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VERIFICATION OF TECHNICAL ENGLISH LANGUAGE SKILLS OF FUTURE AIRCRAFT MAINTENANCE SPECIALISTS USING BLOCKCHAIN TECHNOLOGY

Abstract. *This study aims to explore the potential of implementing blockchain-based verification in the language training of aviation technical specialists. The research objective is to find a transparent, reliable, and professionally validated tool for assessing student performance in language training. The research methodology utilized a quasi-experimental approach, comparing control and experimental groups, which underwent introductory and final testing. Within this approach, experiments were conducted to assess the results of individual components, learning success, the verification index, and student confidence in the assessment system. The results demonstrated that the proposed technology significantly enhances competency development, improves academic performance and competence, and increases trust in the assessment procedures. An additional finding was a positive correlation between the verification index and English language proficiency. In conclusion, the proposed technology serves as a reliable performance measurement tool and a pedagogical mechanism for assessing competencies. This study contributes to the development of transparent, verifiable, and professional models for teaching English for specific technical purposes.*

Keywords: *blockchain based verification, aviation English, aircraft maintenance education, competence assessment, digital credentials.*

Introduction.

The development of the aviation industry and the increasing internationalization of aircraft maintenance require modern engineering and technical personnel to have a good command of English. While reading and understanding documentation was once sufficient, today's key skills include interpreting it, following clear procedures, completing logs, describing malfunctions, and communicating with international colleagues. Due to these requirements, proficiency in technical language has become a crucial component of training future specialists [1].

Previously, English in aviation was primarily viewed as a communication tool between pilots and dispatchers. However, with the transition to aircraft from foreign manufacturers, the effectiveness of their maintenance is directly dependent on English-language documentation, terminology, and technical communication. Airlines receive maintenance manuals, service bulletins, troubleshooting guides, parts catalogs, and other documentation from aircraft manufacturers only in English. Misunderstanding and misinterpreting this documentation can negatively impact the accuracy of the procedures and, ultimately, flight safety. As a result, language training should be closely linked to professional tasks and the practice of interacting with documentation [2].

Furthermore, the higher education system frequently faces the challenge of increasing the transparency, reliability, and practical relevance of knowledge and skill assessment. Most

language training courses rely primarily on traditional assessment systems, which in most cases do not fully reflect competency development. Technical education related to aircraft maintenance must prepare future specialists for traceability, accountability, and procedural compliance. To ensure these factors, assessment systems must provide a clear evidence base [3]. In this context, blockchain represents a promising mechanism for verifying results. Blockchain is a distributed and secure technology that enables transparency, data integrity, and secure verification of a knowledge base [4]. In the education literature, blockchain is used for account control, holistic assessment, and tracking learning paths throughout professional careers [5]. The authors see the main value of this implementation in the creation of verifiable database records of student achievements that are difficult to alter and easy to authenticate.

Blockchain-based English language training for aviation maintenance personnel could prove highly relevant. It utilizes mechanisms for documenting the completion of training modules, validating micro-qualifications, and ensuring transparency in tracking student progress. Such a system ensures alignment between the language learning process and the professional logic of maintenance, in which accurate recording and procedural adherence are crucial [6]. Despite growing interest in blockchain applications in education, its application to specialized English language training and its application to the aviation industry remains understudied. Existing research primarily focuses on the verification of theses, academic records, or general digital documents. Less attention has been paid to assessing professional competencies. This creates a gap in the research landscape at the intersection of technology, pedagogy, technical education, and knowledge assessment [7]. The authors of this study attempt to fill this gap by examining the problem of blockchain-based verification in the language training of future aviation specialists. The primary focus of this research is assessing the impact of blockchain-based verification on competency development, increasing assessment transparency, and strengthening trust in the assessment system. The study is based on the assumption that blockchain is significant for the educational process when it is integrated into a competency-based learning model rather than considered as a standalone tool [8].

The aim of the study is to assess the pedagogical potential of using blockchain-based verification to improve technical English proficiency. The study focuses on comparing student learning outcomes with a traditional assessment system and blockchain-based verification. Additionally, the impact of verification on competency development and its use as a trustworthy assessment system are examined. The scientific novelty of the study lies in its application of blockchain-based verification not to general educational certification, but to the assessment of technical English proficiency of aviation students. The integration of these mechanisms into the assessment system facilitates the development of transparent and professionally oriented language training models for technical training programs.

Materials and research methods.

To achieve the stated goal of the study, the authors developed a study design that included quasi-experiments involving pre- and post-testing of students. The experiments were designed to effectively study the impact of blockchain verification on the development of technical English competency skills. To ensure proper validation and interpretation of the results, the students were divided into two groups. The first group served as the control group, which received traditional instruction. The second group served as the experimental group, whose learning outcomes were assessed using blockchain.

Student competence was assessed using a holistic framework consisting of four core elements. These elements are integral to the learning process and include: reading and understanding documentation (R_i), writing essays and maintenance reports (W_i), understanding technicians (L_i), and discussing or oral presentations on troubleshooting (S_i). The overall competency-based approach score C_i is calculated as follows for each student.

$$C_i = \alpha_R R_i + \alpha_W W_i + \alpha_L L_i + \alpha_S S_i \quad (1)$$

where $\alpha_R, \alpha_W, \alpha_L, \alpha_S$ are the weight coefficients and their sum is 1.

Given the specific training and future work of aircraft maintenance technicians, the model considers learning progress ΔC_i, taking into account assessment results at the beginning C_i^{pre} and end of the course C_i^{post}. A student's individual progress during training is assessed in the model as follows:

$$\Delta C_i = C_i^{post} - C_i^{pre} \quad (2)$$

After calculating the progress, we needed to determine the normalized value G_i. It was calculated as follows:

$$G_i = \frac{C_i^{post} - C_i^{pre}}{100 - C_i^{pre}} \quad (3)$$

The next step involves introducing a Blockchain Verification Index into the model, which is necessary for quantifying the certification implementation process. The verification index V_i is defined as follows:

$$V_i = \beta_M M_i + \beta_B B_i + \beta_T T_i + \beta_I I_i \quad (4)$$

where M_i is the share of verified modules; B_i is the share of micro-credentials received; T_i is the assessment of the timeliness of checking assignments; I_i blockchain data integrity assessment and β_i is the weight coefficients.

In addition, the model calculates a Trust Index, which incorporates data from student surveys. The survey included questions on the following characteristics: transparency P_i, fairness of assessment Q_i, usefulness U_i, and system security S_i. The Trust Index TR_i in the assessment system is calculated in the model as follows:

$$TR_i = \gamma_P P_i + \gamma_Q Q_i + \gamma_U U_i + \gamma_S S_i \quad (5)$$

Several tools were selected for model analysis and validation. In the first stage, comparisons were made within two groups of students using paired tests. In the second stage, comparisons were made between groups using independent samples analysis. In the third stage, a correlation analysis was conducted, and finally, the authors conducted an ANCOVA analysis to assess the competency characteristics of the entrance and exit tests. This resulted in a regression model, which looks as follows:

$$C_i^{post} = \theta_0 + \theta_1 C_i^{pre} + \theta_2 V_i + \theta_3 TR_i + \theta_4 E_i + \varepsilon_i \quad (6)$$

where E_i is the engagement score. In the model, the reliability of the questionnaire assessment is assessed using Cronbach's alpha coefficient.

Results and their discussion.

In this article, the effectiveness of the verification process was assessed by comparing two groups of students. The following characteristics were selected as evaluation metrics: competency development, subjective knowledge gain, competencies by group, trust in the assessment system, and verification of results. Figure 1 presents the results of the students' entrance and exit assessment tests.

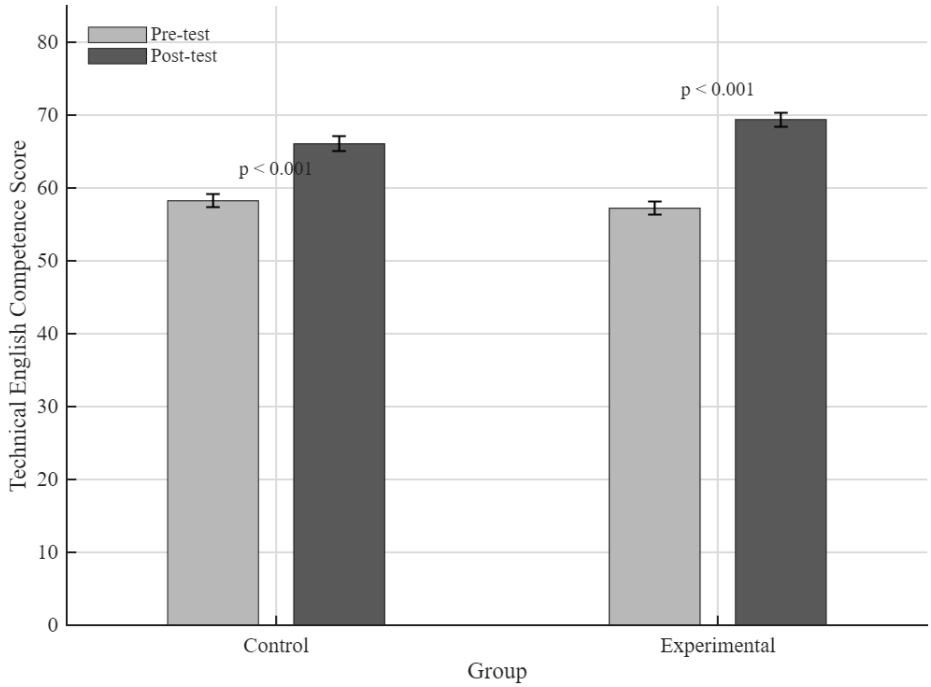

Figure 1 – Results of entrance and exit testing of students.

Analyzing Figure 1, we can conclude that both groups improved their language proficiency scores. The control group's initial average score was 58, and following the final assessment, this average increased to 66 on a 100-point scale. The experimental group's initial average score was 57, while the final score reached 69. The changes recorded following the training are significant for both groups. However, the experimental group showed the greatest improvement, suggesting the potential effectiveness of blockchain. Figure 2 shows the distribution of results within groups.

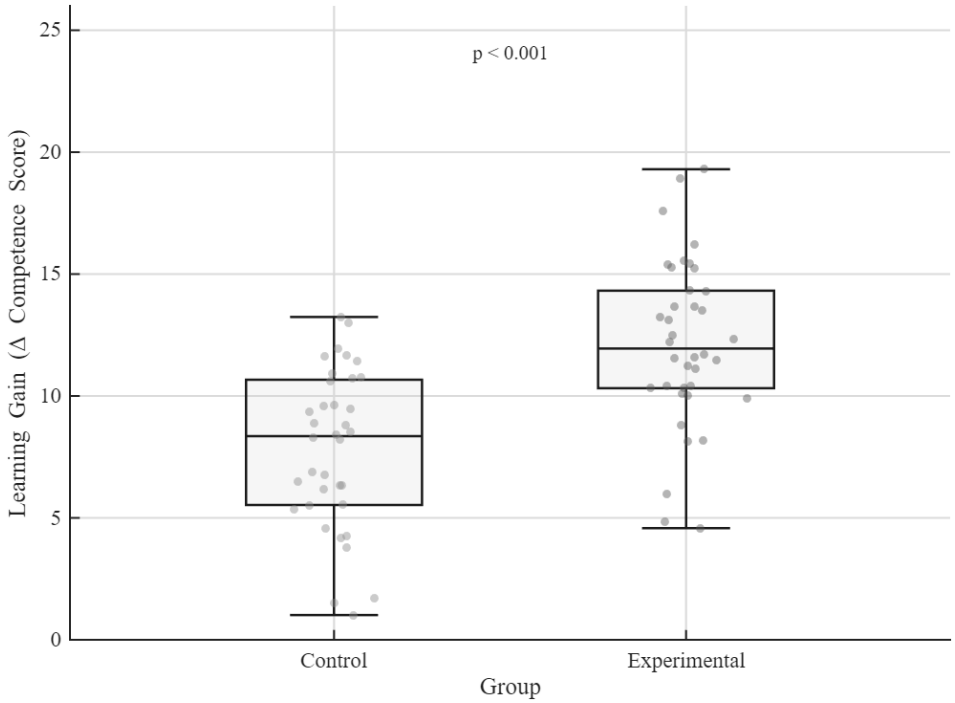

Figure 2 – Distribution of results between groups

Based on Figure 2, we can conclude that the control group had a lower average gain and a narrower upper limit of improvement. Meanwhile, the experimental group demonstrated higher gains, and their results were concentrated in the zone of significant progress. The difference between the groups was considered statistically significant. This result demonstrates the effectiveness of blockchain in increasing average results and systematically enhancing students' knowledge. Figure 3 shows the students' results for specific competencies.

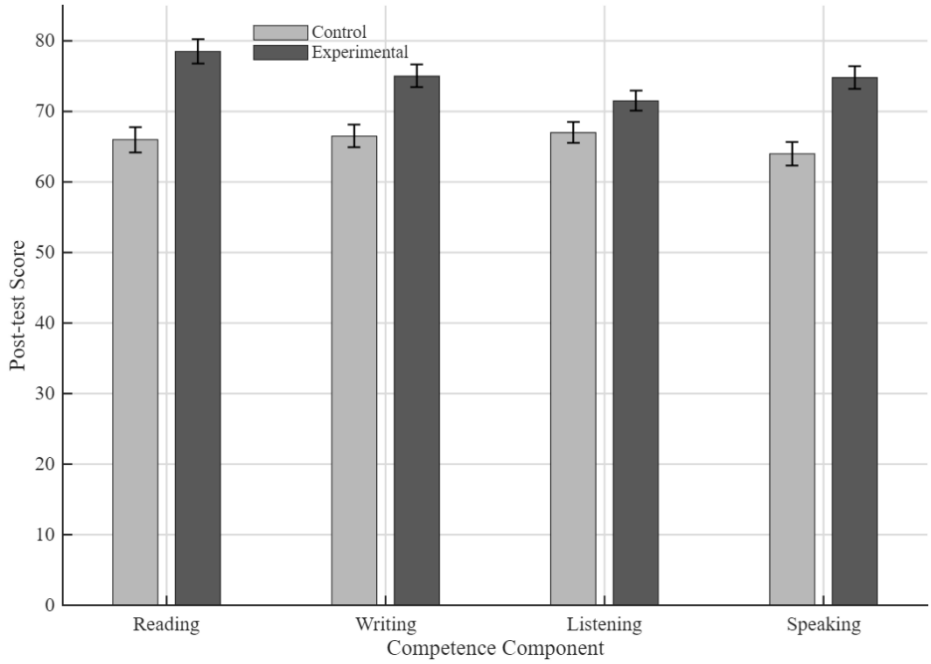

Figure 3 – Component final profile of two groups

Figure 3 shows that the experimental group improved across all four components. The greatest improvement was seen in reading and speaking skills. Writing also showed significant improvement, with the smallest gap between groups. This assessment model has important

methodological implications, as the blockchain-based learning group demonstrated strong results in areas requiring structured progress. Results in reading technical documentation and prompt oral responses also serve as confirmation. Figure 4 shows the relationship between blockchain implementation and the final test.

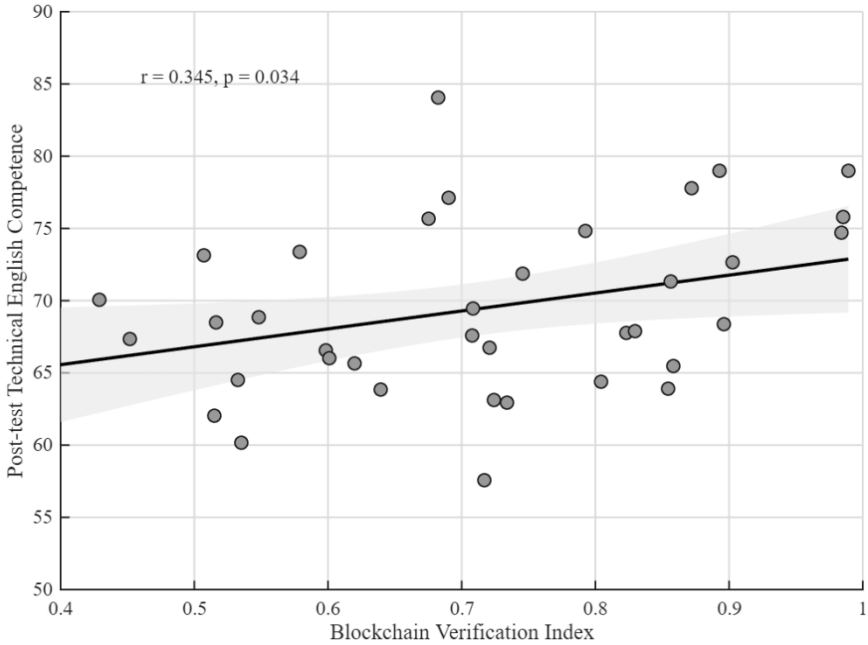

Figure 4 – The Impact of the Final Test on the Blockchain Verification Level

Figure 4 shows the relationship between the blockchain verification index and final language proficiency in the experimental group. The analytical results revealed a correlation coefficient of 0.345 with p=0.034. This indicates statistical significance of the positive correlation. Based on the graph, it can be concluded that students with a greater number of completed modules, accumulated qualifications, and a consistent final assessment achieved higher final test scores. While this relationship cannot be used to accurately determine language proficiency, it does support the interpretation of blockchain-based mechanisms for competency development. Figure 5 shows the correlation matrix of variables.

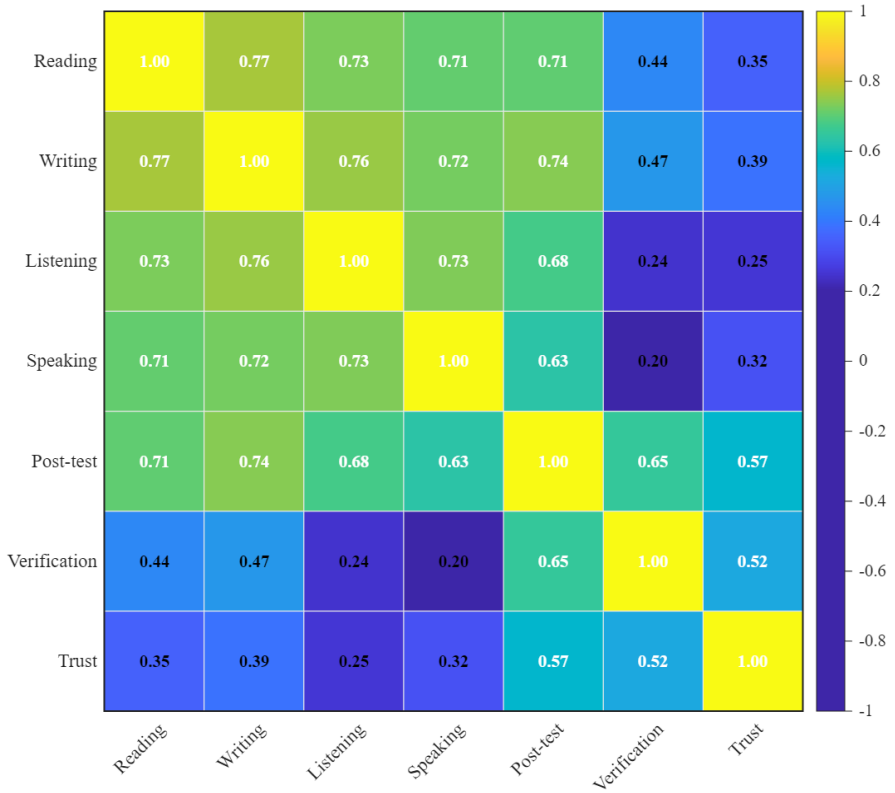

Figure 5 – Correlation matrix of variables

An analysis of Figure 5 reveals a direct relationship between the two indicators of internal consistency and theoretical stability. Competence integrity is formed by four components, resulting in coefficients ranging from 0.71 to 0.77. The results of the final transformation directly correlate with additional components at levels ranging from 0.63 to 0.74. This fact reflects the validity of using an integrated indicator for student final testing. Furthermore, the model provides a positive correlation between the final testing and verification at a level of 0.65, as well as a moderate correlation with security at a level of 0.57. The correlation between verification and protection from the system indicates that students are gaining confidence in the fairness and transparency of medical care cost assessment procedures. Figure 6 shows a graph of students' confidence in the final assessment.

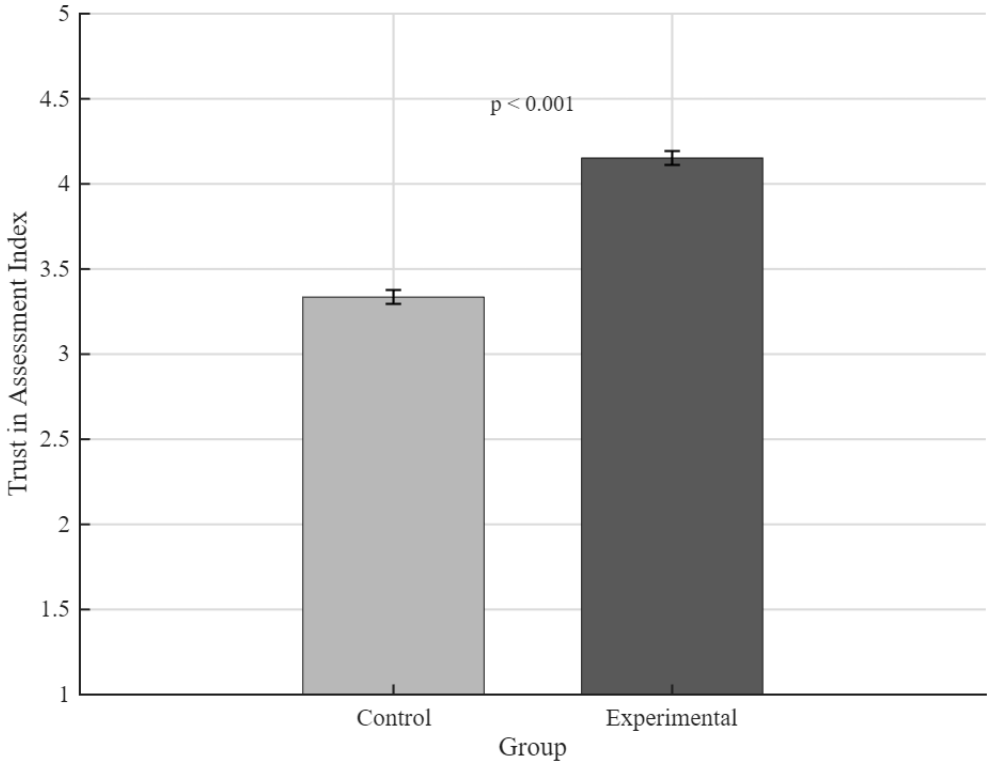

Figure 6 – Level of confidence in the final assessment

Figure 6 shows that the assessment confidence index in the experimental group (4.1) is higher than in the control group (3.3). This difference is statistically significant ($p<0.001$). This indicates not only the positive impact of blockchain implementation on the educational process but also a change in students' perceptions of the reliability, transparency, and fairness of such assessments. This is especially important for language training of technical specialists, who require confidence in the objectivity and tracking of their assessment progress to motivate students.

Summing up the experiment's results, it can be concluded that the blockchain-based results verification model has a positive impact on the educational process. First and foremost, the model improved students' competencies across all components of technical English. Furthermore, a positive correlation was observed between the final grade and the students' individual level. It also increased students' confidence in the assessment process itself. Thus, the empirical research suggests that blockchain technology not only facilitates technological innovation but also strengthens the pedagogical potential of teachers.

The study demonstrates that blockchain-based verification of learning outcomes is not only a technical solution for storing results but also a pedagogical tool. This is particularly important for maintenance training, as it is closely linked to accurate documentation, transparent procedures, and strict accountability [1, 2]. After completing their training, students will encounter similar rigor daily in their work, making clear documentation an integral part of training highly qualified specialists.

The research methodology is directly related to ensuring transparent tracking of student competencies and the formalization of interim milestones. This approach is relevant in the current agenda of implementing digital certificates, module-based micro-certification, and secure assessment of learning outcomes [3, 5]. The introduction of blockchain technology for aviation students will strengthen their understanding of the importance of structure, clarity, and professionalism [5, 7]. Another benefit of implementing this technology is trust in assessment. In the learning process, the use of technology not only strengthens confidence in fair assessment but also provides clarity in understanding procedures and tracking results. For aircraft maintenance, where safety depends on reliable documentation and procedures, early adoption is an advantage

[1, 2, 6]. Therefore, blockchain should be considered a tool with educational value, as it reflects the professional norms adopted in this field.

However, the authors recognize that the educational impact of blockchain implementation should not be overestimated. Implementing the technology alone will not improve the learning process without integrating it into course design, establishing an assessment system, and developing user competencies [5]. Therefore, the technology should be viewed as a complementary tool. Blockchain is primarily needed to ensure transparency and trust in training, but the quality of the final assessment directly depends on the course content, assignments, and student engagement [3, 5].

The study has several limitations. For example, the sample was limited to one professional field, and the effects were measured over a limited training period. Future research will focus on examining the long-term impact, comparing a larger number of certification models, and testing the approach in other technical fields. Overall, verifying results using blockchain is a promising approach to teaching English to future aviation technicians.

Conclusion.

This study demonstrates the practical potential of blockchain-based test results verification for implementation in the English language training of aviation technicians. The primary value of such implementation is the creation of a transparent and professionally oriented assessment mechanism. Within this mechanism, language achievements should be documented, verified, and interpreted as part of aviation training. The contribution of such technology to the learning process goes beyond simple digital record-keeping. Blockchain offers a model for linking competency-based language learning with verification procedures, student responsibility, and trustworthy assessment practices. Based on this logic, blockchain is considered an important tool for modernizing the linguistic education system for technicians.

This study demonstrates the importance of blockchain when integrated into teaching practices, rather than used as an isolated technical tool. The effectiveness of implementation depends on how verification mechanisms are integrated into course structures, assessment systems, and the practical orientation of learning outcomes. From a practical perspective, the proposed model has potential for implementation in higher education institutions to enhance the reliability of knowledge assessment, support the micro-certification process, and improve the traceability of student results. The research findings open a new avenue for blockchain-based knowledge assessment for other courses within student education. Overall, the study's findings can be considered as an innovation in the educational process for training aviation engineering personnel, closely linking learning objectives, procedural transparency, and the reliability of final assessments.

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БОЛАШАҚ ҰШАҚ КЕМЕСІНЕ ТЕХНИКАЛЫҚ ҚЫЗМЕТ КӨРСЕТУ МАМАНДАРЫНЫҢ ТЕХНИКАЛЫҚ АҒЫЛШЫН ТІЛІ ДАҒДЫЛАРЫН БЛОКЧЕЙН ТЕХНОЛОГИЯСЫН ҚОЛДАНЫП ТЕКСЕРУ

Аңдатпа*. Бұл зерттеу авиациялық техникалық мамандардың тілдік дайындығында блокчейн негізіндегі тексеруді енгізу әлеуетін зерттеуге бағытталған. Зерттеу мақсаты - тілдік дайындықтағы студенттердің жұмысын бағалау үшін мөлдір, сенімді және кәсіби түрде тексерілген құралды табу. Зерттеу әдістемесінде кіріспе және қорытынды тестілеуден өткен бақылау және эксперименттік топтарды салыстыратын квазиэксперименттік тәсіл қолданылды. Бұл тәсіл шеңберінде жеке компоненттердің нәтижелерін, оқудағы табыстылықты, тексеру индексін және студенттердің бағалау жүйесіне деген сенімін бағалау үшін эксперименттер жүргізілді. Нәтижелер ұсынылған технологияның құзыреттілікті дамытуды айтарлықтай жақсартатынын, академиялық көрсеткіштер мен құзыреттілікті жақсартатынын және бағалау рәсімдеріне деген сенімді арттыратынын көрсетті. Қосымша тұжырым тексеру индексі мен ағылшын тілін меңгеру арасындағы оң корреляция болды. Қорытындылай келе, ұсынылған технология сенімді өнімділікті өлшеу құралы және құзыреттіліктерді бағалаудың педагогикалық механизмі ретінде қызмет етеді. Бұл зерттеу нақты техникалық мақсаттар үшін ағылшын тілін оқытудың мөлдір, тексерілетін және кәсіби модельдерін әзірлеуге ықпал етеді.*

Түйін сөздер*: блокчейн негізіндегі тексеру, авиациялық ағылшын тілі, ұшақтарға техникалық қызмет көрсету бойынша білім беру, құзыреттілікті бағалау, сандық куәліктер.*

ПРОВЕРКА ТЕХНИЧЕСКИХ НАВЫКОВ АНГЛИЙСКОГО ЯЗЫКА БУДУЩИХ СПЕЦИАЛИСТОВ ПО ТЕХНИЧЕСКОМУ ОБСЛУЖИВАНИЮ АВИАЦИОННЫХ ТЕХНИК С ИСПОЛЬЗОВАНИЕМ ТЕХНОЛОГИИ БЛОКЧЕЙН

Аннотация. *Целью данного исследования является изучение потенциала внедрения проверки на основе блокчейна в языковую подготовку специалистов авиационной техники. Задача исследования – найти прозрачный, надежный и профессионально обоснованный инструмент для оценки успеваемости студентов в ходе языковой подготовки. Методология исследования включала квазиэкспериментальный подход, сравнивающий контрольную и экспериментальную группы, которые прошли вводное и заключительное тестирование. В рамках этого подхода были проведены эксперименты для оценки результатов отдельных компонентов, успеваемости, индекса проверки и уверенности студентов в системе оценки. Результаты показали, что предложенная технология значительно повышает развитие компетенций, улучшает академическую успеваемость и компетентность, а также повышает доверие к процедурам оценки. Дополнительным результатом стала положительная корреляция между индексом проверки и уровнем владения английским языком. В заключение, предложенная технология служит надежным инструментом измерения результатов и педагогическим механизмом оценки компетенций. Данное исследование способствует разработке прозрачных, проверяемых и профессиональных моделей обучения английскому языку для конкретных технических целей.*

Ключевые слова: *верификация на основе блокчейна, авиационный английский, образование в области технического обслуживания воздушных судов, оценка компетенций, цифровые удостоверения.*

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