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APPLYING THE CAREER-ORIENTED PERSONAL EDUCATIONAL TRAJECTORY IN ENGINEERING EDUCATION ON THE BASIS OF INFORMATION-METHODOLOGICAL SUPPORT

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Abstract. The article presents the results of experimental work conducted at three higher-education institutions with the participation of 460 students to determine the effectiveness of the methodology for forming the personal educational trajectory (PET) of future engineers on the basis of information-methodological support. Using the example of the subject "Database Management Systems," it sets out the assessment matrix broken down by profession (Programmer, Network Administrator, Information Security Specialist), the integration of the Moodle LMS and the "Innovation Navigator" platform, and the results of statistical analysis using Student's t-test.

Keywords: experimental study, personal educational trajectory, Student's t-test, LMS, Innovation Navigator, professional competence, engineering education, effectiveness.

Introduction. To determine the practical effectiveness of the ideas of forming the personal educational trajectory of future engineers on the basis of information-methodological support, a thorough planning and consistent organization of pedagogical experimental work is required [1; 2]. In the field of the individual educational trajectory, B. Bloom proved the effectiveness of individual tutoring within the framework of the "Mastery Learning" concept [3]; J. Anderson created a knowledge-tracing system through cognitive tutors [4]; A. Corbett developed the "Bayesian Knowledge Tracing" (BKT) model [5]; K. VanLehn studied the effectiveness of intelligent tutoring systems using meta-analysis [6]; and R. Baker founded the field of Educational Data Mining [7].

Based on the experience of these scholars and on the model and methodology substantiated in the second chapter, a pedagogical experimental program for the research and a three-stage procedure for its organization were developed.

Experimental Program and Organization. The experimental work was carried out at three higher-education institutions: the Bukhara Institute of Engineering and Technology (250 students), the Andijan Institute of Mechanical Engineering (110 students), and the Karshi Institute of Engineering and Economics (100 students) — a total of 460 students. At each institution, the students were divided into experimental and control groups of equal size. In the experimental group, the "Innovation Navigator" platform and the "Profession Direction" method were applied, while the control group was taught using the traditional method.

The experimental work was carried out in three stages:

First stage — preparing teachers: forming the list of professions, preparing the diagnostic materials (questionnaire, tests, practical tasks), differentiating the subject syllabus by profession, labeling lecture review questions and practical tasks with profession codes, and placing the materials in the LMS on the basis of algorithmic management.

Second stage — preparing students: logging in to the "Innovation Navigator" platform (via HEMIS integration), undergoing the three-category diagnostics of aptitude, foundational knowledge, and interests, and adapting to the profession-based PET on the LMS platforms.

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Third stage — the experimental process: selecting elective subjects during the credit week and forming the primary PET, teaching on the basis of the PET throughout the semester (traditional, independent, and via LMS), and collecting and analyzing the results.

Integration with the LMS. The research applied the four main differentiation mechanisms of the Moodle LMS [8]: Restrict access — conditioning access to an activity on a grade, date, group, or completion of a previous module; Groups/Groupings — dividing students into groups by profession and assigning each a separate task; adaptive Quiz/Lesson — a branched scenario that selects the next page depending on the answer; and flexible assessment (Rubric/Outcomes) — criteria-based and transparent assessment by profession.

Assessment Matrix by Profession. Using the example of the subject "Database Management Systems," a matrix was developed for three professions (Programmer, Network Administrator, Information Security Specialist) that combines four levels (high – 5, medium – 4, lower – 3, low – 2) and four criteria (creative, partially exploratory, reproductive, low). For example, at the "high-creative" level in the "Programmer" profession, the student "independently develops a complex DBMS project: a normalized schema, optimized complex SQL queries, transactions, and indexes"; in the "Network Administrator" profession, at the "high-creative" level, the student "independently configures the DBMS on a network: optimally organizing user roles, a backup strategy, remote connection, and security" [9].

Experimental Results. The results obtained at all three institutions showed the following common trend: in the experimental groups, the number of students who received "high" and "medium" grades increased significantly, the number who received "lower" grades decreased, and the number who received "low" grades dropped to almost zero.

At the Bukhara IET (125/125 students): in the experimental group, "high" grades rose from 17.6% to 28.0% and "medium" grades from 32.0% to 48.8%; "lower" grades fell from 44.0% to 23.2%, and "low" grades dropped from 6.4% to 0%. In the control group, the changes were considerably smaller.

At the Andijan IME (55/55 students): in the experimental group, "high" grades rose from 9.1% to 29.1% and "medium" grades from 29.1% to 54.5%; "lower" grades fell from 56.4% to 16.4%.

At the Karshi IEE (50/50 students): in the experimental group, "high" grades rose from 8.0% to 30.0% and "medium" grades from 32.0% to 56.0%; "lower" grades fell from 56.0% to 14.0%.

Mathematical-Statistical Analysis. The average achievement indicators of the experimental and control groups were analyzed using Student's mathematical-statistical method [10; 11]:

Experimental group mean score: $\bar{x} = (0\times2 + 45\times3 + 119\times4 + 66\times5) / 230 \approx 4.09$

Control group mean score: $\bar{y} = (8\times2 + 104\times3 + 81\times4 + 37\times5) / 230 \approx 3.63$

Effectiveness coefficient: $\eta = \bar{x}/\bar{y} \approx 4.09/3.63 \approx 1.12$ (12%)

Sample variances: $S^{x2} \approx 0.47$; $S^{y2} \approx 0.62$

Standard deviations: $S^{x} \approx 0.68$; $S^{y} \approx 0.78$

Coefficients of variation: $CS^{x} \approx 1.10\%$; $CS^{y} \approx 1.42\%$ ($CS^{x} < CS^{y}$ — the experimental group's results are more precise)

95% confidence interval for the mean: $a^{x} \in [4.00; 4.18]$; $a^{y} \in [3.53; 3.74]$

Observed value of Student's t-test:

$T(\text{observed}) = |3.63 - 4.09| \times \sqrt{[(229\times0.47 + 229\times0.62) \times (230\times230\times458) / (230+230)]} \approx 6.54$

Degrees of freedom: $k = 230 + 230 - 2 = 458$

Table value: $t(0.95; 458) = 1.98$

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Result: 6.54 > 1.98, therefore H_0 is rejected and, with 95% confidence, hypothesis H_1 is accepted — the difference between the achievement indicators of the experimental and control groups is considered statistically significant [10].

Conclusion. The results of the experimental work statistically confirmed the effectiveness of the methodology for forming the PET of future engineers on the basis of information-methodological support. The experimental group achieved an indicator 12% higher than the control group (Student's t-test T = 6.54 > t(crit) = 1.98). At all three institutions, the number of students who received “high” and “medium” grades in the experimental groups increased significantly, and the number who received “low” grades dropped to almost zero. The integration of the “Innovation Navigator” platform and the “Profession Direction” teaching method with the Moodle LMS contributes to effectively forming students' professional competencies, increasing their motivation, and improving the quality of education. In the future, it is planned to extend the experimental work to other subjects and educational fields and to integrate Big Data and deeper AI components into the platform.

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