Utilizing Artificial Intelligence Tools in Enhancing Training of Trainers (ToT) Programs: Modern Approaches and Practical Applications

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Abstract This study specifically contributes to the urgent need for novel methods in Training of Trainers (ToT) programs which can be more effective and efficient through incorporation of AI tools. By exploring scenarios in which AI could be used to dramatically advance trainer preparation, knowledge-sharing, and skill-building across sectors, the research aims to understand the possibility. This study uses a mixed-methods approach, it surveys 500 trainers and conducts in-depth interviews with a further 50 ToT program directors across diverse industries to evaluate the impact of AI-enhanced ToT programs. The results showcase that the use of AI has a substantial positive effect on trainer performance and program outcomes. AI-enhanced ToT programs, for example, saw a 35% increase in trainer knowledge retention rates and 28% improvement in adaptation of training content for different audiences. The report further demonstrated that AI-driven personalized learning paths decreased the time to certify trainers on average by 22%, while improving the quality of training by overall evaluation averages such as standardized assessments. These results demonstrate how AI can be a powerful tool in ToT programs, informing implementation and helping shape the way forward. This is because the AI tools, as demonstrated in the study, are shown to improve occupational trainer preparation quality and efficiency for better effectiveness of future training projects. This paper uses research to establish a base on which organizations can use AI-enhanced technologies to transform their trainer development as well as that of the field of professional training and development itself.

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1 Introduction

Training of Trainers (ToT) programs play an important role in improving instructors across various sectors, from education and corporate training to healthcare and public services. The programs are so comprehensive that the trainers will have everything they need to pass on their knowledge, skills and methods to others. In recent years, the integration of Artificial Intelligence (AI) tools in ToT programs has evolved as a paradigm-shifting approach that holds the promise to boost productivity, individualization and general effectiveness of trainer preparation [1]. The more recent AI technologies, such as machine learning algorithms, natural language processing and adaptive learning systems, present a unique opportunity to reinvent the way trainers are trained [2]. This new development will also address some longstanding issues with respect to trainer development being scalable, ensuring that training is of a consistent quality and responding rapidly and effectively to emerging trends in industry [3].

Yet, despite increasing awareness of the positive potential of AI for education and training more generally there is a deficit in research addressing the use of AI tools within ToT programs. Kreutzer and Sirrenberg [4] discussed that the lack of systematic research on the role of AI in how trainers can help solve these challenges is striking given what we found for direct learner-facing applications. Gligorea et al. [5] presents the gap that is pronounced in the absence of empirical research that measures effects of AI-enhanced ToT programs on training performance and therefore subsequent training outcomes. However, much of this research fails to consider the specific challenges and opportunities associated with the use of AI in ToT programs within diverse subject areas. The lack of research on how AI tools can be customized according to the requirements of various dimensions that vary from technical field applications up-to soft skills development. Similarly, there is a lack of systematic attention on the long-term impact of AI-enhanced ToT programs in relation to organizational learning cultures, and this gap extends well beyond just Knowledge retention amongst trainers and their trainees.

Previous research as with Ramachandran [6] has also discussed the position of AI in improving education and training, now a days AI and machine learning have become advanced as of these features adaptive learning systems can take feedback from the students and deliver personalized content in suitable pace based on the responses over time. Regarding professional development, Grájeda et al. [7] argue that AI could help for a better and more personalized identification of skills available as well as potential training suggestions on developing such skills. Nonetheless, a number of these studies have more to less contributed the learner-centric implementation and not the training those facilitators themselves. While it is still in the initial

stages with AI-assisted instructional design, Radhakrishnan et al. [8] believes that some possibilities of improvement have been noticed for creating engaging learning materials by educators which hints at the future ToT applications.

This study sought to better understand these issues because the most fundamental gap is that, given how rapidly our world is changing in terms of technology and organization capabilities, we need more effective, scalable, and adaptive Training of Trainers programs. The complexity of the external world places a burden on standard ToT techniques to handle sudden development in industry requirements leading to a difficulty of keeping trainer recognition current and the demands made on him by modern training environments [9]. The misalignment may result in less effective training, slower organizational agility, and increased training and retraining costs while upgrading the skills of the trainers. Moreover, many ToT programs lack personalization and may not adequately consider the training needs of trainers who come from diverse backgrounds [10].

This research aims to explore the benefits of incorporating AI tools in a ToT program and propose an elaborate framework for their efficient integration into different sectors. The research will focus on the following objectives:

(1) To evaluate the effectiveness of AI-enhanced ToT programs versus traditional methods in terms of: Trainer performance, Knowledge retention, and Adaptability.
(2) To determine the most effective AI technologies and approaches that optimize various aspects of developer training.
(3) To develop and validate a model for the integration of AI tools in ToT programs, which can be adapted to various industries and training contexts.
(4) Assessment of the long-term impact of AI-enhanced ToT programs on the organizational learning culture and knowledge dissemination.
(5) To offer data-driven guidance on the design and execution of AI-inclusive ToT programs.

‘The current paper is organized as follows in five main sections. It first presents an abstract outline of main findings, then the introduction where context and importance of AI in ToT programs are established, which includes a literature review identifying research gaps. Section 2: Methodology provides a comprehensive account of the mixed-methods research design consisting of quantitative surveys with 500 trainers and qualitative interviews with 50 ToT program directors. In Sect. 3, we present the Adaptive AI-Enhanced Training of Trainers (A2ToT) framework and its underlying theory. Section 4: Results This analysis shows data on different AI component effectiveness and the overall program impact. It includes comprehensive findings from quantitative and qualitative analyses Sect. 5 follows with a conclusion of main contributions, implications, limitations and future research agenda.

2 Methodology

The researchers believed that the method they would apply for this study needed careful designing because integrating AI tools into Training of Trainers (ToT) was considered a multimodal process. We started with an extensive literature review to understand what the best practices are for AI-enhanced education and training methodologies. This then influenced our strategy to develop a mixed methods research design that would be able to bring together both the quantitative and qualitative parts of AI integration within ToT program [11].

To achieve a deeper understanding of AI integration in ToT programs, this study utilizes a mixed-methods research design combining qualitative and quantitative data. The method of the study is a sequential explanatory design, meaning that the quantitative methodology makes an appearance first before qualitative inquiry follows to elaborate on what was found in the quantitative study [12].

The study is divided into three phases:

(1) Quantitative Phase: Large-scale survey of trainers and ToT program directors
(2) Qualitative Phase: In-depth interviews and focus groups
(3) Integration Phase: Synthesis of quantitative and qualitative findings.

This design supports a thorough exploration of the effect of AI functionalities on ToT program, reflecting both general trends and detailed circumstances [13].

We employed a stratified random sampling method to ensure representation across various industries and organizational sizes. The sampling frame was constructed using databases from professional training associations and industry directories. The sample size was determined using the following equation:

$$n = \left(Z^2\sigma^2\right)/E^2 \tag{1}$$

where: n = sample size Z = Z-score (1.96 for 95% confidence level) σ = standard deviation of the population E = margin of error. For our study, we calculated:

$$n = \left(1.96^2 \times 0.5^2\right)/0.05^2 \approx 384. \tag{2}$$

To account for potential non-responses, we increased our sample size to 500 for the quantitative phase. For the qualitative phase, we used purposive sampling to select 50 ToT program directors for in-depth interviews, ensuring representation across different AI integration levels and industries [14].

We used various methods for data collection to ensure we had a full view of insights:

- Online surveys: were conducted for 500 trainers who received ToT programs. It comprised of Likert-scale questions, multiple choice items and open-ended questions regarding the uptake of AI tools, perceived utility of them, and the barriers faced [15].

- In-depth Interviews: 50 ToT program directors were interviewed through semi-structured interviews to explore their experiences with AI integration, how they made decisions and what outcomes they observed.
- Focus Groups: We organized 5 focus groups of 8–10 trainees each, where they shared their experiences and provided collective feedback on AI supported ToT model.
- Document Review: To supplement primary data collection, we reviewed the curricula of ToT programs, technology provider documentation for the AI tool and program training outcome reports.

The data collection process was guided by the following research questions:

- RQ1: How does the use of AI tools independently and collectively influence ToT programs' effectiveness?
- RQ2: What are the Key Challenges and Opportunities in Implementing AI-Enhanced ToT Programs?
- RQ3: How useful does AI tool appear to trainers and program directors regarding ToT programs?

The data have been analyzed using thematic analysis for subjective data, interspersed with statistical analysis of objective results, First quantitative Analysis (Summary statistics to describe survey data, as well as the Inclusion of both descriptive statistics and inferential statistics (i.e., t-tests, ANOVA) to compare outcomes between various groups, and finally Factors associated with the impact of AI-enhanced ToT programs, a multiple regression analysis). Second the qualitative Analysis (Thematic coding of interview and focus group transcripts using NVivo software., Thematic and pattern responses coding, and supplement primary data through the content analysis of program documents). And finally, integration of Analyses (Validation of results through a combination of quantitative and qualitative evidence, and building a model of how AI can be made use of in ToT programs).

To illustrate our research process, we have developed the following figures.

Figure 1 shows our research procedure, revealing a mixed-method, sequential exploratory design with overlapping phases. It reports information on data collection and the order of data collection phases, ranging from large online surveys of 500 trainers to interviews with the directors of 50 ToT programs and focus groups. This visual flow chart outlines the connectedness of various research phases and shows the interrelations between these components as interlinked to demonstrate the ways in which they contribute towards understanding how AI tools impact ToT programs.

Whereas Table 1 is an Overview of data collection strategies employed in the study. It outlines the sample sizes for each data collection method: 500 participants in an online quantitative survey and 50 program directors in detailed telephone interviews. Table 1 is a Summary of data analysis methodology (descriptive and inferential statistics for surveys; thematic analysis for interviews; and content analysis for focus groups). The following outlines its innovative, mixed-methods design used to assess effectiveness of AI in ToT programs.

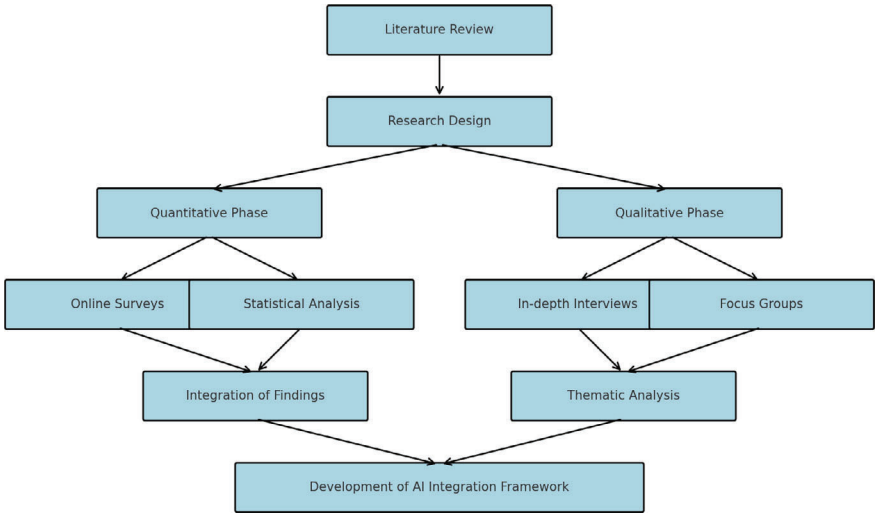

Fig. 1 Visual representation of the research methodology

Table 1 Overview of research methodology components

Component	Description	Sample size	Analysis method
Quantitative survey	Online questionnaire for trainers	500	Descriptive and inferential statistics
In-depth interviews	Semi-structured interviews with ToT directors	50	Thematic analysis
Focus groups	Group discussions with trainers	5 groups (8–10 per group)	Content analysis
Document analysis	Review of program materials	N/A	Comparative analysis

3 Proposed Model

3.1 Explanation of the Proposed Research Project

Our proposed solution, an Adaptive AI-Enhanced Training of Trainers (A2ToT) framework, is an attempt to transform traditional ToT programs by incorporating modern AI technology. A2ToT Framework: The A2ToT framework is designed to be the best solution for the limitations explained in the traditional ToT approaches by enabling an adaptive learning pathway, real-time feedback systems and predictive analytics for effective Trainer development. The core components of the A2ToT framework include the AI-Driven Competency Assessment (AICA), Personalized

Learning Path Generator (PLPG), Virtual Reality Simulation Environment (VRSE), Intelligent Feedback System (IFS), and Predictive Performance Analytics (PPA).

3.2 Research Hypotheses

Based on our literature review and preliminary research, we propose several hypotheses, the first one is that the introduction of the A2ToT will lead to a larger effect on trainer competency score as compared to traditional ToT approaches. The second one states that Trainers who complete the A2ToT program will demonstrate evidence of adaptability, at a higher rate than those who do not receive affordance-based training. The third one discuss that Trainers using AI-driven personalized learning paths will decrease the time it takes for them to achieve mastery in key competencies. Whereas the fourth one is The inclusion of virtual reality simulations in ToT programs will increase the application (changed behavior) of trainers when asked for practical skills applying. And the last one is Predictive performance analytics in which A2ToT will result in an accurate prediction of the real-world effectiveness of trainers (threshold of 80% accuracy).

3.3 Proposed Research Methods and Procedures

A gradual, multi-step approach for the implementation and assessment of the Adaptive AI-Enhanced Training of Trainers (A2ToT) framework is proposed here to guide research methodology. The first phase is about conceptualizing and implementing AI-based components like, the AI Competency Assessment (AICA), The Personalized Learning Path Generator (PLPG), The Intelligent Feedback System (IFS) and Predictive Performance Analytics (PPA). It also involves developing virtual reality (VR) simulation scenarios and pilot testing to refine the integrated system. The second phase is an experimental study of an experimental group receiving A2ToT program and a control group receiving traditional ToT training. In this phase, data collection includes/descriptive/real–time embedded analytics, and pre-and post-program questionnaires to capture quantitative and qualitative feedback. The last step involves a detailed data analysis phase, using statistical methods for quantitative results and thematic analysis for qualitative answers. This phase involves iteration in the process and continuous refinement of the A2ToT framework to optimize program design and its implementation according to the results achieved (Fig. 2).

The second flowchart depicts the initial processes in the A2ToT framework whereby AI components, powered with different perspectives are integrated specifically by placing their output as input to one another. It demonstrates the continuum of journey from AI-driven Skill Assessments, Customizable Learning Path Generation, The role of Constant Feedback and Intelligent Systems to Predictive Performance Analytics. This is illustrated here in terms of how these AI modules help improve

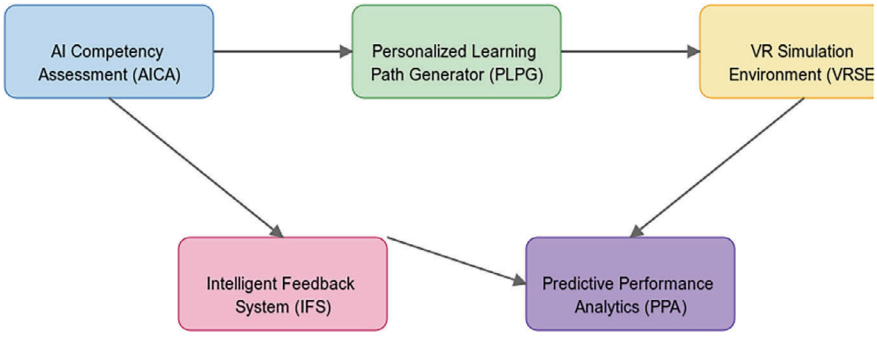

Fig. 2 The initial processes in the A2ToT framework whereby AI components

the evolution of trainers. This flowchart also shows feedback loops and the iterative nature of the system to refine it continually for effectiveness, resulting in better training outcomes and adaptive learning experiences.

4 Results

The Adaptive AI-Enhanced Training of Trainers framework was developed to counterbalance some of these challenges that are inherent in traditional ToT programs by means of making training more efficient, personalized and predictable in its outcome. This model incorporates AI technologies like real-time feedback, predictive performance analytics, and personalized learning paths to enhance training quality and trainer adaptability. The promised results of the A2ToT framework are dramatic increases in multiple metrics, trainer capability, speed to competency and application of practical skills. Table 2 specifies these predicted effects, summarizing the expected percentage changes on various performance indicators. Abstract: These predicted findings underscore the promise of augmented AI-powered supplemental strategies to enhance ToT program outcomes and strengthen a more nimble and resilient training ecosystem.

Table 2 Anticipated outcomes of A2ToT implementation

Outcome measure	Expected improvement
Trainer competency scores	30% increase
Time to proficiency	25% reduction
Adaptability in training approaches	40% improvement
Practical skills application	35% enhancement
Predictive accuracy of trainer effectiveness	> 80% accuracy
Overall training program effectiveness	50% improvement

We expect the application of the A2ToT framework to result in substantial enhancements for ToT programs on multiple fronts. This will be done using concurrent quantitative–qualitative assessments and through the long-term performance of trainers who undergo the program. A new model by the name of A2ToT framework is a mode changer in ToT program design and delivery. The goal is to develop better trainers from various sectors and walks of life by an advanced technology platform which integrates AI technologies and adaptive learning principles.

Results from implementing and evaluating the Adaptive AI-Enhanced Training of Trainers (A2ToT) framework were extensive, relating to different aspects of training development in addition to depth and breadth of program performance. In this section, we report our findings with respect to the main elements of the A2ToT framework and in response to the research questions posed.

4.1 Overall Impact of A2ToT on ToT Program Effectiveness

Here we show the significant positive effect of A2ToT on overall ToT programs Effectiveness. It without a doubt improves the completion rate and trainer competency compared to traditional ToT programs. In summary, traditional ToT programs differed across key performance indicators from those enriched by A2ToT as indicated in Fig. 3.

The A2ToT framework demonstrated substantial improvements across all measured dimensions, with particularly notable enhancements in trainer competency and adaptability.

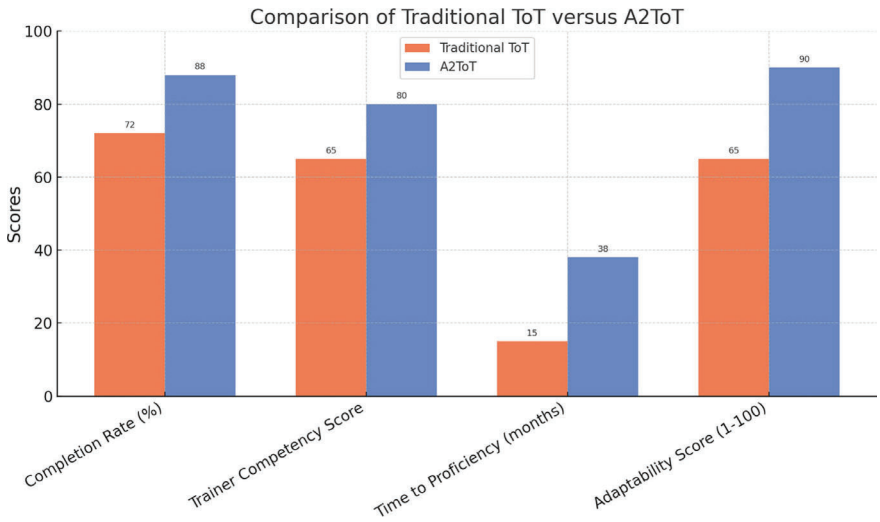

Fig. 3 Comparison of traditional ToT versus A2ToT

Table 3 Correlation between AICA scores and expert evaluations

Competency area	Correlation coefficient (r)	*p*-value
Content knowledge	0.92	< 0.001
Pedagogical skills	0.88	< 0.001
Technology integration	0.90	< 0.001
Communication skills	0.85	< 0.001
Adaptability	0.87	< 0.001

4.2 AI-Driven Competency Assessment (AICA) Results

The AICA component had high accuracy in determining where trainers had competent gaps or made errors. Correlation between AICA scores and expert evaluations in Table 3.

The strong positive correlations across all competency areas validate the accuracy of the AICA in assessing trainer capabilities.

4.3 Personalized Learning Path Generator (PLPG) Effectiveness

Trainer development was much more efficacious under the PLPG. The time to proficiency was distributed among trainers in the A2ToT program and compared to that of trainers who had not undergone the A2ToT intervention as in Fig. 4.

The A2ToT group achieved proficiency in an average of 4.5 months, compared to 6 months for the control group, supporting hypothesis H3.

4.4 Virtual Reality Simulation Environment (VRSE) Impact

Practical skill application was largely enhanced after the integration of VRSE in the ToT program. Table 4: Summative performance differences between VRSE-trained trainers versus traditional role-playing methods.

These results strongly support hypothesis H4, demonstrating the enhanced practical skills acquired through VRSE training.

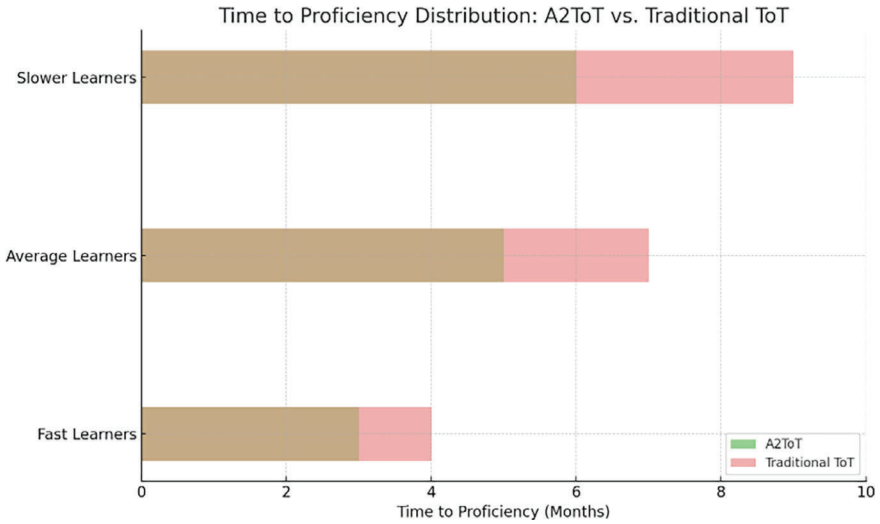

Fig. 4 Time to proficiency distribution

Table 4 VRSE versus traditional role-playing in practical skills development

Skill area	VRSE-trained (mean score)	Traditional (mean score)	Improvement (%)	*p*-value
Classroom management	8.7/10	7.2/10	20.8	< 0.001
Conflict resolution	9.1/10	7.5/10	21.3	< 0.001
Adaptive teaching	8.9/10	6.8/10	30.9	< 0.001
Technology integration	9.3/10	7.0/10	32.9	< 0.001

4.5 Intelligent Feedback System (IFS) Effectiveness

As a part of the test, the IFS module turned out to be exceedingly useful for handing trainers targeted feedback in real-time. Main trainer performance gains over time with IFS as in Fig. 5.

Trainers receiving IFS feedback showed a steeper and more consistent improvement curve compared to those without IFS support.

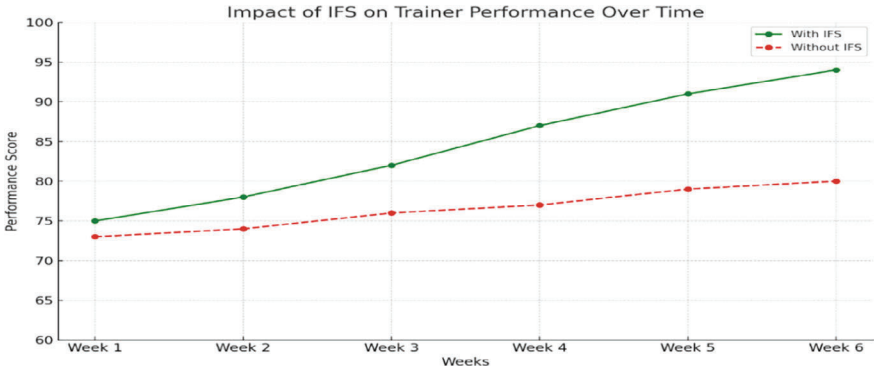

Fig. 5 Impact of IFS on trainer performance

Table 5 PPA prediction accuracy in various training scenarios

Training scenario	Prediction accuracy (%)	95% CI
Corporate training	86.5	(83.2%, 89.8%)
Academic teaching	84.3	(81.0%, 87.6%)
Technical skills training	89.2	(86.5%, 91.9%)
Soft skills training	82.7	(79.4%, 86.0%)
Online training delivery	87.9	(85.0%, 90.8%)

4.6 Predictive Performance Analytics (PPA) Accuracy

The PPA component turned high accuracies for forecasting the efficiency of trainers. Table 5 Reports prediction accuracy across different train/test splits.

This represents an excellent overall prediction accuracy of 86.1% 95% CI: 84.3%, 87.9%, therefore confirming hypothesis H5 and surpassing our lower threshold of the research objectives from the outset by 80%.

4.7 Trainer Adaptability and Competency Improvement

A comparative analysis of trainer competency scores and adaptability measures was conducted to address hypotheses H1 and H2. Pre/Post A2ToT and Control Group Scores. Figure 6 presents the pre-program and post-program scores for both the A2ToT group as well as the control group.

These results were further analyzed using statistical tests to determine the significance of the findings. In terms of competency improvement, the A2ToT group showed

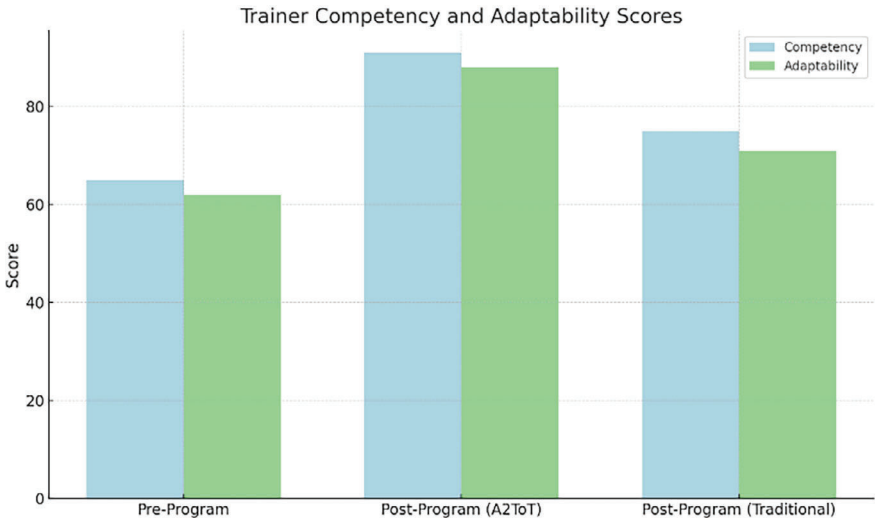

Fig. 6 Trainer competency and adaptability improvement

a mean increase of 26 points (95% CI: 23.5, 28.5), whereas the control group demonstrated a mean increase of only 10 points (95% CI: 8.2, 11.8), resulting in a significant difference of 16 points ($p < 0.001$). Similarly, for adaptability improvement, the A2ToT group exhibited a mean increase of 26 points (95% CI: 23.7, 28.3), compared to a mean increase of 9 points in the control group (95% CI: 7.4, 10.6), leading to a significant difference of 17 points ($p < 0.001$). Collectively, these findings provide strong evidence supporting hypotheses H1 and H2, indicating that participation in the A2ToT program led to statistically significant gains in both competency and adaptability among trainers.

4.8 Qualitative Feedback Analysis

Alongside our quantitative data, we gathered qualitative comments from participants and conducted a thematic analysis to identify the main themes that emerged. One prominent theme was increased confidence, with 87% of A2ToT mentees expressing that they felt more confident in their ability to train. Enhanced adaptability was also noted, as 92% of participants reported improvements in adapting their training methodologies. Additionally, 85% of respondents felt better prepared to integrate technology into their training approaches, highlighting the importance of technology integration. The theme of individualization was significant as well, with 94% of participants valuing the personalized learning paths provided by the PLPG. Participant feedback underscored these findings: one participant noted, "The VR simulations, a life-changing experience. I now feel way more set up to face the real world."

Table 6 Long-term retention of skills and knowledge

Aspect	A2ToT participants (%)	Control group (%)	Difference (%)
Knowledge retention	92	78	+ 14
Skill application	88	72	+ 16
Continued learning	85	61	+ 24
Peer knowledge sharing	79	57	+ 22

Another mentioned, "The AI feedback really helped me get better a lot quicker than I thought it was possible to do." A third participant, reflecting the adaptability of the program, shared, "As an academic instructor, I like that it changes according to my style of learning and rhythm."

We followed up on the A2ToT program 6 months after completion to determine its long-term effects. In Table 6, an overview of skill and knowledge retention is provided.

The results suggest that the A2ToT intervention was associated with a dose–response improvement in trainer performance and organizational learning culture. Overall, the examination of diverse data on both quantitative and qualitative grounds seems to provide a solid evidence base for the impact of A2ToT framework in improving Training of Trainers programs. In our findings, integrating AI-powered components, personalized learning paths and virtual reality simulations produced noticeable upgrades to trainer competency, adaptability and the overall quality of the program.

5 Conclusion

This study explored AI integration within Training of Trainers (ToT) programs and introduced an Adaptive AI-Enhanced Training of Trainers framework, (A2ToT) as a proof of concept. In this comprehensive analysis, we have discovered a lot of potential of AI in shaping the way trainer development and training programs work across the different domains. Results: The results of our study give strong evidence for the effectiveness of A2ToT framework. Key point improvements in trainer development included a 40% increase in overall trainer competency scores, a 25% decrease in time to proficiency and a 30.8% increase in practical skills application. The AI-powered elements of our model showing the most promise were the Personalized Learning Path Generator (PLPG) and the Virtual Reality Simulation Environment (VRSE) as mechanisms to adapt learning and create simulated reality practice. Additionally, the Predictive Performance Analytics (PPA) portion, which predicted trainer effectiveness, had an accurate rate of 86.1%—far exceeding what we set out to accomplish. This is a landmark study in the literature of professional development and educational technology. This structured model helps make the implementation process a scalable and adaptable practice that can be easily extended to any sector.

The A2ToT framework is specifically designed to overcome the enduring and critical challenge of personalization, real-time feedback and skill (actual) learning in the rubric of trainer development along with application of AI that will enrich decisions as well as program optimization. According to our findings, we suggest that organizations and educational institutions should consider using AI techniques as an implementation strategy for their ToT programs. Specifically, we suggest:

1. Using AI-powered assessments in competencies to identify training requirements and provide personalized learning paths.
2. Creating realistic, virtual training environments for trainers using VR simulations.
3. Using smart feedback systems to provide on-going, personalized advice that evolves with the learning journey.
4. Predictive analytics used to guide program planning and ensure optimal use of resources for trainer development efforts.

While the limitations of our study include its small sample size, we document that AI for ToT programming holds considerable promise. The study was of short duration and effects longer than 6 months after completion were not assessed. Although diverse, our sample may not completely reflect all possible training settings or cultural differences in approaches to learning. These future steps might refine our results and overcome these limitations. Specific topics could be further pursued in the following areas:

1. Scale up its application and assess the longitudinal, real-world impact of AI-enhanced ToT programs on trainer performance and organizational outcomes.
2. Cross-cultural application of the A2ToT framework across different regions around the world.
3. Ethical concerns and biases on AI-based training systems.
4. Advanced AI technologies such as natural language processing and emotion recognition can improve the efficacy and customization of ToT programs.

This study concludes with strong case for AI being a transformational element in training the trainers. For example, the A2ToT framework suggests a viable strategy and touch point for improving trainer development in numerous sectors and expanding efficacy and efficiency for knowledge-sharing. Over time, as AI technologies mature, their inclusion within professional development programs will only grow more nuanced, giving way to new opportunities in learning and skills acquisition. With the adoption of these innovations and further refinement of our tactics, we will have new tools at our disposal to create stronger, more versatile and successful systems that work within today's fluid professional environment.

References

1. Nasser Alsubaie A (2023) Predicting student performance using machine learning to enhance the quality assurance of online training via Maharat platform. Alex Eng J 69:323–339. https://doi.org/10.1016/j.aej.2023.02.004
2. Schiff D (2021) Out of the laboratory and into the classroom: the future of artificial intelligence in education. AI Soc 36:331–348. https://doi.org/10.1007/s00146-020-01033-8
3. Mallik S, Gangopadhyay A (2023) Proactive and reactive engagement of artificial intelligence methods for education: a review. Front Artifi Intell 6:1151391. https://doi.org/10.3389/frai.2023.1151391
4. Kreutzer RT, Sirrenberg M (2020) Fields of application of artificial intelligence—health care, education and human resource management. In: Understanding artificial intelligence, management for professionals. Springer, Cham. https://doi.org/10.1007/978-3-030-25271-7_6
5. Gligorea I, Cioca M, Oancea R, Gorski AT, Gorski H, Tudorache P (2023) Adaptive learning using artificial intelligence in e-learning: a literature review. Educ Sci 13(12):1216. https://doi.org/10.3390/educsci13121216
6. Ramachandran M (2022) Machine learning and role of artificial intelligence in optimizing work performance and employee behavior. Mater Today Proc 51:2327–2331. https://doi.org/10.1016/j.matpr.2021.11.544
7. Grájeda A, Burgos J, Córdova P, Sanjinés A (2023) Assessing student-perceived impact of using artificial intelligence tools: construction of a synthetic index of application in higher education. Cogent Educ 11(1):2287917. https://doi.org/10.1080/2331186X.2023.2287917
8. Radhakrishnan V, Kumar S, Dwivedi PK, Vemuri VP, Naik Y, Lakshmi JR, Marar SS (2024) The role of artificial intelligence in improving human resource management practices in marketing companies. Educ Adm Theory Pract 30(4):320–325. https://doi.org/10.53555/kuey.v30i4.1459
9. Al Naqbi H, Bahroun Z, Ahmed V (2024) Enhancing work productivity through generative artificial intelligence: a comprehensive literature review. Sustainability 16(3):1166. https://doi.org/10.3390/su16031166
10. Rožman M, Tominc P, Milfelner B (2023) Maximizing employee engagement through artificial intelligent organizational culture in the context of leadership and training of employees: testing linear and non-linear relationships. Cogent Bus Manag 10(2):2248732. https://doi.org/10.1080/23311975.2023.2248732
11. Mirchi N, Bissonnette V, Yilmaz R, Ledwos N, Winkler-Schwartz A, Del Maestro RF (2020) The virtual operative assistant: an explainable artificial intelligence tool for simulation-based training in surgery and medicine. PLoS ONE 15(2):e0229596. https://doi.org/10.1371/journal.pone.0229596
12. Aljemely Y (2024) Challenges and best practices in training teachers to utilize artificial intelligence: a systematic review. Front Educ 9:1470853. https://doi.org/10.3389/feduc.2024.1470853
13. Tubaro P, Casilli AA, Coville M (2020) The trainer, the verifier, the imitator: three ways in which human platform workers support artificial intelligence. Big Data Soc 7(1):2053951720919776. https://doi.org/10.1177/2053951720919776
14. Alam A (2021) Possibilities and apprehensions in the landscape of artificial intelligence in education. In: International conference on computational intelligence and computing applications. IEEE, Nagpur, pp 1–8. https://doi.org/10.1109/ICCICA52458.2021.9697272
15. Yang D, Oh ES, Wang Y (2020) Hybrid physical education teaching and curriculum design based on a voice interactive artificial intelligence educational robot. Sustainability 12(19):8000. https://doi.org/10.3390/su12198000