HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

EFFECTIVENESS OF DIFFERENTIAL-DIAGNOSIS-BASED TRAINING FOR SYMMETRIC ANALYSIS COMPETENCE: A MATHEMATICAL AND STATISTICAL EVALUATION

Abdusalimov Sardorbek Abdullaevich
Fergana Medical Institute of Public Health, Fergana, Uzbekistan
doi:https://doi.org/10.5281/zenodo.24322142

Abstract. This article evaluates the effectiveness of a differential-diagnosis-based methodology for developing symmetric analysis competence among undergraduate medical students. At baseline, experimental and control groups showed virtually identical mean scores across cognitive, analytical-comparative and differential-diagnostic components. At final assessment, experimental-group means reached 3.740, 3.793 and 3.723, compared with 3.299, 3.336 and 3.283 in the control group. Effectiveness coefficients were 1.134, 1.137 and 1.134, respectively, demonstrating a consistent advantage of the intervention.

Keywords: statistical analysis, educational effectiveness, differential diagnosis, clinical reasoning, experimental study, medical education

INTRODUCTION

Demonstrating educational effectiveness requires more than descriptive improvement. Baseline equivalence, post-intervention differences, confidence intervals and component-specific effect indicators must be considered together to determine whether a pedagogical methodology produces a systematic advantage.

Mathematical and statistical analysis of the pedagogical experiment was an essential stage for objectively evaluating the effectiveness of the methodology and pedagogical model developed in the study. The statistical analysis aimed to determine the baseline level of symmetric analysis competence in experimental and control groups, compare changes after the formative intervention, test the statistical significance of observed differences, and evaluate the practical magnitude of the pedagogical effect.

A total of 486 students participated: 242 in experimental groups and 244 in control groups. The experimental sample included 80 students from Andijan State Medical Institute, 81 from Fergana Medical Institute of Public Health, and 81 from Urgench State Medical University; the corresponding control groups included 82, 82, and 80 students. The close similarity in group sizes reduced the risk of substantial numerical imbalance in subsequent comparisons.

In accordance with the methodological framework developed in Chapter II, symmetric analysis competence was evaluated across three components: cognitive, analytical-comparative, and differential-diagnostic. The cognitive component reflected activation of knowledge relevant to the

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

clinical problem, identification of diagnostically important information, and understanding the clinical purpose of investigations. The analytical-comparative component reflected parallel comparison of diagnostic alternatives using common criteria, identification of shared and discriminating features, and evaluation of the diagnostic value of evidence. The differential-diagnostic component reflected prioritization of alternatives, justification of additional investigations, and evidence-based defense of the final clinical decision.

Each component was assessed across ordered competence levels. For statistical aggregation, the dissertation used numerical scores assigned to the ordered categories as an auxiliary integral indicator for describing group distributions on a common scale. These scores were not treated as absolute units of clinical competence, but as a practical means of comparing experimental and control groups.

Because the competence levels are ordinal categories, the analysis was not limited to means alone. Pearson's chi-square test was used to examine the association between competence-level distribution and study group, while the Mann-Whitney U test was considered appropriate for additional analysis of ordered outcomes. This approach preserved the ordinal nature of the categories in the inferential analysis.

MATERIALS AND METHODS

Data from 486 students were analyzed by comparing experimental (n=242) and control (n=244) groups. Mean values, variance, standard deviation, standard error, 95% confidence intervals and effectiveness coefficients were calculated for cognitive, analytical-comparative and differential-diagnostic components. Baseline mean scores were also compared to verify initial group equivalence.

The study population comprised 486 undergraduate General Medicine students from three medical higher education institutions.

RESULTS

Table 1

Final statistical indicators by competence component

Component	Group	Mean	Effectiveness coefficient	Variance	Standard deviation	Standard error	95% confidence interval
Cognitive component	Experimental	3.740	1.134	0.550	0.742	0.048	3.646–3.834
Cognitive component	Control	3.299	1.134	0.474	0.688	0.044	3.212–3.386
Analytical-comparative component	Experimental	3.793	1.137	0.563	0.750	0.048	3.698–3.888

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

Analytical-comparative component	Control	3.336	1.137	0.504	0.710	0.045	3.247–3.426
Differential-diagnostic component	Experimental	3.723	1.134	0.541	0.736	0.047	3.630–3.816
Differential-diagnostic component	Control	3.283	1.134	0.483	0.695	0.045	3.195–3.370

Table 2
Methodological indicators of the pedagogical experiment

Criterion	Group	Mean	Variance	Standard deviation	Standard error	95% confidence interval
Cognitive	Experimental	2.764	0.845	0.919	0.059	2.649–2.880
Cognitive	Control	2.766	0.830	0.911	0.058	2.652–2.881
Analytical-comparative component	Experimental	2.752	0.826	0.909	0.058	2.638–2.867
Analytical-comparative component	Control	2.750	0.855	0.925	0.059	2.634–2.866
Differential-diagnostic component	Experimental	2.719	0.825	0.908	0.058	2.605–2.833
Differential-diagnostic component	Control	2.717	0.804	0.897	0.057	2.605–2.830

Table 3
Methodological indicators of the pedagogical experiment

Criterion	Calculated statistic	Critical value, p=0.05	Statistical conclusion
Cognitive component	0.024	1.96	not rejected

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

Analytical-comparative component	0.024	1.96	not rejected
Differential-diagnostic component	0.024	1.96	not rejected

Table 4
Methodological indicators of the pedagogical experiment

Criterion	Higher education institution	Group	N	High, 5	%	Intermediate, 4	%	Low, 3	%	Lowest, 2	%
Cognitive component	Andijan State Medical Institute	Experimental	80	13	16.3	31	38.8	36	45.0	0	0.0
Cognitive component	Andijan State Medical Institute	Control	82	6	7.3	14	17.1	58	70.7	4	4.9
Cognitive component	Fergana Medical Institute of Public Health	Experimental	81	15	18.5	30	37.0	36	44.4	0	0.0
Cognitive component	Fergana Medical Institute of Public Health	Control	82	7	8.5	15	18.3	56	68.3	4	4.9
Cognitive component	Urgench State Medical University	Experimental	81	15	18.5	32	39.5	34	42.0	0	0.0
Cognitive	Urgench	Control	80	7	8.8	16	20.	53	66.	4	5

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

component	State Medical University						0		3		.0
Cognitive component	Total	Experimental	242	43	17.8	93	38.4	106	43.8	0	0.0
Cognitive component	Total	Control	244	20	8.2	45	18.4	167	68.4	12	4.9
Analytical-comparative component	Andijan State Medical Institute	Experimental	80	15	18.8	31	38.8	34	42.5	0	0.0
Analytical-comparative component	Andijan State Medical Institute	Control	82	7	8.5	15	18.3	56	68.3	4	4.9
Analytical-comparative component	Fergana Medical Institute of Public Health	Experimental	81	16	19.8	33	40.7	32	39.5	0	0.0
Analytical-comparative component	Fergana Medical Institute of Public Health	Control	82	8	9.8	16	19.5	54	65.9	4	4.9
Analytical-comparative component	Urgench State Medical University	Experimental	81	17	21.0	32	39.5	32	39.5	0	0.0
Analytical-comparative component	Urgench State Medical Universit	Control	80	8	10.0	16	20.0	53	66.3	3	3.8

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

	y										
Analytical-comparative component	Total	Experimental	242	48	19.8	96	39.7	98	40.5	0	0.0
Analytical-comparative component	Total	Control	244	23	9.4	47	19.3	163	66.8	11	4.5
Differential-diagnostic component	Andijan State Medical Institute	Experimental	80	14	17.5	30	37.5	36	45.0	0	0.0
Differential-diagnostic component	Andijan State Medical Institute	Control	82	7	8.5	15	18.3	56	68.3	4	4.9
Differential-diagnostic component	Fergana Medical Institute of Public Health	Experimental	81	13	16.0	31	38.3	37	45.7	0	0.0
Differential-diagnostic component	Fergana Medical Institute of Public Health	Control	82	6	7.3	14	17.1	57	69.5	5	6.1
Differential-diagnostic component	Urgench State Medical University	Experimental	81	14	17.3	32	39.5	35	43.2	0	0.0
Differential-diagnostic component	Urgench State Medical University	Control	80	7	8.8	14	17.5	54	67.5	5	6.3

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

Differential-diagnostic component	Total	Experimental	242	41	16.9	93	38.4	108	44.6	0	0.0
Differential-diagnostic component	Total	Control	244	20	8.2	43	17.6	167	68.4	14	5.7

The final-stage data demonstrate positive dynamics across all components of symmetric analysis competence in the experimental groups. Whereas baseline indicators were very similar between experimental and control groups, by the end of the intervention the proportions of students at higher performance levels were substantially greater in the experimental groups across cognitive, analytical-comparative, and differential-diagnostic components. The absence of students at the lowest level in the experimental groups, while such cases remained in the controls, further supports the developmental effect of the pedagogical technology.

Baseline analysis showed that the experimental and control groups were nearly identical in symmetric analysis competence. For the cognitive component, the mean was 2.764 in the experimental group and 2.766 in the control group, an absolute difference of only 0.002 points. This indicates comparable baseline ability to activate clinically relevant knowledge, identify diagnostically important information, and understand the purpose of investigations.

For the analytical-comparative component, the mean was 2.752 in the experimental group and 2.750 in the control group, again a difference of only 0.002 points. Thus, baseline ability to compare diagnostic alternatives under common criteria, identify shared and discriminating findings, and evaluate the relative importance of diagnostic evidence was essentially equivalent between groups.

For the differential-diagnostic component, the mean was 2.719 in the experimental group and 2.717 in the control group. The same 0.002-point difference confirms that the groups were comparable before the intervention in their ability to prioritize diagnostic alternatives, justify additional investigations, and formulate an evidence-based clinical conclusion.

Variance values ranged from 0.804 to 0.855 and standard deviations from 0.897 to 0.925, indicating no marked difference in dispersion between the experimental and control groups. Standard errors of 0.057-0.059 suggest that the sample sizes allowed the group means to be estimated with adequate precision.

The 95% confidence intervals for the experimental and control groups almost completely overlapped for each component. For the cognitive component, the intervals were 2.649-2.880 and 2.652-2.881; for the analytical-comparative component, 2.638-2.867 and 2.634-2.866; and for the

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

differential-diagnostic component, 2.605-2.833 and 2.605-2.830, respectively. This further confirms that there was no practically meaningful baseline difference between groups.

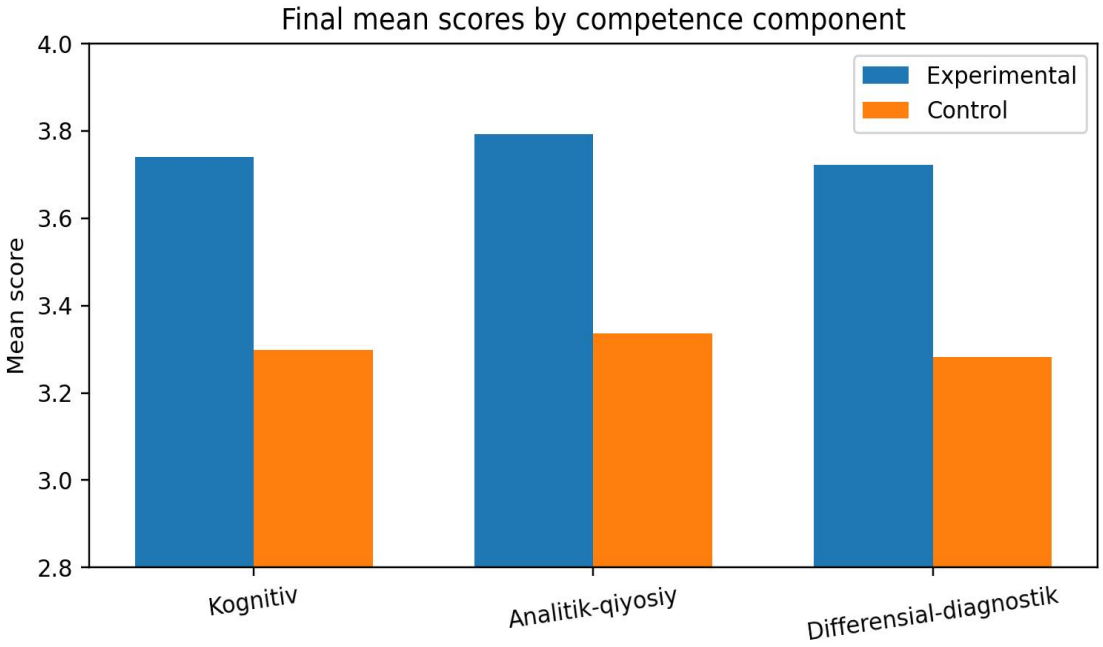


Figure 1. Graphical representation of experimental results.

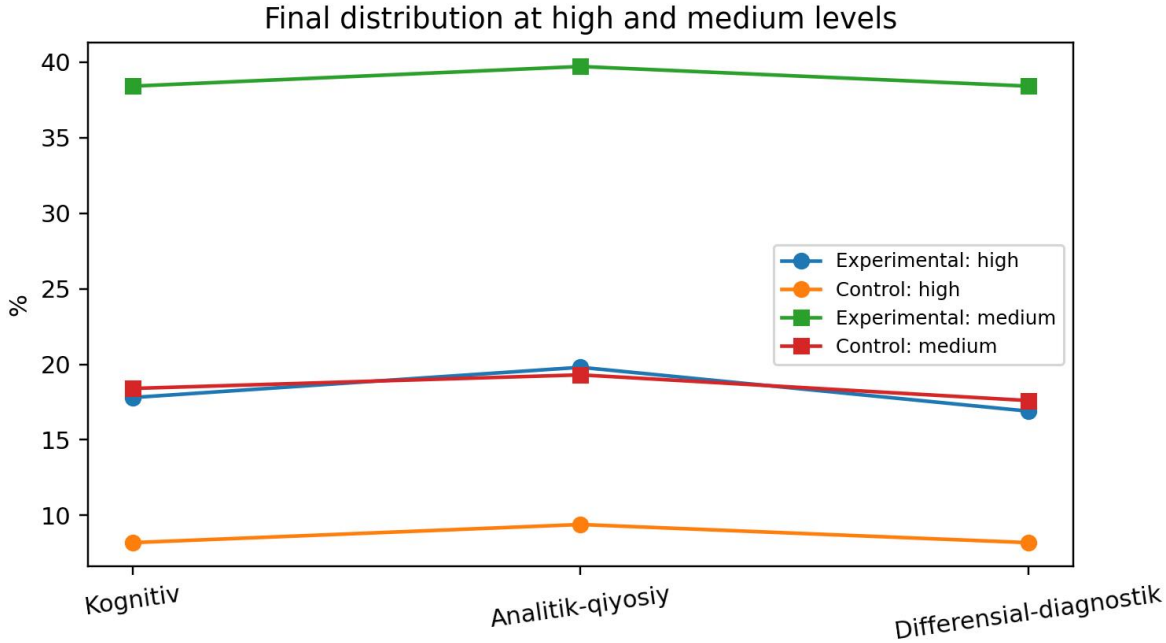


Figure 2. Graphical representation of experimental results.

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

DISCUSSION

At baseline, mean scores were nearly identical: 2.764 vs 2.766 for the cognitive component, 2.752 vs 2.750 for analytical-comparative competence, and 2.719 vs 2.717 for differential-diagnostic competence. After the intervention, the experimental group exceeded the control group across all components. The largest absolute mean difference was observed in the analytical-comparative component (3.793 vs 3.336), consistent with the intervention's emphasis on common criteria, parallel comparison and discriminating evidence. The disappearance of the lowest level in the experimental group at final assessment further supports a meaningful shift in competence distribution.

At the final assessment, the analytical-comparative component had a mean of 3.793 in the experimental group and 3.336 in the control group, an absolute difference of 0.457 points. The effectiveness coefficient was 1.137, the highest among the three components. This pattern is consistent with the intervention's direct emphasis on comparing clinical conditions using common criteria, identifying shared and discriminating findings, and evaluating the diagnostic importance of evidence.

For the differential-diagnostic component, the final mean was 3.723 in the experimental group and 3.283 in the control group. The between-group difference was 0.440 points and the effectiveness coefficient was 1.134. These findings indicate better performance in the experimental group in prioritizing alternatives, considering supporting and opposing evidence, selecting targeted investigations, and justifying the final clinical conclusion.

Variance and standard-deviation values also showed relatively stable distributions around the group means. Standard deviations ranged from 0.736 to 0.750 in the experimental groups and from 0.688 to 0.710 in the control groups. Standard errors were 0.047-0.048 and 0.044-0.045, respectively, indicating adequate precision of the estimated sample means.

Importantly, the 95% confidence intervals no longer overlapped between experimental and control groups at the final assessment. For the cognitive component, the intervals were 3.646-3.834 versus 3.212-3.386; for the analytical-comparative component, 3.698-3.888 versus 3.247-3.426; and for the differential-diagnostic component, 3.630-3.816 versus 3.195-3.370. These results show that the final group differences were not merely descriptive and warranted inferential statistical evaluation.

CONCLUSION

1. Baseline equivalence indicates that post-intervention differences are unlikely to be explained by initial group imbalance.
2. The intervention produced consistent gains across all three competence components, with effectiveness coefficients of approximately 1.13.
3. The strongest advantage was observed in the analytical-comparative component, directly corresponding to the core mechanism of symmetric analysis.

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

REFERENCES

1. Association of American Medical Colleges. Competency-Based Medical Education (CBME). – Washington, DC: AAMC.
2. Association of American Medical Colleges, American Association of Colleges of Osteopathic Medicine, Accreditation Council for Graduate Medical Education. Foundational Competencies for Undergraduate Medical Education. – Washington, DC, 2024.
3. Chamberland M., Mamede S., Bergeron L., Varpio L. A layered analysis of self-explanation and structured reflection to support clinical reasoning in medical students // Perspectives on Medical Education. – 2021. – Vol. 10(3). – P. 171–179.
4. Connor D.M., Durning S.J., Rencic J.J. Clinical Reasoning as a Core Competency // Academic Medicine. – 2020. – Vol. 95(8). – P. 1166–1171.
5. Fernandes R.A.F. et al. Adding guidance to deliberate reflection improves medical student's diagnostic accuracy // Medical Education. – 2021. – Vol. 55(10). – P. 1161–1171.
6. Schuwirth L.W.T., Durning S.J., King S.M. Assessment of clinical reasoning: three evolutions of thought // Diagnosis. – 2020. – Vol. 7(3). – P. 191–196.
7. Si J. Strategies for developing pre-clinical medical students' clinical reasoning based on illness script formation: a systematic review // Korean Journal of Medical Education. – 2022. – Vol. 34(1). – P. 49–61.
8. Torre D.M., Chamberland M., Mamede S. Implementation of three knowledge-oriented instructional strategies to teach clinical reasoning: AMEE Guide No. 150 // Medical Teacher. – 2023. – Vol. 45(7). – P. 676–684.
9. Xu H., Ang B.W.G., Soh J.Y., Ponnamperuma G.G. Methods to Improve Diagnostic Reasoning in Undergraduate Medical Education in the Clinical Setting: a Systematic Review // Journal of General Internal Medicine. – 2021. – Vol. 36(9). – P. 2745–2754.
10. Young M. et al. The terminology of clinical reasoning in health professions education: Implications and considerations // Medical Teacher. – 2019. – Vol. 41(11). – P. 1277–1284.
11. Francis H.W. et al., eds. Cummings Otolaryngology: Head and Neck Surgery. – 8th ed. – Philadelphia: Elsevier, 2025.
12. Dent J., Harden R.M., Hunt D., eds. A Practical Guide for Medical Teachers. – 6th ed. – Edinburgh: Elsevier, 2021.
13. Harden R.M., Laidlaw J.M. Essential Skills for a Medical Teacher. – 2nd ed. – Edinburgh: Elsevier, 2016.
14. Kassirer J.P., Wong J.B., Kopelman R.I. Learning Clinical Reasoning. – 2nd ed. – Philadelphia: Lippincott Williams & Wilkins, 2009.