twenty-Five Emerging Trends in Learning and their Implications for Military Partners: An International Study

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ABSTRACT

The training and education domain is rapidly evolving. New capabilities, such as artificial intelligence and data science, combined with a growing understanding of cognition, neuroscience, and educational theory are transforming the ways we learn. What are the implications for defense organizations, and what are military stakeholders' perceptions of them? These were the questions posed to our aligned activity in The Technical Cooperation Program (TTCP).

TTCP is a multinational R&D cooperative for the Five Eyes countries, i.e., Australia, Canada, New Zealand, United Kingdom, and the United States. This paper, written by the delegates from each nation on the Future Defence Learning aligned activity, describes work undertaken to analyze emerging learning approaches, compare international military perspectives on them, and identify opportunities for related multinational coordination.

Specifically, this paper showcases findings from the group's learning trends study. We began by broadly evaluating emerging methods and technologies for education and training from industry, academia, and defense institutions. We identified 25 distinct trends, such as individualized personal learning, learning through social media, and ebooks as a learning platform. After synthesizing the trends, we developed a survey to gauge our respective defense organizations' perceptions of them according to interest, level of current adoption, and estimated time for future adoption. Respondents also ranked and rated the trends, and they provided free-response qualitative comments. We compared these results in aggregate and between the nations. Finally, from those analyses, we identified gaps and opportunities, including useful targets for investment.

This paper presents the group's findings, including the background research, survey (N = 91), subsequent analysis, and results. It closes by summarizing eight recommendations that outline ways these five partners can work together to modernize their defense learning enterprises and collectively push the boundaries of readiness.

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INTRODUCTION

Military personnel and defense civilians face ever-increasing demands. Our warfighters and workforce are expected to achieve an expanding set of sophisticated skills, rapidly adapt to new challenges, and continue to grow and learn across their entire careers. To overcome these challenges, defense institutions need to effectively develop and support their human capital, to include optimizing traditional training and education as well as informal learning and just-in-time support. The rationale for *why* such modernization is needed has been well explored (e.g., Raybourn et al., 2017; Schatz et al., 2015), and pundits have also examined *what* that evolution might involve (e.g., Walcutt & Schatz, 2019).

In a similar vein, our team sought to explore how industry and academia were addressing comparable challenges. That is, how are others modernizing their learning systems? What new methods or technologies are promising to enhance corporate or school-based training and education, and how do defense stakeholders perceive those emerging capabilities? Towards that end, we conducted a broad literature review to identify emerging learning capabilities currently popular in industry and academia, ultimately identifying 25 distinct trends. Then we developed a survey to gauge defense stakeholders' perceptions of the trends. Ninety-one (91) subject-matter experts from national defense organizations across five nations responded, providing both controlled responses on an anchored survey and open-ended qualitative feedback. From these results, we collectively evaluated stakeholders' perceptions and compared these across nations.

This work was undertaken as part of The Technical Cooperation Program (TTCP), a multinational R&D defense cooperative for "Five Eyes" countries. This paper, written by the national delegates on the Future Defence Learning aligned activity, describes the work undertaken to analyze the emerging learning approaches, compare international military perspectives on them, and identify opportunities for related multinational coordination. The paper begins by providing background on TTCP, then describes this project's research and results, and closes with recommendations on how military allies can innovate their learning approaches—both individually and in partnership.

BACKGROUND: THE TECHNICAL COOPERATION PROGRAM

TTCP is a research and development cooperative including Australia (AUS), Canada (CAN), New Zealand (NZL), the United Kingdom (GBR), and USA members. Through TTCP, these nations collaboratively explore defense science. TTCP originally grew from an agreement between the United States and United Kingdom governments in 1957. The Canadian government soon joined, and the initiative became the "Tripartite Technical Cooperation Program." In the 1960s, Australia and New Zealand became part of the program, inspiring its name change (Office of the Secretary of Defense [OSD], n.d.). These five countries, also called the Five Eyes nations, remain the current TTCP participants.

At this time, TTCP includes nine groups, each focused on a major area of collaborative defense research, such as aerospace, maritime, and land systems (OSD, n.d.). Each group is further subdivided into project teams, either technical panels (to exchange information and conduct joint initiatives) or action groups (to complete well-defined, high-priority efforts). Through these panels and groups, TTCP integrates fresh perspectives from the public sector and academia, gathers and shares data, and encourages collaborative solutions for coalition defense endeavors. TTCP participants are military personnel and defense civilians, assigned by their respective national defense organizations.

The Future Defence Learning aligned activity is led by a representative from the UK's Defence Science and Technology Laboratory, and it includes representatives from the US Office of the Secretary of Defense, Canadian Department of National Defence, Australian Defence College, and New Zealand Defence College. The activity falls under Technical Panel 23 (TP23), which emphasizes innovation in personnel-focused research in areas such as recruitment, retention, selection, social issues, and training and education, within the Human Resources and Performance group.

Upon its initiation in 2015, the Future Defence Learning aligned activity was assigned several tasks. One involved developing a vision for the future of defense learning, to include understanding the needs associated with future military learning from a multinational perspective, constructing a shared vision, and comparing methods and technologies to assess which may support progress towards that vision (pending TTCP HUM TP23 report). This project grew out of those requirements. A two-phased method was used. Phase 1 comprised a literature review to identify military training and education needs as well as cutting-edge trends in learning and development. Phase 2 involved obtaining feedback from stakeholders on these emerging trends. This was followed by quantitative and qualitative analyses to interpret and compare the results. Finally, the delegates developed recommendations in response to these analyses.

Phase 1: Trend Identification

Literature Review

First, the five TTCP delegates conducted a meta-literature review (building upon other summary analyses and research reviews) to identify innovative trends in the learning and development domain. Initially, 16 existing reports from a range of sectors were reviewed. Primarily, these were written for industry professionals or policymakers, and they aimed to analyze, evaluate, and forecast innovations expected in the next 5–20 years.

Ultimately, six of these summary reports proved the most useful. The *Emerging Technologies Landscape Report* (Padrón Nápoles et al., 2013) formed an initial part of this review; it broadly summarized technologies expected to have an impact on training and education over the coming decade such as game-based learning, augmented reality, and ubiquitous computing. The *E-Learning Market Trends and Forecast 2017–2021* (Docebo, 2016) predicted global future learning trends, particularly for e-learning, highlighting topics such as microlearning, mobile learning, and corporate Massive Open Online Courses (MOOCs). The *Trends in Learning Report* (The Open University, 2016) identified seven emerging trends, particularly for higher-education design and delivery, including incidental learning, learning analytics, ebooks, and mobile learning. Similarly, *Innovating Pedagogy* (Sharples et al., 2016) identified trends for higher education and also estimated the timescales for their widespread implementation; these diverse trends included (among others) learning through social media, learning from the crowd, and blockchain for learning. *Trends in Learning Delivery and Design* (The Open University, n.d.) reviewed near-term emerging trends related to the design, delivery, and assessment of learning, particularly for workforce learning and development. It included innovations such as learning to learn and maximizing engagement through storytelling. Finally, the *NMC Horizon Report: Higher Education Edition* (Johnson et al., 2016) evaluated educational technology trends likely to have a global impact on higher education institutions, beginning in 2016–2020.

Developing a List of Learning Trends

Individual learning trends were extracted from papers and were further refined through additional research and consultation with subject-matter experts across our respective defense institutions. Initially, a total of 42 emerging learning trends were extracted. A multidisciplinary analysis was then undertaken by the researchers to group these trends into broad overarching themes. The concepts were progressively re-ordered, consolidated, and refined to develop a coherent, sufficiently orthogonal organized list. This refinement process led to some learning trends being removed from the categorical framework if they seemed to represent applications of other trends, rather than distinct trends in their own right (e.g., translanguaging). A small number of trends were also removed because they seemed largely applicable beyond training and education (e.g., idea management) or because they represented lower-level pedagogical tactics that had simply been re-branded over time (e.g., productive failure and teach-back). Through successive iterations, this consequently led to an overall list of 25 trends, grouped into four categories (which the authors developed for the sake of readability). A summary of the 25 trends is provided in Table 1.

Table 1: Learning Trends and Definitions

TRENDS IN LEARNING DESIGN

1. Ubiquitous Computing: In "Ubiquitous Computing," technology becomes integrated into everyday objects and activities, so much that it fades into the background; this changes the way individuals interact with technology, and subsequently, how, when, and where they learn.

2. New Procurement Methods for Learning Tech: Given the rapid pace of advancement in learning technologies, training/education organizations must identify more agile contracting and procurement approaches to avoid stagnation, such as using Platform as a Service contracts or novel contracting methods.

3. Game-Based Learning: Game-Based Learning uses game mechanics (e.g., points, levels, scoreboards, challenges) in learning contexts to motivate learners, make learning more engaging, and encourage collaborative and cooperative learning, or other unique learner behaviors.

4. Performance Support: "Point of Need" Learning: Although the concept of "Performance Support" is not new, most organizations have yet to formally introduce a learning-at-the-point-of-need strategy. In the future, organizations will *intentionally* deliver more learning at learners' fingertips, as just-in-time support.

5. Learning to Learn: "Learning to Learn" involves self-managed learning and explicit teaching and training in *metacognition* (i.e., the knowledge and skills needed to effectively manage one's own learning). This trend focuses on empowering learners to effectively guide their own learning.

6. Incidental Learning: Incidental learning is unstructured learning outside of formal settings, such as learning by collaborating with an expert teammate. Incidental learning already happens, but organizations will increasingly recognize, reward, and explicitly encourage it.

7. Individual Personalized Learning: Personalization is a move away from one-size-fits-all learning; however, what this looks like can vary. In general, personalization involves changing some core aspect of learning (e.g., duration, delivery) in response to an individual's needs or characteristics.

TRENDS IN LEARNING DELIVERY

8. Learning through Social Media: "Social media" refers to internet-based technologies that promote group engagement, such as Facebook, Twitter, Skype, Blackboard, and enterprise-specific media. These technologies can facilitate and enhance learning via collaboration, communication, and sharing.

9. eBooks as a Learning Platform: An eBook is an electronic version of a book read on digital devices such as personal computers, smartphones, or tablets. Unlike traditional books, eBooks can include video and audio files, quizzes, embedded graphics, learner analytics, and other functionalities.

10. Communities for Learning: A "learning community" is an intentionally designed cluster of learners and learning facilitators (e.g., teachers, trainers). Social media technologies may support these communities, but this trend refers to the explicit encouragement and formation of the cohorts.

11. Social Learning: Social learning refers to peer-to-peer learning. While such learning already occurs in all organizations, this trend specifically refers to explicitly supporting peer-to-peer learning in formal learning settings or on the job, such as through dedicated forums, group activities, and purposeful social networks.

12. Augmented Reality as a Learning Platform: Augmented reality places a learner in a *real* environment but with artificial enhancements, such as when a learner points a smartphone at a vehicle and sees a list of its parts superimposed. (Not to be confused with virtual reality which is totally artificial environment.)

13. Mobile Learning: Mobile learning refers to learning via handheld devices, e.g., tablets, smartphones. In contrast to traditional eLearning, these devices encourage smaller and less formal learning segments, just-in-time learning, and use of embedded GPS, accelerometers, cameras etc.

14. Microlearning: Microlearning is often referred to as "bite-sized learning." It involves short learning nuggets (≈3–5 minutes) designed to meet precise learning outcomes. These nuggets often include rich multimedia and are designed for easy access via smartphones, tablets, and laptops.

15. Learning through Storytelling: Storytelling has supported learning for millennia. However, this trend refers to the *explicit* use of narrative techniques as part of a broader learning strategy. This also involves providing instructors and designers (etc.) intentional training in storytelling for learning.

16. Novel Instructional Techniques: The Learning Science literature identifies numerous instructional techniques, such as "Productive Failure" or "Teach-Back." Increasingly, instructional designers are moving beyond the use of direct ("sage on the stage") techniques to incorporate more novel tactics.

17. Wearable Bio-Feedback Technologies: Small technologies can be readily incorporated into clothing and accessories. They can, for instance, monitor a trainee's exertion during physical training, their stress level during a computer-based scenario, or even their level of engagement in a classroom.

TRENDS IN ENABLING AND MANAGING LEARNING

18. Learning Analytics: Learning analytics refer to the collection, analysis, and reporting of rich data about learners, their context, and learning experiences in order to understand and optimize learning. Learning analytics may involve "big data" methods, visualizations, and predictive algorithms.

19. Content Repositories (Across Systems): Content repositories refer to those stores of learning objects and/or meta-data registries that enable instructional designers to discover, reuse, and/or repurpose existing learning content and/or media elements across learning systems.

20. Personal Learning Environments: "Personal learning environments" are a broad class of tools, and associated management processes, for supporting self-directed learning. They help learners collect their learning resources (formal and informal), set their own goals, and communicate with others.

21. Redesigning Learning Spaces: New methods of teaching and learning encourage new space designs. For example, "flipped classrooms" may rearrange their spaces for active learning, and learner-centric courses may use dynamic layouts (versus rows of chairs facing a stage) to encourage interaction.

22. Accrediting Informal Learning: Informal learning occurs outside of formal training or education settings, such as on-the-job. Increasingly, organizations are recognizing the knowledge and skills individuals gain in these informal learning contexts, e.g. via badging or other credentials.

23. Blockchain for Learning: Blockchain technology creates a "digital ledger" that stores events permanently and securely in a distributed manner. In learning contexts, blockchain can facilitate the shift from centralized learner records to a model where learners own and control their own data.

TRENDS IN LEARNING AT SCALE

24. MOOCs (Massive Open Online Courses): MOOCs are web-based courses with potentially thousands of learners at any given time. They are generally available the worldwide public, can be taken independently or as part of a larger program, and are often self-paced.

25. Crowdsourcing for Learning: Crowdsourcing refers to the completion of some task (such as generating learning content, curating learning resources, or providing ratings and feedback on materials) via the use of a large number of relatively unmanaged people.

Phase 2: Defense Stakeholder Perceptions

Apparatus

After identifying the 25 trends, we developed a feedback questionnaire to assess the current use and perceptions of these capabilities, collectively and comparatively, across the five nations. The questionnaire included four sections. First, demographic questions asked about each participant's nation, self-asserted level of awareness, and positional level within their military organizations. Next, respondents rated their perceptions (i.e., structured responses) across their defense institutions of each of the trends listed in Table 1, specifically indicating:

- **Level of interest**: A three-point Likert-style scale, ranging from 1 (*low*) to 3 (*high*);
- **Level of current adoption**: As above, the same three-point scale, ranging from 1 (*low*) to 3 (*high*); and
- **Estimated time for future adoption**: A four-point Likert-style scale, including 0 (*never*), 1 (*long*, 10+ years), 2 (*mid, 5–10 years*), and 3 (*near*, 0–5 years).

Respondents also had the opportunity to provide open-ended **comments** (i.e., freeform responses) on each learning trend. Lastly, to obtain a sense of which trends were perceived to have the greatest potential benefits, participants were asked to **list the "top five" most promising trends** at the end of the survey.

Participants

Ninety-one (N = 91) participants completed the survey, with the USA and NZL achieving the highest participation rates. (Unfortunately, the nations provided an uneven set of responses.) Table 2 indicates the organizational role that respondents self-reported. All respondents held military or civilian training/education roles, with most serving as *program leaders* (i.e., a program, office, or military commander, such as the Army War College dean) or *service leaders* (i.e., program, office, or military commander for Navy-wide training or for Air Force-wide education).

Table 2: Level of Positions by Nation

Nation	Local-level Faculty/Staff	Program-level Leader	Service-level Leader	Senior National Leader	Nation Total (% of Total)
CAN	1	0	3	2	6 (7%)
GBR	1	2	0	3	6 (7%)
USA	9	22	9	2	43 (47%)
AUS	0	0	4	0	4 (4%)
NZL	3	19	5	5	32 (35%)
Total	**14**	**43**	**21**	**12**	**91**

Note. Percentages rounded to whole figures; one USA participant choose not to respond to this question.

Most participants reportedly held a *service-level* or *national level* of awareness of their defense training and education systems. That is, respondents felt they could reasonably estimate the sentiment of their service (e.g., Army, Navy, Air Force) or their "full defense enterprise," respectively. This implies that most respondents at least felt that they could report broad perceptions for this study (see Table 3).

Table 3: Scope of Awareness

Awareness	*N*	% of Total
Local	6	7%
Program	11	12%
Service	31	34%
National	37	41%
Other-Civilian	1	1%
All Levels (Local to National)	4	4%
Missing	1	1%
Total	**91**	**100.0**

Data Analysis

The analysis of data was divided into two major categories—structured and freeform responses.

For the structured data collected via the multiple-choice questionnaire, descriptive statistics were first created for each learning trend. Specifically, the average across participants (means; *Ms*) provided an indication of general trends, while standard deviations (*SDs*) indicated the degree of agreement across participants. Second, nations' perceptions were compared using analyses of variance (ANOVAs), with Bonferroni post-hoc analyses where the main effect was

Table 4: Structured Responses from Questionnaire

Trend	*Interest*			*Adoption Lvl*			*Adoption Timeline*			
	M	***SD***	Δ	***M***	***SD***	Δ	***M***	***SD***	Δ	Label
1. Performance Support: "Point of Need" Learning	2.43	.67		1.73	.67	✓	2.49	.73		Near
2. Mobile Learning	2.41	.72		1.56	.70	✓	2.43	.87		Near
3. Learning Analytics	2.39	.75		1.61	.73	✓	2.40	.81		Mid
4. Content Repositories (across systems)	2.31	.70		1.53	.71	✓	2.31	.95		Mid
5. New Procurement Methods for Learning Tech	2.31	.71		1.47	.66	✓	2.24	.89		Mid
6. Ubiquitous Computing	2.25	.75		1.45	.65	✓	2.16	.87	✓	Mid
7. Learning to Learn	2.25	.73		1.56	.74	✓	2.35	.85		Mid
8. Augmented Reality as a Learning Platform	2.20	.80		1.33	.60		1.82	.99		Mid
9. Accrediting Informal Learning	2.12	.79		1.61	.72		2.16	1.05		Mid
10. Game-based Learning	2.08	.69		1.53	.64		2.23	.91		Mid
11. Individual Personalized Learning	2.06	.78		1.52	.66	✓	2.13	.97		Mid
12. Personal Learning Environments	2.06	.76		1.37	.66		2.14	.90		Mid
13. Social Learning	2.02	.73		1.58	.64		2.44	.88		Near
14. Incidental Learning	2.00	.74		1.52	.55		2.20	.95	✓	Mid
15. Redesigning Learning Spaces	1.99	.75		1.46	.66		2.12	.98		Mid
16. eBooks as a Learning Platform	1.96	.74		1.52	.66		2.41	.96		Mid
17. Communities for Learning	1.94	.73		1.50	.60		2.16	.95		Mid
18. Microlearning	1.93	.80		1.30	.55	✓	2.20	.94		Mid
19. Learning through Social Media	1.90	.85		1.40	.60	✓	1.91	1.10		Mid
20. Novel Instructional Techniques	1.81	.79		1.42	.62		2.02	1.07		Mid
21. MOOCs (Massive Open Online Courses)	1.75	.77		1.19	.45	✓	1.69	1.15		Long
22. Learning through Storytelling	1.67	.76	✓	1.42	.60	✓	1.97	1.17	✓	Mid
23. Wearable Biofeedback Technologies	1.62	.75		1.18	.42	✓	1.43	1.03		Long
24. Blockchain for Learning	1.49	.69		1.12	.36		1.40	1.03		Long
25. Crowdsourcing for Learning	1.40	.68		1.11	.38		1.08	1.09		Very long

Note. The total number of respondents to each question varied slightly (n = 87–91).
A checkmark in the Δ column indicates a significant difference in this item between at least two of the nations.
For Interest and Adoption Levels, 1 = *low* to 3 = *high*; that is, "higher is better."
For Adoption Timeline, 0 = *never* to 3 = *near-term, 0–5 years*; that is, "higher is nearer-term" adoption.

found statistically significant. Given the differences in group sizes between nations, the responses were also visually examined using simple frequency counts to rank-order common responses and examine differences across nations. Similarly, the "top five" most beneficial trends were examined via basic frequencies and rank-order comparisons.

For the 522 free-form responses, we conducted a thematic analysis using approaches advocated by Braun and Clarke (2006). Overall, 47% of the participants across all the nations made comments, with NZL (39% of total comments) and USA (31% of total comments) participants providing the majority of this qualitative commentary. We examined stakeholders' comments for each of the 25 learning trends. Due to the relatively small number of comments and the imbalance across nations, it was not possible to follow a fully structured approach. Instead, we searched for broad themes, grouping those comments that shared similar meanings. This approach offered valuable insights but was imperfect. Comments were disparate at times, and themes were not always consistent across responses. Additionally, the themes are likely skewed by the views of NZL and USA respondents, relative to the other participating nations, given their size. Despite these limitations, the comments proved useful in shaping the recommendations (see the discussion).

Structured-Data Results

First, the **perceived levels of interest** for each trend were analyzed. Respondents expressed the highest levels of interest for *Performance Support* and *Mobile Learning*, and they showed lower levels of interest for *Crowdsourcing* and *Blockchain for Learning* (Table 4). Comparisons across nations using ANOVAs yielded only one significant difference: Nations differed significantly on their interest in *Storytelling*, $F(4, 85) = 5.11$, $p < .001$, with NZL reporting significantly higher levels of interest than did GBR and USA ($p < .01$).

Next, the **levels of current adoption** were evaluated. Responses indicated most learning trends are currently adopted at low- to moderately-low degrees, as evidenced by low means ($M < 2.00$), and there was general agreement among participants for these perceptions, as evidenced by the low standard deviations ($SD < .70$). Even *Performance Support*, which had the highest level of interest, had reportedly low-levels of current adoption across the five nations. ANOVAs revealed that 13 learning trends differed significantly among the nations in terms of current adoption levels, $Fs(4, 83 \text{ to } 89) = 3.27 \text{ to } 8.48$, $ps < .05$. AUS had significantly higher levels of current adoption of *Content Repositories*, *Individual Personalized Learning*, *Learning to Learn*, *Mobile Learning*, *Performance Support*, and *MOOCs* than did all other nations. Similarly, AUS reported higher levels of *Ubiquitous Computing* and *New Procurement Methods* than did CAN, USA, and NZL (although not GBR); higher levels of *Wearable Biofeedback Technologies* than did CAN and NZL (but not GBR and USA); and higher levels of *Learning Analytics* than did the GBR, USA, and NZL. In addition, NZL reported significantly lower adoption levels of *Microlearning* than did AUS and the USA, and significantly higher levels of adoption for *Storytelling* than did GBR and the USA.

Third, the **estimated timeframe** each nation might adopt these learning trends was analyzed. (For the sake of readability in this paper, we have opted to report these results as parametric statistics, which treat the data as a continuous span of time). On average, respondents indicated a relatively distant timeline for adoption (i.e., $M < 2.07$, $SD = .35$, which represents a *mid-term timeframe* of five to ten years). However, responses were often mixed, as evidenced by the relatively large standard deviations. Across nations, the learning trends likely to be implemented in the shortest timeframes included *Performance Support*, *Social Learning*, and *Mobile Learning*, while the trend likely to take the longest to implement was *Crowdsourcing for Learning*. When compared across nations, three learning trends were found to differ significantly on their estimated adoption timeframe, $Fs(4, 83 \text{ to } 86) = 3.13 \text{ to } 4.16$, $ps < .001 \text{ to } .05$. AUS was found to have significantly nearer time estimates for the future adoption of *Ubiquitous Computing* than did CAN and significantly further time estimates for *Incidental Learning* than did the USA and NZL. NZL also reported significantly nearer time estimates for the adoption for *Storytelling* than did the USA.

Table 5: Frequency of trends rated among the "top five"

Trend	Frequency
Performance Support: "Point of Need" Learning	37
Learning Analytics	33
Individual Personalized Learning	31
Game-based Learning	27
Mobile Learning	27
Augmented Reality as a Learning Platform	22
Learning to Learn	20
Accrediting Informal Learning	18
Microlearning	18
New Procurement Methods for Learning Technology	18
Communities for Learning	17
Personal Learning Environments	15
Content Repositories (across systems)	14
Ubiquitous Computing	14
eBooks as a Learning Platform	11
Redesigning Learning Spaces	10
MOOCs	8
Social Learning	8
Incidental Learning	7
Learning through Storytelling	5
Novel Instructional Techniques	5
Wearable Biofeedback Technologies	5
Blockchain for Learning	3
Learning through Social Media	2
Crowdsourcing for Learning	1

Fourth, we examined participants' **rank ordering of the most impactful trends**. The trends are listed in Table 5 in a top-down order, from most- to least-frequently ranked items. *Performance Support* was ranked as having the top potential across all nations, and it was correspondingly ranked as having the highest level of interest. Similarly, *Learning Analytics* and *Mobile Learning* were ranked as having high potential

and high interest. However, this logical correlation was not the case for all of the trends (see the discussion for more details). When compared among nations, the rank-orders were only examined visually, as responses across nations were imbalanced. Nonetheless, the examination revealed some notable insights. For example, *Learning Analytics* was the only trend in the top five for all nations, and *Individual Personalized Learning* was among the top-five for all nations except CAN.

Freeform-Data Results

We conducted a thematic analysis of the **522 open-ended comments**, identifying 26 themes from these responses. Details were also compiled for each learning trend. These offered useful insights, and they lent themselves to hierarchical thematic mapping. (A more detailed analysis of these comments and their emergent themes was provided to TTCP and the five nations as part of this project; only a succinct overview of themes is provided here.) As a whole, the most frequently addressed topics included implementation challenges and varied implementations across organizations. Also, stakeholders indicated several specific learning trends represented likely growth areas (see discussion).

In relation to **implementation challenges**, stakeholders often identified concerns relating to perceived current (or potential future) barriers to implementation created by their respective defense organizations. These included issues such as: Information Computing Technology (ICT), infrastructure, personnel capacity, financial, security and/or policy constraints, and organizational culture, as well as difficulties documenting, recording, and recognizing some forms of training/education. This implies that any plans to implement these trends will need to identify and address such obstacles in broad and strategic ways.

The prevalent **varied implementation** theme referred to stakeholders' comments indicating there may be variation in the extent of use or integration of specific learning trends—both between nations and across a single nation's own defense institutions. In other words, there was a strong pattern of inconsistency in the degree to which specific learning trends have been embedded within different organizations. This indicates it may be beneficial to encourage greater levels of cohesion, consistency, and communication across national organizations and the Five Eyes allies.

Another theme was the perception that certain learning trends represent **growth areas**, that is, expressions showing stakeholders are either keen to embed a specific learning trend within their organizations and/or they are already using it as part of some preliminary trial. Learning trends primarily described as growth areas included *Incidental Learning*, *Social Learning*, and *Accrediting Informal Learning* (the latter largely by GBR respondents). Further, two specific learning trends were noted as having **fundamental importance**. These were *Learning Analytics*, the importance of which was especially emphasized by USA respondents, and *Content Repositories*, which was highlighted by respondents from the USA and AUS. Stakeholders' comments frequently indicated these learning trends were "central," "integral," "necessary," or "fundamentally important" for their training and education enterprises.

Discussion and Recommendations

After analyzing the study results, TTCP delegates examined them to identify gaps or opportunities. These might include, for example, areas where one nation could offer recommendations or where all nations reported a strong common interest. A summary of our top eight recommendations is provided below.

(1) Collaborate on resolving challenges to broader adoption of **Performance Support: "Point of Need" Learning**

Respondents across all nations indicated both high levels of interest and perceived value for *Performance Support: "Point of Need" Learning*. It also topped the ranking of trends, indicating respondents felt it had the greatest potential to impact defense organizations. From the qualitative comments, respondents praised its potential to reduce the "requirement for upfront training" and "the need for regular refresher training resulting from skill fade," and one remarked it is "likely to result in a reduced training burden (both personnel and financial)." However, other comments cautioned "significant culture change" would be needed, and this reflects "a different model of learning than is currently employed by the majority of defence organisations (for example, the impact on training pipelines and readiness levels)." One respondent also cautioned it may "increase pressure on logistic supply chains especially when the 'point

of need' is in an operational environment." This suggests there is a strong desire to pursue this capability, but development and implementation challenges will need to be carefully addressed.

(2) Audit current efforts in **Learning Analytics**, share lessons learned, and aid coordination

Respondents across all nations reported high levels of interest in *Learning Analytics*, and its perceived value was rated second—only lower than *Performance Support: "Point of Need" Learning*. It was also the only trend all five nations ranked in their "top five" in terms of perceived value. The open-comments reinforced this advocacy, too. For instance, participants remarked that learning analytics can "optimize training, education, employment and transition for personnel" and "provide enhanced assessment and effectiveness of training and training products." Two USA respondents noted learning analytics are necessary for structured on-the-job training, and a respondent from NZL stated that "big data and analysis informs intelligence and makes sense of learning in the Defence environments."

Despite this attention, responses also indicated relatively sparse levels of current adoption. For example, two NZL respondents referred to current implementations within their military organizations while another reported that the capability was still under-developed. Some GBR respondents referred to its use in after-action reviews of exercises and within their virtual learning environment, but others reported low awareness and lack of experience with learning analytics. USA respondents claimed learning analytics formed the foundational underpinnings of projects such as the Navy's Ready Relevant Learning and the Air Force Learning Services Ecosystem, yet also highlighted implementation issues, such as the lack of "ready now" commercial-off-the-shelf capabilities. Respondents also warned of adoption challenges, such as a lack of technical standardization, lack of enterprise-wide electronic learning systems integration, an insufficient number of qualified staff to help implement it, questionable data quality, and concerns with privacy and information assurance. They also had questions regarding how data should be organized, collated, managed, and controlled. This led some to forecast that full implementation of learning analytics would be a long way into the future.

Overall, respondents marked learning analytics as a growth area, with high levels of interest and perceived value; yet, they also seem to perceive it as a complex and nascent capability, with high levels of risk. To mitigate that risk, it is recommended nations look for examples of "inkblots of excellence" in this area, to identify challenges and lessons learned—and then share these results across the defense organizations.

(3) Identify opportunities to facilitate coordinated implementation of 5G-enabled **Mobile Learning**

In aggregate, *Mobile Learning* was rated as the second most popular trend, in terms of interest. Respondents also ranked it among the overall top-five trends in terms of perceived value, with NZL and GBR respectively ranking it as the first and second most valuable. Despite the positive outlook on its promise, the five nations reported inconsistent instantiations of mobile learning, both between nations and within any given military, and across all nations respondents worried implementation barriers would delay or prevent its full adoption. They remarked on the lack of policy guidance, cybersecurity concerns, coordination issues with developing and disseminating m-learning content, and network infrastructure limitations; saying, for example, "no central policy to guide this approach; ad-hoc adoption by schools/learning institutions" and "the desire to adopt mobile learning is strong but infrastructure limitations (no WiFi and poor 3/4G coverage at military sites) make it impractical at present."

Training and education stakeholders have a unique opportunity to capitalize on the high-levels of interest in mobile learning and the simultaneous development of 5G capabilities. A useful first step may be to examine the benefits of a shared 5G mobile learning infrastructure, to include network connectivity, the hosting and distribution system, and associated implementation policy. If they act quickly and in concert, the nations could outpace the development of duplicative, local 5G m-learning solutions that will inevitably appear across their defense enterprises.

(4) Inventory enterprise-level challenges, possible solutions, and ROI for **Individual Personalized Learning**

Individual Personalized Learning represents another area of high perceived value and future growth, ranking among the top five highest-value trends across four of the five nations—even though levels of interest for this trend were only moderate. The discrepancy between perceived value and perceived interest might be attributable to the number of

anticipated implementation barriers, which many respondents noted in their comments. Barriers included financial constraints, lacking a suitable number of skilled personnel, and constraining bureaucratic processes. Participants also indicated this "approach would require a significant culture change" and "there may be an impact on training pipelines (e.g., availability of personnel on completion of training)."

Despite these challenges, respondents from USA and NZL highlighted a few projects ongoing in this area, including the Total Learning Architecture Project (TLA) and some self-paced learning initiatives. Most personalized learning projects still tend to be localized, though, while the concerns raised emphasized issues with scaling personalized learning to enterprise levels. Hence, given the high interest and perceived promise in this area, and the apparent successes of localized projects, it would be worthwhile to formally document the specific challenges for scaling-up personalized learning to defense-wide implementation. This comprehensive list of challenges should also identify possible solutions for barriers, and for the sake of practicality, it should also evaluate the solutions with an eye towards return-on-investment (ROI).

(5) Investigate **Content Repositories** as part of the gaps/risk analysis task described in Recommendation 4

Content Repositories were rated as the fourth most interesting trend, and Canadian respondents listed it as the third most beneficial trend. In the qualitative comments, AUS and USA respondents also underscored its importance. For instance, one participant remarked they are "a critical component to achieve true, adaptive and personalized training." Others wrote that content repositories are "a growth area that will mature over time" and the "lure of reusable content is strong." Despite these endorsements, this trend's current adoption levels are relatively low, and in aggregate, respondents ranked it near the middle in terms of its potential value. This means that, similar to individual personalized learning, respondents' feedback about content repositories is mixed. The mixed signals may be attributable to the perceived barriers to implementing and maintaining such repositories. Respondents raised concerns about maintaining up-to-date content and data integrity issues, and two NZL respondents noted that, while they are exploring content repositories, their implementation "will require a digital end-to-end process to be developed first." Other reasons for the disparate data may be a lack of widespread understanding of content repositories. As one USA respondent explained, "few IT folks understand its value and reason for slow adoption in Navy functional requirements." If this is true, it implies some people may not fully appreciate the critical role repositories play in enterprise learning systems (i.e., serving as enablers to other trends, including the top three "most valuable" trends: *Performance Support: "Point of Need" Learning*, *Learning Analytics*, and *Individual Personalized Learning*).

So, there appears to be high interest in content repositories, but some questions regarding their potential ROI. In this instance, the hesitancy in implementing them may lie in both their perceived challenges (costs) and lack of communication around their utility (benefits). Hence, it would be worthwhile to formally document the specific challenges, possible solutions, and ROI associated with this trend. This work could be conducted in parallel with the gaps/risks analysis report described in Recommendation 4—particularly given that enterprise content repositories (in some form) will likely be a necessary component of an effective personalized learning system.

(6) Review R&D investments for the lowest-ranked trends, e.g., **Biofeedback**, **Blockchain**, and **Crowdsourcing**

While all of the learning trends included on the survey have value and garnered interest from the respondents, some ranked lower than others. Specifically, *Wearable Biofeedback Technologies*, *Blockchain for Learning*, and *Crowdsourcing for Learning* were rated towards the bottom in terms of perceived potential benefit, and they also ranked at the bottom in terms of perceived interest and future adoption. In the open-ended comments, respondents also highlighted a range of concerns for these capabilities. For *Biofeedback*, they commented on the need for new policy requirements, training for instructional staff, the need for additional research, and likely costs for procurement and maintenance. For *Blockchain*, they highlighted questions related to data security and privacy (albeit with comments that blockchain could also mitigate these concerns), and comments pointed to new policy and research that would be needed. Similarly, for *Crowdsourcing*, respondents pointed to data protection and copyright issues, as well as the need for policy, processes, and updated IT infrastructures (e.g., "large, connected, searchable data repositories").

The low ranking for these trends should not necessarily imply they are poor investments; however, it does raise questions. The most obvious is whether these trends represent good targets for investment, in terms of ongoing research in these areas. If current investment levels are adequate, then are stakeholders fully aware of these projects and their potential value? Are researchers taking appropriate steps to engage their eventual end-users and other stakeholders? Are the perceived risks manageable, and do the potential benefits warrant the costs needed to overcome the barriers to adoption? As a next step in these areas, it may be worthwhile to investigate the level of integration between the research and operational communities for these three trends and for the research labs to evaluate the right levels of investments for these R&D topics—which in some cases may require *more* investment to ensure their deliverables are well-aligned with the operational context they will eventually transition into.

(7) Develop best practice guides to help implement **eBooks** in focused, low-barrier contexts

Responses regarding *eBooks* were a mixed bag. Respondents indicated relatively low-levels of interest, moderate levels of perceived value, and some remarks noted they are a low priority. Nonetheless, comments also indicated some stakeholders view them as beneficial and "a good return on investment." More notably, *eBooks* were ranked first in terms of soonest full adoption, with the USA leading in this regard, followed by CAN. In fact, USA respondents ranked *eBooks* first in terms of shortest adoption timeframe, and one USA stakeholder noted the Navy is actively adopting ebooks as a primary delivery platform. Regarding implementation barriers, three themes stood out from the open-ended comments. First, stakeholders felt learners and instructors would need some training in the best use of ebooks. Second, ebooks as internet-connected mobile devices (versus platforms with libraries of preloaded books) may present logistical challenges, and third using ebooks for sensitive content may present challenges. Based on these comments, it appears that ebooks may prove useful in low-barrier contexts, i.e., when the content is unclassified and the ebooks can function without consistent external-internet connections. A worthwhile next step may be for those defense organizations that are already adopting ebooks to lead development of a "best practices" guide for training/education administrators, instructors, and learners on their use.

(8) Catalog case studies of both effective and ineffective **Game-Based Learning** in defense contexts

Respondents showed only moderate interest in *Game-Based Learning* but still rated it among the top-five in terms of perceived value. When looking at the by-nation responses, it becomes clear the five nations had notably different perceptions of this trend, which likely caused the mixed results. USA participants reported higher levels of both interest and current adoption rates, and USA and GBR reported greater perceived value of game-based learning than the other nations. These discrepant results make game-based learning an interesting target for additional investigation.

The disparate responses might stem from questions on the utility of game-based learning. Some comments highlighted concerns regarding its efficacy, and others identified a range of cautionary notes. These included a need to validate performance improvement from game-based learning and to ensure game-play does not overrule the uptake of material. Stakeholders also noted a lack of coordination in the implementation of game-based learning (as the mixed results suggest). These responses raise questions: Does game-based learning lead to better outcomes in military contexts, and if so, under what conditions does it offer good ROI? The disparate results seem to imply game-based learning is suited to only certain conditions. A relatively simple way to identify those conditions may be to examine case studies from *military* uses of game-based learning, ensuring to include both effective and ineffective examples. This could inform a short guide on where and how to best use (or avoid) game-based learning, in practice.

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