IMPACT OF AN ENHANCED ADAPTIVE MICROLEARNING SYSTEM ON LEARNING ACHIEVEMENT AND ADAPTABILITY IN ON-THE-JOB ADULTS

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ABSTRACT

This research compared the effectiveness of two microlearning systems, the Adaptive Microlearning (AM-learning) System and the Conventional Microlearning (CM-learning) System, in enhancing the learning achievement and adaptability of on-the-job adults. The AM-learning system is an enhanced adaptive microlearning system, serving as the experimental group with adaptive qualities, compared to the control group, CM-learning.

Through ANCOVA, after controlling for the effect of prior knowledge, the results showed that the AM-learning system was significantly better than the CM-learning system in enhancing learning achievement and adaptability. Specifically, the mean learning achievement score of the AM-learning group was 17.59, significantly higher than the CM-learning group's mean score. The mean learning adaptability score of the AM-learning group was 179.74, also significantly higher than the CM-learning group's score. This result is attributed to the adaptive qualities of the system, which can adjust learning content and difficulty in real time according to learners' needs and progress, provide personalized learning paths, and improve learners' engagement and adaptability through a dynamic feedback mechanism. The originality of this research lies in its focus on adaptive microlearning systems tailored for on-the-job adults, a demographic often overlooked in microlearning studies. Additionally, this study uniquely measures both learning achievement and adaptability, offering a comprehensive assessment of the benefits of adaptive microlearning. This research introduces a promising approach that could stimulate the development of alternative adaptive learning systems and inspire further innovations in the field of educational technology. In summary, this research supports the significant advantages of the AM-learning system in enhancing the learning achievement and adaptability of on-the-job adults and emphasizes the great potential of adaptive microlearning systems in modern education. Future research can further explore the application of adaptive microlearning systems in different educational contexts and populations, with the aim of providing more comprehensive guidance for educational practice.

KEYWORDS

Adaptive, Microlearning, Adaptive microlearning system, On-the-job adult, Adaptability

1. INTRODUCTION

On 25 September 2015, the United Nations Summit on Sustainable Development established the 2030 global agenda for sustainable development and defined a new set of objectives. The 17 Sustainable Development Goals (SDGs) listed by the Summit include the goal of "ensuring inclusive, equitable, and quality education and promoting lifelong learning opportunities for all" as SDG 4 (United Nations, 2020). The Summit emphasizes that education is not only a key goal of sustainable development but also a crucial means to achieve other sustainable development goals.

Online learning is essential for achieving lifelong learning (Eynon & Malmberg, 2021). Compared to traditional education methods, online learning has expanded the scale and improved the quality of education through advances in information technology, such as the Internet, multimedia, and databases. It can expand education's reach to protect citizens' right to education, promote equal access to higher education, and facilitate the social sharing of learning resources (Eynon & Malmberg, 2021). This contributes to fair educational starting points, processes, and outcomes.

The "Outline of the National Medium and Long-term Educational Reform and Development Plan (2010-2020)," issued by China in 2010, highlighted the importance of education informatization and online education. According to China Audio Broadcasting News, as of March 2020, the number of online education users in China reached 423 million, an increase of 222 million from the end of 2018. The number of mobile online education users reached 420 million. Users' willingness to purchase online education services has also gradually increased. The overall operation and development of lifelong education are rapidly progressing, and the number of people participating in online education has expanded, creating an unprecedented new education ecology.

With the rise of online learning and the popularization of mobile devices, mobile learning in informal environments has gradually become mainstream in adult on-the-job education. The learning medium has shifted from traditional physical spaces—classrooms—to virtual spaces—mobile devices (Dixit et al., 2021). This transformation has broadened the definition of learning, creating microlearning that caters to the increasing demand for knowledge. Microlearning is characterized by clear goals and short, independent content (Park & Kim, 2018), changing the learning method and core, allowing learning to take place anytime and anywhere. However, existing research primarily focuses on general or student populations, with limited attention to on-the-job adults. This study addresses this gap by specifically examining the impact of adaptive microlearning systems on this demographic, providing new insights into the field of adult education and microlearning. By introducing an adaptive microlearning system tailored for on-the-job adults, this research offers a promising approach that could inspire the development of alternative adaptive learning technologies and methods.

2. PROBLEM STATEMENT

With the widespread adoption of Internet technology, "Information Overload" has become a significant issue (Edmunds & Morris, 2000). The diversity, complexity, and volume of information individuals receive exceed their processing capacity. A major problem in adult teaching and learning is that attention, a limited psychological resource, is often distracted. Their attention can only handle limited tasks within a restricted range (Neumann, 1987), allowing for only one main task at a time.

Online microlearning miniaturizes learning resources that are already vast in number. It delivers the same content to all learners, ignoring individual differences in learning goals, prior knowledge, and learning styles. Faced with vast learning resources, learners often make poor judgments, easily "following the trend" to browse and learn only "knowledge hotspots." Under these circumstances, actual learning quality and effectiveness are hard to guarantee. This indicates a strong need for an enhanced online microlearning system to help adults choose learning strategies suitable for their individual situations.

Another issue in teaching and learning among on-the-job adults is their weak ability to connect related knowledge. In microlearning, the information in each fragment often lacks clear connections to other fragments (Dolasinski & Reynolds, 2020). Therefore, when learners try to construct internal knowledge connections, the knowledge system lacks integrity and coherence, and connections between knowledge fragments cannot be smoothly established.

The vast amount of microlearning content and resources means that learners receive more information in a unit of time than they can reasonably process. Microlearning differs from traditional learning and often lacks structure, preventing learners from mastering and absorbing knowledge as a whole. Since learners' time is scattered and random, and the location of learning is uncertain, most learners simply browse piecemeal knowledge during microlearning. Most of the time, learners passively accept this unordered information. There is a lack of adaptability between the learner and the learning system.

Although microlearning allows learners to make full use of fragmented time, the interrelationship between knowledge fragments is difficult to quickly integrate into the learner's original cognitive structure. Scattered information causes adults to become bored and irritable, particularly when articles are lengthy and require deeper thought (Winter, 2002).
Given these learning issues, adaptive microlearning is a promising new and open online learning mode that can be enhanced to address these problems. This research highlights the novelty of applying adaptive microlearning systems to on-the-job adult education, addressing specific challenges such as information overload, lack of knowledge integration, and poor adaptability in learning systems. By focusing on these unique issues, this study introduces new problem-solving strategies and contributes to the advancement of educational technology.

3. OBJECTIVES OF THE RESEARCH

The primary purpose of this research is to evaluate an enhanced adaptive microlearning system suitable for on-the-job adults. To achieve this goal, the following specific objectives have been formulated:

1). Evaluating the effect of the adaptive microlearning (AM-learning) system on learning achievement scores of on-the-job adults in China.
2). Evaluating the effect of the AM-learning on learning adaptability of on-the-job adults in China.

4. RESEARCH QUESTIONS

Specifically, the research will answer the following Research Questions (RQ):

RQ1: Is there any significant difference in learning achievement scores (AS) among on-the-job adults using the adaptive microlearning (AM-learning) system and the conventional microlearning (CM-learning) system?

RQ2: Is there any significant difference in learners' learning adaptability (LA) among on-the-job adults using the AM-learning system and CM-learning system?

5. RESEARCH HYPOTHESES

This research aims to develop an enhanced adaptive microlearning system suitable for on-the-job adults to learn during fragmented time. As there is no existing similar research for reference, it is assumed that the initial hypothesis is that the system has no effect on learners. The level of significance used for this research is 0.05 ($\alpha = 0.05$).

$H_0$1: There is no significant difference in achievement scores (AS) between learners using the AM-learning system and CM-learning system. (RQ1)

$H_0$2: There is no significant difference in learners' learning adaptability (LA) between learners using the AM-learning system and CM-learning system. (RQ2)

6. CONCEPTUAL FRAMEWORK

A 2 by 2 quasi-experimental factorial design was employed to measure the efficacy of AM-learning system on on-the-job adults' learning. The conceptual framework assumed one independent variable (IV) affecting two dependent variables (DVs), which are the indices of learning effect in the context of the research. The IV is the type of microlearning system, consisting of the AM-learning and CM-learning systems. The DVs are learners' learning achievement scores and learning adaptability, as summarized in Figure 1.

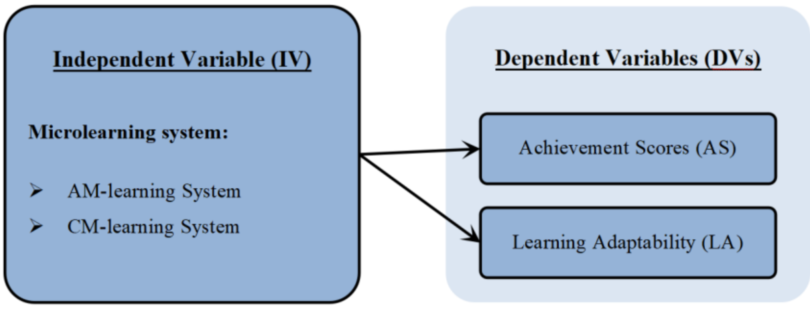

Figure 1. The Conceptual Framework

7. THEORETICAL FRAMEWORK

Figure 2 presents a theoretical framework that describes the distribution of the theories and vividly illustrates their interrelationships.

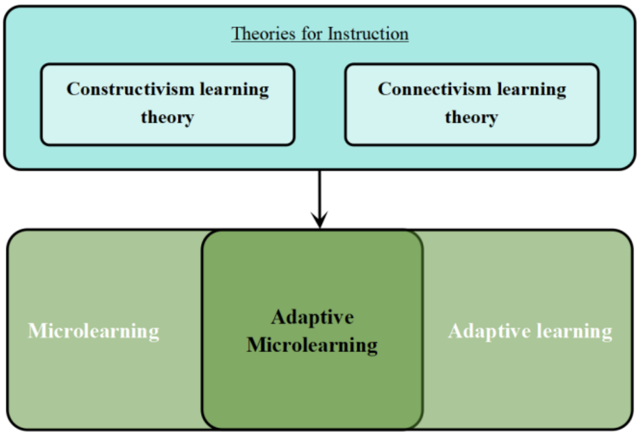

Figure 2. The Theoretical Framework

The unified concept of adaptive microlearning is the primary focus of this research and serves as a crucial guide for constructing the adaptive microlearning system. The instructional theories in this research, including Constructivism learning theory and Connectivism learning theory, provide a broad foundation for conceptualizing adaptive microlearning. The theoretical foundations for constructing adaptive microlearning systems are supported and expanded by these instructional theories.

8. LITERATURE REVIEW

Based on the conceptual and theoretical framework, the following literature review was conducted.

8.1. The Conceptual of Adaptive Microlearning

8.1.1. Micro Learning

Hug (2007) considered microlearning as a learning activity dealing with relatively small units of learning and focusing on shorter duration activities (Hug, 2007). Bruck (2012) interpreted microlearning as breaking down knowledge into small, loose, but interrelated units. It is an activity that can be integrated into daily communication and work (Bruck et al., 2012). Lindner (2007) summarized microlearning into three levels. First, microlearning addresses theoretical and practical problems, reprogramming learning based on digital micro-content and micro-media. Second, microlearning challenges existing teaching and educational theories by proposing new concepts such as "loose and distributed knowledge," "instant knowledge," and "associative knowledge." Third, since microlearning is not initially a theory but an empirical concept, it should be viewed experimentally (Lindner, 2007).

8.1.2. Adaptive Learning

Adaptive learning, a concept proposed by American scholars in the 1990s, builds a knowledge framework network by analyzing the knowledge system and evaluating learners' abilities. It formulates a personalized learning plan for each learner to achieve individualized teaching (Brusilovsky, 1996). Learning itself is a complex process, influenced by individual characteristics that result in different learning methods (Zliobaite et al., 2012). Learners' perception of knowledge and learning processes are affected by internal skill levels and external environmental factors. Research by Bozkurt and Aydo ğ du (2009), Demirtas and Schafer (2003), and Veznedaroglu and Ozgur (2005) has shown that different learning and teaching environments significantly affect learning activities. Brusilovsky (2001) noted that different learners have different learning needs and environmental requirements. Lee and Park (2008) studied the adaptive learning ability of different learners in various learning environments, emphasizing the design based on learner characteristics to create a learning environment that adapts to their abilities.

To sum up, this research defines adaptive microlearning as a learning method that completes core instructional functions through programming algorithms and database mechanisms, automatically providing learning assistance and real-time interaction. It constructs personalized learning strategies for each learner. With adaptive learning mechanisms, learners in conventional microlearning systems can find suitable learning approaches, progress, and pace according to their own characteristics and deficiencies, thereby improving learning adaptability.

8.2. Theories for Instruction

The instructional theories in this research include Constructivism learning theory and Connectivism learning theory.

Constructivism learning theory is derived from Piaget's theory of children's cognitive development. Constructivism emphasizes constructing a learning context and views teaching as the "transformation" rather than the "transmission" of knowledge. It advocates that learners cannot directly access the external world but can only organize experiences and develop knowledge using internal construction principles (Tam, 2000).

Complementing Constructivism is Connectivism learning theory. Siemens (2005) proposed Connectivism and defined it as a theory that adapts to the learning needs of the Internet Age. The core idea of Connectivism posits that knowledge is primarily distributed in the form of a network (Siemens, 2005). The learning process involves dynamically linking knowledge and information distributed across various sources. This theory emphasizes the importance of external knowledge and connections.

9. Research Methodology

This research was quantitative, and Figure 3 illustrates the 2x2 quasi-experimental factorial design, which is a variation of an experimental design.

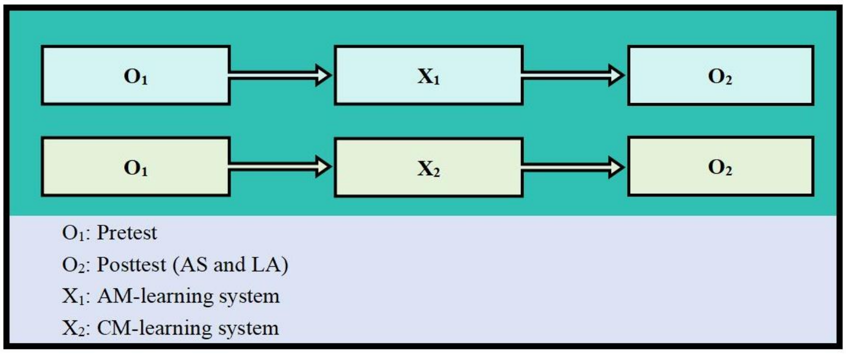

Figure 3. The Research Design

Using a quantitative research method, this research aims to investigate whether there are significant differences between the AM-learning system and the CM-learning system for on-the-job adults. The main purpose is to analyze its impact on the two variables: achievement scores and learning adaptability.

9.1. Sample and Sampling

The target population for this research was 76 participants, with the selection of subjects limited to Dongying City, Shandong Province, China. The primary reason for sampling in one city was that the learning motivation of on-the-job adult learners is influenced by the city's urbanization level. Sampling in one city helps to avoid the influence of varying city GDPs on the subjects' learning motivation. The second reason is that Dongying City is where the researcher lives, making it easier to recruit volunteers for the experiments. Additionally, the researcher is more familiar with the city's corporate data, facilitating agreements with various companies to support the experiment.

Before the formal start of the experiment, the researcher sought formal permission from the subjects to collect and analyze their learning data throughout the process. After obtaining permission, each subject was asked to sign a consent form. Since the subjects were on-the-job, the researcher also sought formal permission from their workplaces. They conducted learning without being told the specifics of the AM-learning and CM-learning systems. To ensure their full cooperation, they were informed that their participation would contribute to the development of an enhanced microlearning system for on-the-job adults. They were also provided with free learning opportunities and facilities for further learning.

9.2. Procedure

This experiment was conducted online over a period of five weeks. Since it involved online self-learning for on-the-job adults, there were no specific requirements for individual learning times. Adult learners participating in the experiment independently planned their learning time according to their individual circumstances. The researcher observed their learning behavior without interfering with them.

The experiment was divided into two groups: the experimental group using the online Adaptive Microlearning (AM-learning) system and the control group using the Conventional Microlearning (CM-learning) system. Subjects were randomly assigned to groups with different treatments without knowing the details of the research. They were not able to discuss, compare, or interact, thus preserving the reliability of the findings.

The first week of the experiment was Mentoring Week. During this week, subjects gained a brief understanding of the learning content and made preliminary attempts to adapt to the assigned microlearning system. At the end of the first week, subjects were tested for learning motivation, marking the official start of the experiment in the second week. At the end of Mentoring Week, the researcher conducted the first data collection. Data for the Posttest were collected from the second week until the end of the fifth week of the experiment.

9.3. Instructional Materials

The instructional materials used in this research were derived from the multimedia software microlearning courses provided by the Digital Media Instructional Technology Laboratory of Qingdao University (QD-DMITL). The control group in the experiment, the CM-learning group, conducted microlearning entirely according to the multimedia software micro-courses provided by QD-DMITL. The experimental group, the AM-learning group, used an improved version of the CM-learning system.

Compared with the CM-learning system, the AM-learning system did not significantly reduce the learning content but made substantial adjustments to the construction of learning resources. The enhanced learning contents were adapted to the learner's individual requirements. Additionally, the AM-learning system included an adaptive feature that provided learning feedback based on the learners' real-time learning situations and further adapted the learning content through this feedback.

9.4. Research Instrumentation

Three measurement instruments were used in this research. The Pretest for Achievement Scores (Pre-AS) measured the prior knowledge of on-the-job adults. The Posttest for Achievement Scores (Post-AS) measured achievement scores after the treatment for on-the-job adults. Both the Pre-AS and Post-AS were created by the researcher. The Learning Adaptation Scale (LAS), adapted from the "Online Learning Adaptability Scale for Adult Higher Education" by Junfang Wang and Chun'er Zhou, was used to measure the learning adaptability of on-the-job adults. The reliabilities of the three measurement instruments are summarized in Table 1.

Table 1. The Reliabilities of Measurement Instruments

Measurement Instrument	Variable	Cronbach's α	Items
Pretest for achievement scores (Pre-AS)	Priori knowledge	0.876	20
Posttest for achievement scores (Post-AS)	Achievement scores (AS)	0.882	20
Learning Adaptation Scale (LAS)	Learning adaptability (LA)	0.954	44

10. Data Analysis

This research used SPSS version 26 to statistically analyze the data collected from the measurement instruments. Analysis of Covariance (ANCOVA) was used to verify the hypothesis that different microlearning systems affect on-the-job adults' learning. The significance level for the data collected in this research was set at 0.05 ($p < 0.05$). The Pretest for achievement scores (Pre-AS) was controlled as covariate.

This research involved 76 on-the-job adults as subjects. The descriptive statistical analysis of the collected data is presented in Table 2.

Table 2. Descriptive Statistics for Variables

Variable		Frequency (N=76)	Percentage (%)
Microlearning System	AM-learning	39	51.3
	CM-learning	37	48.7

10.1.1. Testing of Hypothesis H_01

H_01: There is no significant difference in achievement scores (AS) between learners using the AM-learning system and CM-learning system. (RQ1)

The effect of different microlearning systems (AM-learning and CM-learning) on Post-AS was examined using ANCOVA based on SPSS analysis. Table 3 shows the results of "Levene's Test of Equality of Error Variances".

Table 3. Levene's Test of Equality of Error Variances[a]

Dependent Variable: Post-AS

F	df1	df2	Sig.
2.641	1	74	0.108

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Group + Pretest + Group * Pretest

"Levene's Test of Equality of Error Variances" showed an F-value of 2.641 with a significance level (p-value) of 0.108, which is greater than 0.05 (p>0.05). This indicates that the assumption of variance homogeneity between groups is valid, and the ANCOVA analysis can be continued.

Table 4. Tests of Between-Subjects Effects

Dependent Variable: Post-AS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.[a]
Group	6.128	1	6.128	6.372	0.014
Pretest	22.194	1	22.194	23.078	0.000
Corrected Total	241.197	75			

As reported in the "Tests of Between-Subjects Effects" shown in Table 4, controlling for the effect of Pre-AS, the covariate had a significant effect on Post-AS [F=23.078, p<0.001 (p<0.05)] suggesting that Pre-AS was a significant predictor of Post-AS. In addition, different microlearning systems (AM-learning and CM-learning) differed significantly on Post-AS [F=6.372, p=0.014 (p<0.05)]. This indicates that different microlearning systems have a significant effect on Post-AS.

Table 5. Estimates and Pairwise Comparisons

Estimates

Dependent Variable: Post-AS

			95% Confidence Interval	
Microlearning System	Mean	Std. Error	Lower Bound	Upper Bound
AM-learning	17.799[a]	0.167	17.467	18.132
CM-learning	14.592[a]	0.173	14.248	14.937

a. Covariates appearing in the model are evaluated at the following values: Pre-AS = 4.96.

Pairwise Comparisons

Dependent Variable: Post-AS

(I) Microlearning System	(J) Microlearning System	Mean Difference (I-J)	Std. Error	Sig.[b]
AM-learning	CM-learning	3.207*	0.240	0.000
CM-learning	AM-learning	-3.207*	0.240	0.000

Based on estimated marginal means
*. The mean difference is significant at the 0.05 level.
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

According to the results reported in Estimates and Pairwise Comparisons, shown in Table 5, controlling for a Pre-AS of 4.96, the estimated mean for the AM-learning group was 17.799, and the estimated mean for the CM-learning group was 14.592. This indicates that the mean Post-AS scores of the AM-learning group were significantly higher than those of the CM-learning group, with a mean difference of 3.207, which was statistically significant (p<0.001).

In conclusion, Pre-AS had a significant effect on Post-AS. After controlling for the effect of Pre-AS, there was a significant difference between the microlearning systems (AM-learning and CM-learning) on Post-AS, with the AM-learning group performing significantly better than the CM-learning group.

Therefore, hypothesis $H_0 1$ was rejected.

10.1.2. Testing of Hypothesis $H_0 2$

$H_0 2$: There is no significant difference in learners' learning adaptability (LA) between learners using the AM-learning system and CM-learning system. (RQ2)

Based on the results of SPSS analysis, the effect of AM-learning and CM-learning groups on learning adaptability (LA) was tested using ANCOVA, as shown in Table 6 for Levene's Test of Equality of Error Variances.

Table 6. Levene's Test of Equality of Error Variances[a]

Dependent Variable: LA

F	df1	df2	Sig.
0.412	1	74	0.523

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Group + Pretest + Group * Pretest

Levene's test of variance homogeneity showed an F-value of 0.412 and a p-value of 0.523, which is greater than 0.05 ($p>0.05$). This indicates that the assumption of variance homogeneity between groups is valid, allowing the ANCOVA analysis to continue.
"Tests of Between-Subjects Effects", as shown in Table 7.

Table 7. Tests of Between-Subjects Effects

Dependent Variable: LA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.[a]
Group	2277.640	1	2277.640	7.121	0.009
Pretest	158.998	1	158.998	0.497	0.483
Corrected Total	60001.105	75			

Table 7 reported a nonsignificant effect of the covariate on LA, controlling for the effect of Pre-AS [$F=0.497$, $p=0.483$ ($p>0.05$)] suggesting that the predictive effect of Pre-AS on LA is not significant. In addition, after controlling for the effect of Pre-AS, the difference in LA between the different microlearning systems (AM-learning and CM-learning) was significant [$F=7.121$, $p=0.009$ ($p<0.05$)]. This indicates that the different type of microlearning system has a significant effect on LA.

Table 8. Estimates and Pairwise Comparisons

Estimates

Dependent Variable: LA

Microlearning System	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
AM-learning	178.785[a]	3.004	172.718	184.852
CM-learning	135.877[a]	3.149	129.600	142.155

a. Covariates appearing in the model are evaluated at the following values: Pre-AS = 4.96.

Pairwise Comparisons

Dependent Variable: LA

(I) Microlearning System	(J) Microlearning System	Mean Difference (I-J)	Std. Error	Sig.[b]
AM-learning	CM-learning	42.908*	4.379	0.000
CM-learning	AM-learning	-42.908*	4.379	0.000

Based on estimated marginal means

*. The mean difference is significant at the 0.05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

As shown in the Estimates and Pairwise Comparisons report in Table 8, controlling for a Pre-AS of 4.96, the estimated mean for the AM-learning group was 178.785 and the estimated mean for the CM-learning group was 135.877. The results of Pairwise Comparisons show that the mean LA scores of the AM-learning group were significantly higher than those of the CM-learning group, with a mean difference of 42.908, which was statistically significant ($p < 0.001$).

In summary, when controlling for the effect of Pre-AS, there was a significant difference in learning adaptability between different microlearning systems (AM-learning and CM-learning), with the AM-learning group performing significantly better than the CM-learning group. Therefore, hypothesis $H_0 2$ was rejected.

11. RESEARCH FINDINGS

The ANCOVA results showed that the AM-learning system significantly outperformed the CM-learning system in enhancing learning achievement scores after controlling for the effect of Pre-AS. Specifically, the mean of Post-AS score for the AM-learning group was 17.59, significantly higher than the CM-learning group’s mean of 14.78. This result can be attributed to the adaptive feature of the AM-learning system, which adjusts the content and difficulty in real time according to the learner’s progress and needs. This personalized design allows learners to learn at a pace that best suits them, thus improving their learning outcomes. In contrast, the CM-learning system uses uniform content and progress, which cannot be adjusted for individual differences, resulting in relatively lower learning outcomes.

In terms of learning adaptability, the ANCOVA results also showed a significant advantage for the AM-learning system. The mean of LA for the AM-learning group was 179.74, while the mean for the CM-learning group was 135.78. The mean difference between the two groups was 42.908, which was statistically significant. This difference is attributed to the AM-learning system’s components to assist learners understand their learning status through regular feedback and evaluation, allowing them to make adjustments and improvements accordingly. This dynamic feedback mechanism not only increases learners’ engagement and motivation but also enhances their capability of self-regulation, thereby improving learning achievement scores and learning adaptability.

Additionally, the microlearning content design in the AM-learning system plays an important role. The short and concise learning modules and timely test assessments enable on-the-job adults to learn efficiently after busy work, reducing cognitive load and improving learning outcomes. In contrast, the CM-learning system's content is relatively fixed and lacks personalized adjustments, making it difficult to meet the learning needs of on-the-job adults to the same extent.

12. CONCLUSIONS

The research assessed an online AM-learning system, which is an enhanced adaptive microlearning system. The ultimate objective of the research is to provide an adaptable microlearning system for on-the-job adults to assist them in conducting online learning more effectively. This research compared the effectiveness of the AM-learning system and the CM-learning system in enhancing learning achievement scores and learning adaptability among on-the-job adults. The results indicated that the AM-learning system was significantly better than the CM-learning system in both areas.

Specifically, through its adaptive qualities, the AM-learning system is able to adjust the content and difficulty of learning according to learners' needs and progress, providing personalized learning. These adaptive components enable learners to learn at an optimal pace, significantly improving learning achievement. In addition, the AM-learning system's dynamic feedback mechanism and efficient microlearning content design not only enhance learner engagement and self-regulation but also greatly improve learning adaptability. This research highlights the AM-learning system as the main innovation, serving as an important reference for realizing lifelong education.

13. SIGNIFICANCE OF THE RESEARCH

The online AM-learning system is an enhanced microlearning system for on-the-job adults. This system aligns with the construction characteristics of micro-knowledge and the cognitive characteristics of adult learners. It allows for the meaningful construction of micro-resources and enables learners to engage in meaningful deep learning, avoiding invalid learning due to cognitive obstacles and other reasons.

In addition to exploring the learning demands of on-the-job adults and constructing microlearning resources, this research is significant for providing adaptive learning strategies under the AM-learning system, offering personalized teaching models that conventional microlearning cannot provide.

Another significant aspect of this research is the evaluation and analysis of the AM-learning system. By comprehensively collecting learners' process and result data, the system provides an objective and scientific evaluation of on-the-job adults, identifies problems promptly, and adjusts intervention strategies accordingly. Additionally, it can serve as a reference for future related research.

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