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LECTURE-GROUNDED CHATGPT-4 TUTOR: ENHANCING ADULT LEARNER ENGAGEMENT IN DISTANCE LEARNING

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Abstract

Adult learners in remote university programs often struggle with engagement and satisfaction due to limited real-time interaction and support. This presentation introduces an AI-powered learning tutor that leverages ChatGPT-4 in a context-restricted manner, operating strictly within the instructor's lecture materials and spoken content. By grounding the AI's knowledge solely in the course textbooks, slides, transcripts, and other instructor-provided materials, the system delivers domain-specific support that is aligned with the curriculum and instructor's intent. This controlled knowledge scope is a key innovation: it mitigates the usual pitfalls of generative AI (such as misinformation or irrelevant "hallucinations") by ensuring answers remain faithful to the course content. The AI tutor functions as a virtual teaching assistant, available 24/7 to answer questions and engage in dialogue about the lecture topics. Adult learners can thus seek help at any time without fear of judgment, asking questions they might hesitate to pose to a human instructor. This on-demand, non-judgmental support has been observed to boost learner confidence and promote deeper exploration of course material. Early classroom deployments of the tutor have yielded increased student engagement and satisfaction: the AI's ability to hold extended conversations within the bounds of the courseware has enhanced learners' cognitive engagement and the sense of an instructor presence in remote classes. Learners reported feeling more supported and motivated, and instructors noted students coming to class better prepared. We also discuss the pedagogical implications of constraining an AI tutor's knowledge scope. This approach empowers educators to maintain content control and uphold academic standards while still harnessing AI's scalability and responsiveness. Instructors can focus on higher-order mentoring as routine FAQs are handled by the AI, illustrating a new model of human–AI collaboration in education. Our findings highlight that a lecture-grounded ChatGPT-4 tutor can significantly enhance engagement and satisfaction among adult learners in remote settings,

offering a promising pathway to more interactive, inclusive, and effective online learning experiences.

Keywords:
AI-Powered Learning Tutor, Chatgpt-4, Lecture-Grounded AI, Distance University Education

1. Introduction

1.1 Research Background

In the 21st-century knowledge-based society, lifelong education has been recognized as a core driver for individual competitiveness and social development. Particularly since the COVID-19 pandemic, distance education has emerged as the center of educational paradigms; however, serious problems have been revealed in terms of adult learners' engagement and learning effectiveness. According to the Korean Educational Development Institute's survey on individual lifelong learning participation, the participation rate in lifelong education decreased sharply from 41.7% in 2019 to 28.5% in 2022, and the average annual participation hours per person also decreased by approximately 42% from 132 hours in 2018 to 77 hours in 2024, highlighting the declining participation of adult learners in distance education as a serious social issue (Korean Educational Development Institute, 2024).

The main causes of this phenomenon include decreased learning engagement and lack of individualized learning support. In a survey by the Korean Teachers and Education Workers Union, 80% of teachers responded that they recognized the widening learning gap due to remote classes, and a survey by the Korea Education and Research Information Service (KERIS) showed that only 2.4% of teachers responded that they provided customized feedback (Korea Education and Research Information Service, 2023). This suggests that current distance education systems do not adequately reflect the individual learning needs and characteristics of adult learners.

1.2 Emergence and Necessity of AI-Based Educational Tools

As an innovative approach to solving these problems, AI-based educational tools are gaining attention. In particular, ChatGPT-4, released in March 2023, is being widely used in educational settings based on improved reliability, creativity, and interactivity compared to previous versions. According to the latest meta-analysis research (analyzing 51 studies from 2022-2025), ChatGPT has a large positive impact on learning outcomes ($g = 0.867$) and shows moderate positive effects on learning perception improvement ($g = 0.456$) and higher-order thinking promotion ($g = 0.457$) (Chen, Zou, & Xie, 2023).

The global AI education market is expected to grow at an annual rate of 31.2% from $5.88 billion in 2024 to $32.27 billion in 2030, showing the potential to overcome the limitations

of traditional distance education through advantages such as 24/7 accessible personalized learning support, real-time adaptive feedback, and cost-effective educational service provision (Holmes, Bialik, & Fadel, 2019).

1.3 Innovation of Lecture-Grounded AI Tutors

The "Lecture-Grounded ChatGPT-4 Tutor" proposed in this study is an innovative approach that differentiates itself from existing general-purpose AI educational tools. AI tutors with limited knowledge scope based on specific lecture content provide the following key advantages: (1) Curriculum Consistency - perfect alignment with specific lecture learning objectives, (2) Quality Control and Reliability - minimizing the risk of providing incorrect information by using only verified educational materials as the knowledge base, (3) Learning Context Optimization - customized learning support through organic connection with lecture content, assignments, and assessments.

This approach presents a way to overcome the "hallucination" phenomenon and limitations of general responses of existing AI tutors while simultaneously securing contextual accuracy and educational validity through Retrieval-Augmented Generation (RAG) technology (Kuhn, 2023).

1.4 Research Purpose and Significance

This study aims to empirically verify the effectiveness of ChatGPT-4-based AI tutors for improving adult learners' engagement in distance education. The specific research objectives are as follows:

Theoretical Objective: Constructing an educational framework for AI tutors that integrates adult learning theory, distance education theory, and artificial intelligence educational tool theory

Empirical Objective: Measuring the effects of Lecture-Grounded ChatGPT-4 tutors on adult learners' learning engagement, satisfaction, and achievement

Methodological Objective: Development and application of mixed research methodology and learning analytics techniques for AI-based educational tool research

Practical Objective: Presenting AI tutor introduction and operation guidelines applicable in adult lifelong education settings

The academic significance of this study is first, that it presents a new paradigm of AI tutors with limited knowledge scope based on specific lecture content, departing from existing general-purpose AI educational tool research. Second, in a situation where AI educational tool effectiveness research targeting adult learners is relatively insufficient, it expands the related research area through a systematic approach based on adult learning theory. Third, it contributes to the methodological development of AI educational tool research by applying mixed research methodology that integrates multidimensional learning engagement models and learning analytics techniques.

1.5 Research Questions

The core research questions to be addressed in this study are as follows:

Research Question 1: How does the Lecture-Grounded ChatGPT-4 tutor affect adult learners' learning engagement (behavioral, cognitive, emotional, and social dimensions)?

Research Question 2: What are the effects of ChatGPT-4-based AI tutor utilization on adult learners' learning satisfaction and learning achievement?

Research Question 3: What moderating effects do adult learners' individual characteristics (digital literacy, self-directed learning ability, prior learning experience) have on the educational effectiveness of AI tutors?

Research Question 4: What differential advantages does the educational effectiveness of the Lecture-Grounded approach show compared to existing general-purpose AI tools and traditional distance education methods?

2. Theoretical Background

2.1 Adult Learning Theory (Andragogy)

2.1.1 Malcolm Knowles' Adult Learning Theory

The theoretical foundation for AI tutor research for adult learners starts from Malcolm Knowles' (1980) adult learning theory (Andragogy). Knowles presented five core assumptions about adult learners: (1) Self-concept - adults mature from dependent personalities to self-directed beings, (2) Experience - accumulated experience becomes a rich resource for learning, (3) Readiness to learn - learning readiness is formed according to developmental tasks of social roles, (4) Orientation to learning - preference for problem-centered and immediately applicable

learning, (5) Motivation to learn - intrinsic motivation drives learning (Knowles, Holton, & Swanson, 2015).

These characteristics of adult learning can be directly applied to ChatGPT-4-based AI tutor design. AI tutors can support learners' self-directedness, provide personalized learning paths based on existing experience, and promote adult learners' intrinsic motivation through immediately applicable practice-centered content (Lim & Wang, 2024).

2.1.2 Self-Directed Learning Theory

Garrison's (1997) self-directed learning theory emphasizes that adult learners can autonomously understand their learning needs and perform goal setting, resource acquisition, learning plan establishment, and evaluation. Recent research by Yang et al. (2025) analyzed the impact of self-determination theory on learner engagement in e-learning environments and confirmed that social support, self-regulated learning, and flow experience positively affect learning engagement.

AI tutors can effectively support these core elements of self-directed learning: learning goal setting support, provision of various learning resources and strategies, continuous self-assessment opportunities, and 24/7 learning support ensuring learner autonomy (Zawacki-Richter, Marín, Bond, & Gouverneur, 2019).

2.2 Distance Education Theory

2.2.1 Moore's Theory of Distance Education

Moore's (1970s) theory of distance education explains the effectiveness of distance education through two key elements: Dialog and Structure. Dialog refers to the degree of two-way communication, while structure refers to the program's responsiveness to individual learner needs. Moore argued that the greater the distance between teacher and student, the higher the level of autonomy learners must exercise.

ChatGPT-4-based AI tutors provide an innovative approach that can overcome the limitations of this distance education theory. In the dialog dimension, they overcome physical distance through real-time bidirectional interaction based on natural language, and in the structure dimension, they provide adaptive content adjustment tailored to individual learners' levels and progress (Simonson, Smaldino, & Zvacek, 2019).

2.2.2 Interaction Theory and Social Learning

Wedemeyer's independent learning theory emphasizes the interaction of four key elements: teacher, learner, communication system, and learning content. Recent distance education research shows that online learning users doubled from 293,689 in 2020 to 590,267, with 70% of students evaluating online learning as superior to traditional classroom learning (Coursmos, 2025).

AI tutors implement this interaction theory in a new dimension. Beyond the traditional teacher-learner dichotomy, AI performs a companion role that continuously interacts with individual learners and can realize observational learning and modeling principles of social learning theory through conversations with AI (Kasneci et al., 2023).

2.3 Artificial Intelligence Educational Tool Theory

2.3.1 Intelligent Tutoring System (ITS) Theory

Intelligent Tutoring Systems started from the concept of ICAI (Intelligent Computer-Assisted Instruction) in the 1960s-70s and have developed to the present. The four core components of ITS are domain model (expert knowledge of the learning area), learner model (current knowledge state of individual learners), pedagogical module (teaching strategies based on learner models), and user interface (interface for effective dialog) (VanLehn, 2011).

According to a systematic literature review by Létourneau et al. (2025), analysis of 28 studies involving 4,597 students confirmed the learning outcome improvement effects of ITS, but the difference from non-intelligent systems was relatively limited. This suggests the limitations of traditional ITS and highlights the innovative potential of conversational AI like ChatGPT-4.

2.3.2 Adaptive Learning Theory

Adaptive learning is an approach that dynamically adjusts instructional content and strategies according to individual learners' cognitive levels, interests, and learning pace (Dron, 2018). In connection with Csikszentmihalyi's flow theory, effective adaptive learning systems must maintain a balance between learners' skills and activity difficulty to create continuous flow states.

According to recent research, adaptive learning contributes to academic performance improvement (confirmed in 59% of studies) and increased learner engagement (confirmed in 36% of studies). ChatGPT-4-based AI tutors can realize adaptive learning theory through real-time learning data analysis, dynamic adjustment of individual learning paths, and difficulty adjustment to maintain flow states (Slejournal, 2024).

2.4 Conversational AI and Educational Interaction Theory

2.4.1 Social Learning Theory and AI

Bandura's social learning theory provides a new perspective on AI educational tools. The recent concept of "Socially Situated AI" shows that AI can learn new concepts through interaction with humans. Conversational AI like ChatGPT-4 can implement the observation, imitation, and modeling mechanisms of social learning in new ways through interaction with learners (NCBI, 2022).

2.4.2 Conversation Theory and Knowledge Construction

Pask's (1976) conversation theory views learning as a fundamental process of dialog, distinguishing between dialog with oneself (reflection on current knowledge) and dialog with others (reaching mutual understanding). According to a systematic literature review by Kasneci et al. (2023) analyzing 70 papers, ChatGPT is effective in learning enhancement and information accessibility improvement, but challenges exist such as AI model bias, accuracy issues, and limitations in critical thinking.

2.5 Integrated Theoretical Framework for Lecture-Grounded AI Tutors

The Lecture-Grounded ChatGPT-4 tutor proposed in this study implements a new educational framework that integrates the above theories. Applying the three-level model presented by Zhou & Schofield (2024):

Micro Level (Individual): Implements the self-directedness principle of adult learning theory as a partner in inquiry, learning, and expression with individual learners.

Meso Level (Team/Community): Applies the interaction principle of social learning theory as a creative, collaborative group member.

Macro Level (Cultural): Implements the systemic approach of adaptive learning as a mediator and facilitator of cultural change.

Particularly, the approach of lecture-based limited knowledge scope overcomes the limitations of existing general-purpose AI systems while providing the following educational advantages: (1) Alignment with curriculum - perfect match with specific learning objectives, (2) Cognitive load optimization - improved concentration through exclusion of irrelevant information, (3) Educational consistency - consistent reflection of instructors' educational philosophy and methodology.

3. Research Methodology

3.1 Research Design

This study will adopt a Mixed-Method Research approach with a Randomized Controlled Trial (RCT) design. The research will use an Explanatory Sequential Design that conducts quantitative data collection followed by qualitative data for in-depth interpretation of results.

Experimental Design Overview:

- Design Type: Pretest-Posttest Control Group Design
- Duration: 14 weeks (2 weeks pre-measurement, 10 weeks treatment, 2 weeks post-measurement)
- Group Composition:
  - Experimental Group: Lecture-Grounded ChatGPT-4 tutor utilization
  - Control Group 1: Traditional distance education
  - Control Group 2: General-purpose AI tool utilization

3.2 Participants and Sampling

Target Population: Korean adults aged 25-55 with distance education experience among working professionals

Sample Size: Based on G*Power analysis (effect size $g = 0.8$, power = 0.80, $\alpha = 0.05$), 65 participants per group (195 total) will be recruited considering 20% dropout rate.

Inclusion Criteria: Adults aged 25-55, online education experience within 2 years, basic digital literacy, informed consent

Recruitment Methods: Corporate training centers, lifelong education institutions, online communities, and snowball sampling

3.3 Measurement Instruments

Learning Engagement Assessment: Four-dimensional model (Fredricks et al., 2004)

- Behavioral: Login frequency, session duration, interaction frequency (LMS analytics)
- Cognitive: Korean MSLQ (Motivated Strategies for Learning Questionnaire)
- Affective: Modified Student Engagement Scale (7-point Likert)
- Social: Peer interaction frequency, community participation (Social Network Analysis)

Learning Achievement Assessment:

- Digital Literacy Assessment (DLA) - Korean standardized version
- Learning Transfer Assessment - scenario-based problem-solving tasks

Moderating Variables:

- Self-Directed Learning Readiness Scale (SDLRS) - Korean version
- Digital Literacy Scale (DLS) - Korean modified version
- Technology Acceptance Model (TAM) - AI tutor acceptance scale

3.4 Data Collection and Analysis Plan

Quantitative Data:

- Learning analytics data (xAPI standards)
- Survey data at 5 time points (T0-T4)
- Analysis: ANOVA, Repeated Measures ANOVA, Multilevel Modeling (HLM)

Qualitative Data:

- In-depth interviews (n=20 per group)
- Focus group interviews (3 groups, 8-10 participants each)

- Learning journals (weekly during treatment)
- Analysis: Thematic analysis using NVivo 14

4. Expected Results and Contributions

4.1 Anticipated Research Outcomes

Based on the theoretical framework and preliminary research evidence, this study expects to demonstrate significant positive effects of Lecture-Grounded ChatGPT-4 tutors on adult learners' educational outcomes. Primary expected findings include enhanced learning engagement across all four dimensions (behavioral, cognitive, affective, and social), with particularly strong improvements in behavioral engagement metrics such as session duration and interaction frequency.

Learning Achievement Improvements are anticipated through the AI tutor's ability to provide personalized, immediate feedback and 24/7 accessibility. The lecture-grounded approach is expected to show superior performance compared to general-purpose AI tools due to its curriculum-aligned knowledge base and reduced cognitive load from irrelevant information.

Moderating Effect Analysis will likely reveal that learners with higher digital literacy and self-directed learning readiness benefit more significantly from AI tutor interventions, providing insights for targeted implementation strategies in adult education contexts.

4.2 Theoretical Contributions

This research will make several theoretical contributions to the field of educational technology. First, it will extend existing adult learning theory by demonstrating how AI tutors can effectively support the five principles of andragogy in digital learning environments. The study will provide empirical evidence for the integration of self-directed learning theory with conversational AI technology.

Innovation in AI Education Theory: The lecture-grounded approach represents a novel theoretical framework that bridges the gap between general-purpose AI capabilities and specific educational objectives. This controlled knowledge scope paradigm offers a new model for designing AI educational tools that maintain pedagogical integrity while leveraging advanced AI capabilities.

Distance Education Theory Extension: The research will contribute to Moore's distance education theory by demonstrating how AI tutors can effectively reduce transactional distance through enhanced dialog and flexible structure, particularly in adult learning contexts where autonomy and relevance are paramount.

4.3 Practical Implications and Applications

Educational Practice Enhancement: The findings will provide evidence-based guidelines for implementing AI tutors in adult education programs, including optimal integration strategies, learner preparation requirements, and instructor training protocols. Educational institutions can use these insights to enhance their distance learning offerings while maintaining educational quality and learner satisfaction.

Policy and Implementation Framework: The research will inform policy decisions regarding AI adoption in educational settings, particularly for adult and lifelong learning programs. The study will provide a validated model for lecture-grounded AI implementation that can be scaled across different educational contexts and subject areas.

Technology Design Implications: Results will inform the development of more effective AI educational tools by demonstrating the importance of content-specific knowledge bases versus general-purpose systems. This will guide future AI tutor design toward more targeted, educationally-aligned approaches.

4.4 Broader Impact on Adult Education

Addressing Educational Equity: By providing 24/7 accessible, personalized learning support, lecture-grounded AI tutors may help address educational inequities faced by adult learners who cannot access traditional support systems due to work, family, or geographic constraints. This democratization of educational support could significantly impact lifelong learning participation rates.

Workforce Development: The enhanced learning outcomes expected from this intervention could contribute to more effective professional development and reskilling programs, addressing the growing need for continuous learning in rapidly changing job markets.

5. Limitations and Challenges

5.1 Research Design Limitations

Temporal Constraints: The 14-week study duration, while substantial for educational research, may not capture long-term retention and transfer effects that are crucial for adult learning outcomes. The 3-month follow-up provides some longitudinal perspective but may still be insufficient to assess lasting behavioral changes in learning patterns.

Generalizability Concerns: The focus on Korean adult learners in corporate and continuing education settings may limit the generalizability of findings to other cultural contexts, educational systems, or age groups. Cross-cultural validation will be necessary to establish broader applicability of the lecture-grounded approach.

Sample Characteristics: The requirement for basic digital literacy as an inclusion criterion may introduce selection bias, potentially excluding adult learners who would benefit most from AI-assisted learning support but lack the technical skills to participate effectively.

5.2 Technological and Methodological Challenges

AI Technology Limitations: The study relies on ChatGPT-4's current capabilities, which may evolve during the research period. Model updates, changes in response patterns, or technical limitations could affect the consistency of the intervention across participants and time periods.

Learning Analytics Complexity: Collecting and analyzing real-time learning behavior data presents technical challenges in terms of data quality, privacy protection, and meaningful interpretation of complex interaction patterns. The correlation between behavioral metrics and actual learning may vary significantly across individuals.

Mixed-Method Integration: Combining quantitative learning analytics with qualitative experiential data requires sophisticated analytical approaches to avoid over-interpretation or conflicting conclusions. The challenge lies in creating meaningful meta-inferences that accurately represent the complexity of adult learning experiences.

5.3 Contextual and Implementation Challenges

Institutional Variability: Different educational institutions may have varying technological infrastructures, pedagogical approaches, and organizational cultures that could

influence the effectiveness of AI tutor implementation. Standardizing the intervention across diverse settings while maintaining ecological validity presents a significant challenge.

Instructor and Learner Adaptation: The success of lecture-grounded AI tutors depends heavily on both instructor acceptance and learner adaptation to AI-mediated learning. Resistance to technology, varying comfort levels with AI interaction, and differences in pedagogical philosophy may create implementation barriers that affect research outcomes.

Ethical and Privacy Considerations: Collecting detailed learning behavior data and conversation logs with AI tutors raises important privacy and consent issues, particularly given recent concerns about AI data usage and storage. Balancing research needs with participant privacy rights requires careful protocol development and ongoing monitoring.

6. Conclusion

This research proposal presents a comprehensive investigation into the potential of Lecture-Grounded ChatGPT-4 tutors to enhance adult learner engagement in distance education. By grounding AI tutors in specific lecture content rather than relying on general-purpose capabilities, this study addresses a critical gap in current AI education research while responding to urgent challenges in adult distance learning participation and effectiveness.

The theoretical significance of this work lies in its integration of adult learning theory, distance education principles, and artificial intelligence capabilities into a coherent framework that respects the unique characteristics of adult learners while leveraging technological innovation. The lecture-grounded approach represents a paradigm shift from one-size-fits-all AI solutions toward targeted, pedagogically-aligned AI educational tools.

Methodologically, the study employs a rigorous mixed-methods approach that combines quantitative learning analytics with qualitative experiential data, providing comprehensive insights into both the measurable outcomes and subjective experiences of AI-mediated learning. The randomized controlled trial design with multiple comparison groups ensures robust evaluation of the intervention's effectiveness relative to existing approaches.

The practical implications extend beyond academic research to inform real-world implementation of AI tutors in adult education settings. The expected outcomes will provide evidence-based guidelines for educational practitioners, policy makers, and technology

developers seeking to enhance distance learning effectiveness while maintaining pedagogical quality and learner satisfaction.

Looking forward, this research establishes a foundation for future investigations into AI-human collaboration in educational contexts. The lecture-grounded approach may serve as a model for developing more sophisticated, context-aware AI educational tools that can adapt to diverse learning environments while maintaining strong connections to specific educational objectives and content.

As the landscape of adult education continues to evolve in response to technological advancement and changing workforce demands, research like this becomes increasingly vital for ensuring that innovations in AI technology translate into meaningful improvements in learning outcomes and educational equity. The potential for AI tutors to provide scalable, personalized, and accessible learning support represents a significant opportunity to address longstanding challenges in adult distance education while preparing learners for an increasingly digital future.

The success of this research could catalyze broader adoption of thoughtfully designed AI educational tools, ultimately contributing to more effective, engaging, and equitable adult learning experiences. By maintaining focus on pedagogical principles while embracing technological innovation, this study exemplifies the type of research needed to guide the responsible integration of AI into educational practice.

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